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User Experience Study of Wearable Devices Among Young People

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Abstract

As the prevalence of wearable devices grows, it is more and more common to apply wearable devices in multiple real-life context. User experience is of great importance in both HCI and non-functional perspectives, especially on wearable device, which is rather intimate with its users and the screen of which is relatively small. This study aims at finding factors of user experience for the development of future wrist-worn wearable devices.

This study is a qualitative study designed to investigate the perspective of user experience towards wearable device among young people, which takes an important part in wearable devices users. Thematic interviews were conducted among young people between 20 to 32 years old, in order to find out their experience with wearable devices, feelings towards wearables, and anticipation towards future wearables. Data collected were analyzed and extracted into codes and categories with content analysis. Interviewees were of both genders in two different country and three different nationality. The results indicated five factors in user experience design of wearable devices.

Keywords

Wearable device, User experience, Young Adults

Supervisor

Tonja Molin-Juustila

Foreword

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1. Introduction

The wearable devices we can see nowadays are the result of involvements for several generations, with high performance of components, power efficiency as well as increasing capability of recognizing different usage scenario (Baker, Hong & Billinghamurst, 2014). Wearable devices are one of the outcomes when “Information Age” reached a certain altitude (Billinghamurst & Starner, 1999). As we are now in the era of information explosion, a more advanced approach of information management is increasingly needed. Previous research showed that wearable devices provide a brand-new way of information management (Billinghamurst & Starner, 1999). Wearables bring several benefits to people’s life, especially the continuous data gathering and timely notification pushing. With wearable devices, the distance between people and technology is closer than ever. (Motti & Caine 2016.) As information and communication technologies (ICT) and wearable devices advance over time, wearable devices, playing roles as health monitor, sport instructor, message pushing, are gradually regarded as “digital jewelery”, a life mate or even part of users’ body, displaying personal taste and uniqueness (Miner, Chan & Campbell, 2001).

Finding a clear definition for wearable device concept is not easy. Several definitions have been provided (Miner, Chan & Campbell, 2001; Tehrani & Michael, 2014; Thierer, 2015). For example, Miner, Chan and Campbell (2001) defined wearable devices as electronic device with jewelry-like appearance, enabling communication service and information change. On the other hand, Thierer (2015) regarded wearable devices as devices for data collection and sports tracking. Therefore, for the purpose of this study, the definition provided by Tehrani and Michael (2014) will be used because the wearable device in their definition are most closed to that in my study. In their definition, wearable devices are electronic devices or micro computers that can be worn on body as accessories or integrated with conventional cloth (Tehrani & Michael, 2014). Smart band/watch, smart glasses, head-mounted display (HMD) etc., are different types of wearable devices (Lv, Feng, Feng, & Li, 2015). In this study, wearable devices, shortened as “wearables”, were the “wearable electronics” mentioned above.

When it comes to the relationship between wearable device and internet of things (IoT), Kumari, López-Benítez, Lee, Kim, & Minhas (2017) concluded that IoT interconnects physical substances through the internet and enables them to collaborate with each other to accomplish certain tasks. Research conducted by Post, Reynolds, Gray, Paradiso and Gershenfeld (1997) put much vision on communication technologies and wearable devices connected to other mobile devices wirelessly, exchanging and sharing data with the internet through modern wireless connection. On the other hand, wearable devices also leverage on IoT. Hiremath, Yang and Mankodiya (2014) indicated that rapidly developing wearable devices sparked a new era of IoT, which is “Wearable IoT” (WIoT). WIoT can be described as technological domain which interconnects sensors in different wearable devices to enable monitoring people’s dynamics including fitness, health status, activities and other data which are useful in promoting user’s life quality. (Hiremath, Yang & Mankodiya, 2014.)

Inspired by Hiremath, Yang and Mankodiya (2014), in which “Wearable Technology” and “Internet of Things” was searched as keywords in Google search trend. Here a similar

search from January 2004 to May 2018 is shown and the keywords are “Wearable device” and “Internet of things”. The result is illustrated in Figure 1. From the graph, it is clear that before around June 2007, the number of searches of the two key words are roughly identical. After 2008, there is growth in the number of searches for “Internet of Things”. Search interest for “Wearable Device” after September of 2013 raised a little while search interest for “Internet of Things” had its even higher growth since then.

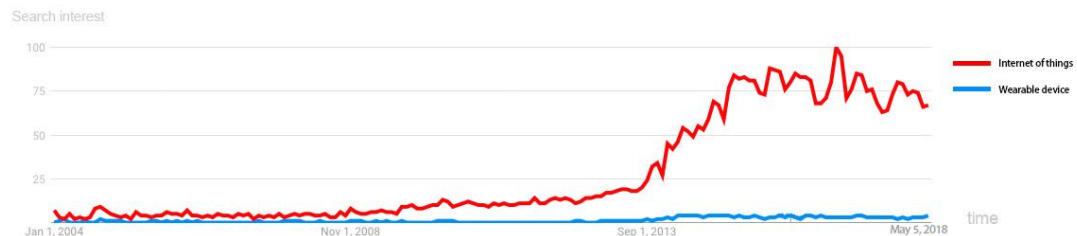


Figure 1. Google search trend 01.01.2004 – 02.05.2018 for keywords — "Wearable Device" and "Internet of Things" (Google Trends, n.d.).

Interaction with wearable devices in specific contexts is also a heated spot for researchers. Previous studies have discovered or developed many interaction modes which could be used in special occasions. One of the findings from previous research is to provide hand-free interaction (Adapa, Nah, Hall, Siau, & Smith, 2018). According to Shirazi and Henze (2015), with its always-on feature, the initial purpose of wearable devices is to provide users with a more efficient way to manage and display concise information to overcome the disruptive nature of information, in other words, the on-the-go experience. One advantage by Rekimoto (2001) is that wearables provide possibilities for users to obtain information by a glance to the wearables without taking out the phone. However, Motti and Caine (2016) also claimed that if the interaction design of wearables cannot keep up with the dynamic change of user’s contexts, it will bring negative user experience. Constant notification can sometimes distract user’s attention, interrupt their normal conversation or meetings, or even makes them annoyed (Shirazi & Henze, 2015).

Based on the findings from related research, and the growing popularity of wearable devices, optimized human-computer interaction makes significant contributions to decent user experience (Motti & Caine, 2016). Knowing how users think about their wearables is one approach to find out the strength and weakness of user experience in current wearables and help to make improvements for future products. However, in the search of articles, there were few research articles related to the user research about the user experience with their wearables, the reason for which might be because of the short history of wearables (McMillan, Brown, Lampinen, McGregor, Hoggan, & Pizza, 2017; Motti & Caine, 2016). “Wearable device” is a relatively new concept, just formed as an emerging sub-discipline of dispersive computing (McMillan, Brown, Lampinen, McGregor, Hoggan, & Pizza, 2017; Motti & Caine, 2016).

The wearable device in my study mainly refers to wrist worn wearables. According to Crawford, Lingel and Karppi (2015) wrist worn wearables are one popular type of wearables in the consumer market. In addition, empirical data shows that wrist worn device is very common among wearable device users. Based on the finding from Motti and Caine (2016), wrist worn wearables can be categorized into three types, in the light of their functionalities: fitness trackers, smartwatches and armbands. Fitness trackers mainly focus on users’ movements and athletic applications. Smartwatch like Apple Watch, are regarded as wrist wearable devices, acting as a complement to smartphones.

Armbands such as Thalmic Myo, are assistance input devices by detecting user gestures. (Motti & Caine, 2016.)

From the articles reviewed, many researchers focus on one or some specific aspects of wearable device, such as wearing behavior, interaction mode, etc., but not the whole user experience of wearables (Jeong, Kim, Kim, Lee & Jeong, 2017; Motti & Caine, 2016). Young people, especially students, account for an important part in the acceptance of using wearable devices (Yang, Yu, Zo & Choi, 2016). In this study, according to UN-Habitat (n.b.), young people are those aged between 15 and 32 years old. As young people has a higher acceptance level for wearables, it is more likely for them to be users of wearable devices. Opinions, or even complaints from young people on current products and their expectation about future products can be representative to the whole industry. Therefore, in order to gain an understanding of the factors influencing user experience of wearable devices, the main research question of this study is:

What makes a good user experience for wearable devices among young people?

The research question is aimed at seeking important factors considering the user experience for future wearable devices, by gathering opinions from young people. There are also two sub-questions which explore the research topic into more detailed aspects:

How users think of the user experience of current wearable devices?

What are their expectations about the experience for products they have not known yet?

The structure of this thesis is organized as follows. Next chapter provides related work on wearable devices and user experience. Chapter 3 explains the research design of this study, which comprises descriptions of the qualitative approach selected for the study and the methods of data collection and analysis used. In chapter 4, findings are extracted from the results and discussed in relation to the related work, some excerpts from the interviews are included as examples. Chapter 5 is the conclusion of the whole study considering also the value for future study and future wearable devices.

2. Related Research

In this section, related work on wearable devices and user experience are introduced as the important background of my study. First, some basic characterization of wearable devices, including brief histories of wearable devices and applications of wearables, are introduced (2.1), presenting previous research on wearable devices and application as well. In addition, the concept and basic elements of user experience will be introduced (2.2). Finally, subsections 2.3 will introduce studies on user experience of wearable devices, including interaction modes of wearables, as which is a significant part of user experience of wearable devices. Research on interaction design of future wearables is also included.

Articles were collected and reviewed through ACM digital library, IEEE Xplore digital library and Google Scholar. “User experience”, “Wearable device” and “Wearable device interaction design” were selected as keywords. Journals and conferences related to user experience of wearable devices in ACM digital library and IEEE Xplore digital library were then searched, key journals and conferences related to wearable devices and user experience such as CHI, MobileCHI, Wearable Computers and International Conference on Pervasive Technologies, were selected as main sources of research articles. Articles in other professional disciplines like medical science were excluded. Besides, reference lists of the articles were checked in order to find more related articles. Finally, 32 articles were found related to user experience of wearable devices or wearable device interaction design.

2.1 Characterizing Wearable devices

Motti and Caine (2016) noticed continuous development in technology has raised the consumerization and usage of wearable devices. They mentioned in their article that the first wearable device was far different from the ones we see in the present days. According to Baker, Hong, & Billingham (2014), the wearable device invented by Ed Thorp and Claude Shannon in 1962, was a machine strap on the wrist and connected to a large box. The device only had one function, to calculate for beating roulette. Now the wearable devices, are of drastic difference with the original one. (Motti & Caine, 2016.)

Rawassizadeh, Price and Petre (2015) identified two major strengths of wearable devices compared with other smart devices, first is their mounted location, as the fixed, known location makes activity recognition easier and more accurate. Another advantage is continuous connection to the skin. Unlike smart phones, usually a wearable device is constantly contacted with the user and is not likely to be put in a bag or on a table. (Rawassizadeh, Price & Petre, 2015.)

In his textbook, Dvorak (2007) pointed out that the technology, or applications in wearables can assist user’s everyday activities. Wearable is available and moves with user all the time since the user wears it on the body. In many personal cases, wearables are integrated seamlessly in daily tasks with compelling applications. Dvorak (2007) allocated the mainstream function of wearable devices into five categories: daily activities, cognitive assistance, task management and planning, health maintenance and support and personal security. (pp. 24-39) He also illustrated five elements of a generic wearable device (see Figure 2), which are, according to him, the basic requirements to

enhance user experience with wearables from function, application and design aspects (Dvorak, 2007, pp. 6-7).

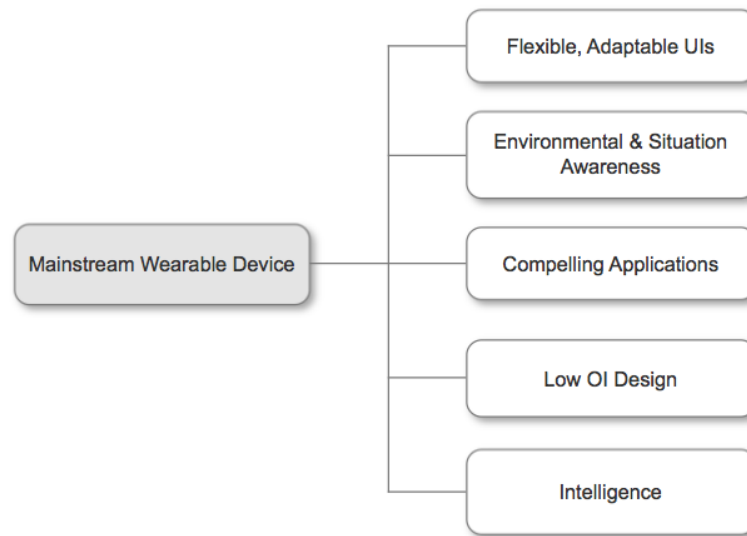


Figure 2. Elements to form a Mainstream Wearable System (Dvorak, 2007).

In Figure 2, Flexible, adaptable user interface proposed requirements on interactions with wearables, as the interface can be diverse and flexible to best support the present situation. Environmental and situation awareness refers to the recognition and reaction to the surroundings to support users' activities. Compelling applications is one of the important requirements as well. Besides, low operational inertia design requires the system is easy to setup, and user will not notice the wearables when they are even wearing them, which is one embodiment of "transparent use". Lastly, intelligence means wearables responds as humans or something in accordance with common sense, nevertheless, it is a challenge to transfer these common sense into codes. As is proposed by Dvorak (2007), application is a "must" to the requirements mentioned above, helping users in daily tasks.

Apart from reminders, Dvorak (2007) found that some wearables with specific sensor and wireless technology can also help users manage their physical assets. The integration of (Radio Frequency IDentification) RFID technology enables wearables to keep track of the physical items, and push notifications when user need to retrieve them or forget to take them. (Dvorak, 2007.) Later in 2015, Schneegass et al. (2015) also mentioned that wearables can collect data of users with its sensors, displaying processed data to users in certain context, providing context-based services or reduce disruption on user's current conversation or other daily activities. Specified by Dvorak (2007), by monitoring user's activities or the operations on wearables, the device can do some assistance by providing certain information or even help to do determination.

Cognitive assistance is one of the embodiments of contextual awareness. One example given by Dvorak's (2007) is flight boarding pass. With the integration of situational context elements, wearable devices are able to show information of the upcoming flight and set reminders for user to choose the seat by retrieving data from the cloud server. Difference to traditional reminders, context-based reminders can be triggered by specific information such as location, traffic or weather conditions, or the upcoming of specific tasks. (Dvorak, 2007.) Furthermore, Thomas (2012) proposed that context awareness has been developing drastically since the emergence of wearable devices, from location-based information presentation, to activity recognition using machine learning.

According to Dvorak (2007), using planning technologies like goal planning, wearables can plan schedules such as driving routines for users. If the wearable is able to get access to user's car by certain interface, it can even trigger some functions of the car, such as turn on the audio system. With the integration of location-based service, wearables can push ads which match user's interest profile. The article by Starner (2014) also discussed about this. With the increasing accuracy of GPS, not only turn-by-turn navigation is made possible, the indoor navigation and location-based service is the next focusing point. He also pointed out the benefit that wireless technology brings to wearable devices. The widely-adopted Bluetooth Low Energy (BLE) technology enables wearables to have a body-centered wireless network, reducing the latency and the data generated by cloud computing can be displayed effectively in wearables. (Starner, 2014.)

Caon et al. (2015) discussed about the development of micro-sensors, for example the development of low-powered micro-sensors and data fusion allows wearables detect body data and exercise status. Using built-in sensors such as gyroscope and GPS chips, wearable devices can detect and recognize user's status, whether (s)he is sitting or jogging, playing a role as their personal virtual fitness trainer or health monitor. (Caon et al., 2015.) Similarly, Dvorak (2007) figured out that after the analysis of data on the cloud server or in local device, wearable systems can give user some advice or warning to anomalous readings.

Based on the findings from Dvorak (2007), many people choose wearable devices as a personal coach because they believe wearables can give them motivation for regular exercise. Sensors in wearable devices can monitor user's heart rate, blood pressure and other body index. During the workout, wearable devices can keep track of the body index as well as user's progress and compare the progress with previously set goal to motivate user for further exercise. If abnormal body index is detected, wearables can display warnings to user or send a notification to the doctor if possible. (Dvorak, 2007, pp.35-36)

2.2 User experience

User experience is the comprehensive outcome of interaction with interactive devices, not only paying attention on the present products in use, but also on the expectation of the products which have not appeared in the market or not known by consumers (Hassenzahl and Tractinsky, 2006). In regards of the factors influencing the user experience, Hassenzahl and Tractinsky (2006) also pointed out that context of use was very important. Bargas and Hornbæk (2011) held the similar idea. They pointed out that one key area of user experience research lies in the dynamics of experience, and research interest often falls on the relationship of interactive products, personality of the user and usage scenario, these three elements are the key factors comprising user experience. Among the studies which focus on user experience, Hassenzahl and Tractinsky (2006) analysed previous studies and concluded three major aspects of user experience, which are referred by many following studies: non-instrumental aspect, emotion and affect aspect and experiential aspect (Figure 3). The quality of products need to be enhanced in design phase, to better understand and address the hedonic needs of users. As for emotion and affect, Hassenzahl and Tractinsky (2006) mentioned the relationship between user experience and emotions. They think that technology is aimed at creating positive emotions. What makes the continuous evolution of HCI is the goal to eliminate the dissatisfaction occurred during the interaction and enhance the pleasure and other positive emotions, dispelling obstacles that cause usability issues or decrease the efficiency. Experiential aspect considers the interrelationship of all the elements from the product itself to the perspective of users. Experience stress the significance of particular situations, whereas the complexity of

situations brings challenge to the design of user experience. (Hassenzahl & Tractinsky, 2006.)

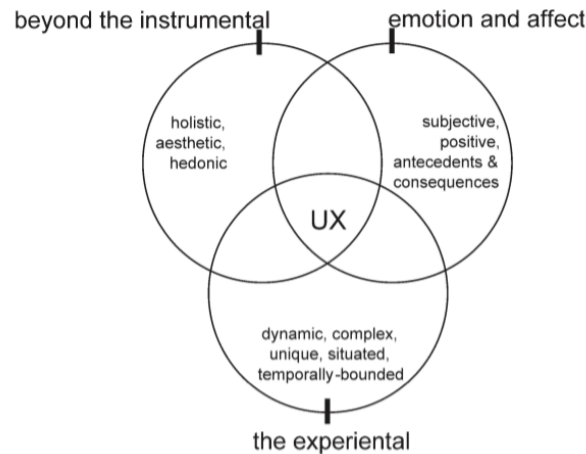


Figure 3. Three major aspects of user experience (Hassenzahl & Tractinsky, 2006).

Hassenzahl and Tractinsky (2006) mentioned that in the research orientation of HCI and usability, besides practical perspective of the product, it is also important to take account of the hedonic perspective, which includes self-expression, memories, personal development, etc. This model combines interactive product with its extra values. The extra value of interactive products is to bring sense of satisfactory to users' potential need by creating stimulation. To realize the extra value, the design of the product brings the meaning to it. (Hassenzahl & Tractinsky, 2006.) Rajanen et al. (2017) pointed out that user experience design needs to meet users' requirements. Similarly, in user experience design of wearable devices, Motti and Caine (2016) indicated that it is important to study and understand how user work with their wearable devices, how user feel about their devices and their expectations for future products. These understandings of user experience were mainly from user's feedback and other research. In addition, they also pointed out that many design issues with wearable devices attributed to the lack of user participation, and the studies with user participation are limited in the number. (Motti & Caine, 2016.)

As a summary of this part, Table 1 shows the important elements in user experience study. First the three facets of user experience form the theoretical basis of user experience study, which pointed out the research direction for user experience studies. The context of use combines many elements from environment to the device itself and to users. Feedback from user study provides resources and motivations to improve the design of user experience.

Table 1. Summary of elements in user experience study.

User experience
Facets of user experience
Context of use
User feedback

In the next section, previous research about user experience on wearables specifically will be introduced.

2.3 User experience research on wearable devices

Pasi (2016) introduced that as a type of system, the basic structure of wearable device is no difference with other systems, it also has its input and output. Wearable device, with its special appearance and volume, needs dedicated interaction modes. Rekimoto (2001) introduced two types of input methods on wearable devices: manual input and contextual-awareness-based sensing. Manual input means user input commands with diversified input approaches. Contextual-awareness-based sensing is, for example, location-based information promotion. As for the output, wearables respond to user's command with either visual, tactile or acoustic feedback. (Rekimoto, 2001.)

According to Chatterjee and Matsuno (2008), touch screen was considered a physical input method which can implement most of the basic user actions. They indicated that the screen, especially touch screen, is more competitive in weight, volume, cost and flexible adaptation to software when compared with other interaction approaches. Previously, the research conducted by Rekimoto (2001) showed that most of the wearable devices were equipped with screen that was very tiny. Thus, the time period of notification displayed on the screen as well as the text fonts are rather significant factors for interaction design. (Rekimoto, 2001.)

Lyons, Nguyen, Ashbrook and White (2012) also did some research on the input method on touch screens, but they mainly focus on the multi-screen interaction design on wearables, which expands the traditional tactile interaction into multi-segment touch. GestureWrist, a wristwatch input device developed by Rekimoto et. al. (2001), is an example of hands-free operations as well as non-obtrusive design. The embedded acceleration sensor can recognize different human hand gestures and give corresponding reactions. They also expect that this technology can motivate other wearable devices such as smartglass, bringing enriched user experience. (Rekimoto et al., 2001.) Bieber, Kirste and Urban (2012) also held a similar idea, they pointed out that wrist device with simple acceleration sensor can realize gesture recognition. An example given in their study is the maintenance workers, whose hands are both occupied and touching interaction techniques can be disturbing or even cause negative effects. In this case, researchers suggested that using gestures to interact is a better substitute. (Bieber, Kirste and Urban, 2012.)

Motti and Caine (2016) pointed out that the wearable devices, as they might be interrupted by ambient environment, must have its awareness to the changes in users' contexts. Appropriate interpretations of contextual information are not only beneficial for improving interaction design, but also fosters better user experience, wider user acceptance and engagement. (Motti & Caine, 2016) Bieber, Kirste and Urban (2012) concluded how the built-in sensors realize context awareness and ambient interaction. Wearable devices analyse information from data collected by sensors, other devices or user input, and present personalized information to user. The personalized information can be related to current workflow or about the prediction of some future tasks. (Bieber, Kirste and Urban, 2012.) One key factor of understanding contextual information is to investigate and learn user's behaviors and habits in depth. Motti and Caine (2016) conducted a user study of ten wrist wearables, collecting user's comments on Amazon.com about their feedback on interaction and user experience. According to the results, one key factor causing the interaction issue is the lack of contextual sensitivity. (Motti & Caine, 2016.)

Similarly, Gilpin (2014) had a positive attitude towards contextual computing, saying that the massive information gathered by wearable applications can anticipate user's future

need and provide better service in the future. Also, Dvorak (2007) introduced more than ten years ago that wearable devices was a system to prevent users from danger or provide information to minimize the effect of danger. By analyzing contextual information, wearables are able to know the location and other ambient situation, to identify whether user came into any danger. If the analysis indicates potential danger, user's location and estimate time of arrival will be automatically sent to a "trusted person". (Dvorak, 2007. pp. 37-38)

In his textbook, Dvorak (2007) claims that wearable devices assist users with their task at hand. One of the most frequently used function of wearables is reminders. As wearables are always on user's body, it is easy and convenient to utilize alarms or reminders on wearables. (Dvorak, 2007, p.25) Earlier in 2001, Miner, Chan, and Campbell (2001) pointed out that, owing to the always-on feature of wearable devices, users tend to wear them all the time, with their access "anytime and anywhere". Hence, in the design of wearable devices, it is far from enough only to consider the "functionality", users' daily life and social needs also matters. (Miner, Chan & Campbell, 2001.)

The user study by Schlögl, Buricic and Pycha (2015) pointed out that, it is very often that users feel it hard to find a function even though the function is designed well in the appropriate place. It is because the navigation mechanism is contradictory or the instructive terminology is somehow misleading or confusing. The ambiguities in the menu items also cause confusion for users, as is reported by participant in their study. (Schlögl, Buricic & Pycha, 2015.)

As for interaction design, Kim, Mansour and Lundell (2016) suggested to design interaction modes in real life scenario and to consider users' emotional requirements. The research conducted by their group is related to developing consumer-faced wearables. Some of these devices are as elaborate as traditional watches. Their research found the importance of understanding the usage in real life scenario. They did an on-the-spot investigation and found that apart from these basic interaction modes, realistic demands and aesthetic needs also require better user experience design. Hence, they stressed the importance of providing consistent experience as users' traditional accessories to satisfy their emotional needs as wearable smart jewellery. (Kim, Mansour & Lundell, 2016.)

Many researchers mentioned one design concept, unobtrusive or non-obtrusive interaction design. As Rekimoto (2001) proposed, wearables need to be as unobtrusive as possible, not to impede users' normal activities, since users wear them every day. Additionally, Motti and Caine (2016) concluded that wearables with unobtrusive design can be used in wider circumstances such as social contexts.

By analysing the feedback in the website, Motti and Caine (2016) found out that the interaction problems proposed by users can be grouped into three categories: environment issues, which means the lack of recognition and adaptation of different using context; user-related issues, which comprise high learning cost and the loss of customization; interaction issues, including input/output difficulties, synchronization issues etc. Schlögl, Buricic and Pycha (2015) hold the similar idea, and they also pointed out that short battery life is one of the factors leading to a dissatisfactory user experience.

In this chapter, related work on wearable devices and user experience design was introduced. Previous studies focus on interaction issues and performance of current wearable devices. As for future wearable devices, unobtrusive interactive design, including context awareness, were the main research topic in the articles reviewed. In next chapter, research design of my study will be introduced.

3. Research Design

In this chapter, the methodology utilized in the study will be introduced. In this study, qualitative approach was applied as the research methodology (3.1); 3.2 will introduce thematic interview used in this study for data collection; content analysis approach used to process and analyze data captured will be introduced in 3.3.

3.1 Qualitative approach

In this study, to answer the research questions, qualitative approach has been followed. According to Hoepfl (1997), qualitative research is a research method which introduces naturalistic approach to explain particular phenomenon in certain contexts. One characteristic of qualitative research is that it takes account of social influence, which is regarded as constantly changing and dynamic in quality. User experience derives from the experience of specific things from participants. (Hoepfl, 1997.) From the experience they shared, various detail and perceptions are included, which is meaningful to my research.

Hoepfl (1997) extracted from previous articles and concluded the main characteristics of qualitative research. Firstly, he pointed out that the design of qualitative research framework is not always predetermined, in the process and the outcomes of the research, researchers follow its emergent design. By preserving the dataset in its original form, qualitative researchers make observation, reflect and interpret the data they collected. In the process of data collection, researcher plays a role as “human instrument” since qualitative data cannot be presented statistically. Instead of presenting plain data and statistics, qualitative research describes and concludes words and text, and sometimes even expressive language if necessary. (Hoepfl, 1997.) He pointed out the interpretive nature lies in qualitative research, doing qualitative research is the discovering process of the experience from individuals, finding out the meaning behind them, by making interpretations. Qualitative research mainly interprets the experience from individuals to find out the meaning and connections behind them. Apart from finding out the common similarity of the cases, qualitative research also pays attention to the exceptionality of each instance. Induction is a widely-used methodology in qualitative data analysis. Lastly, the evaluation criteria about the trustworthiness of qualitative research are quite different from other research methodologies, due to its special characteristics. He also reminds us that compared with statistical research, qualitative research takes more consideration of social contexts where the influence of interaction takes place. (Hoepfl, 1997.) In this study, user’s opinions, including their experience and feelings about wearable devices, are derived from conversations, which are combined with observation during thematic interviews. Content of interviews were transcribed into texts, and potential emotions behind the words were interpreted through the analysis of the transcriptions. Through sharing of user’s experience of wearable device, it is better to gain understanding of their feelings and opinions towards their devices and other products.

3.2 Thematic interviews

Schostak (2005) mentioned a theory saying that the best way to understand people’s activity is to ask them directly. Interview is an activity where participants focus on

leading attentions of each other to enlarge the vision into various area, such as behavior, interests, knowledge, mindset, and values. (Schostak, 2005.)

According to Brenner (1985), there are three basic components in an interview: information, informants and interviewers. There are five factors forming a certain interview: scale, which depends on the number of interviewees; scope, referring to the focusing area of the interview; time, the duration of an interview; interpretive schemes, which means whether the interview is univariate or multivariate; format, which means whether the interview uses open or closed questions, whether it is a structured interview, unstructured interview or a semi-structured interview. (Brenner, 1985.) In my study, there were totally eight interviews, the scope of my study is to look into people's feeling about using wearable devices by having conversations with interviewees, listening to their stories about their wearables devices, their preference and dissatisfaction with the product. Each interview lasted from 30 to 45 minutes. The interview was multivariate, which means, according to Olkin and Sampson (2001), observing more than one variables in one study. During the interview, experience, emotion and expectations were the main variables observed. Semi-structured interview was the main form of interview applied, and interviews were conducted one to one. As one interviewee was a young person who did not have wearable devices in the past or at present, some of the questions prepared beforehand was not suitable for all the interviewees.

Every interview is regarded as a project, whereas the aim of the project, whatever real or imaginary, is explored by interviewees (Schostak, 2005). As Brenner (1985) mentioned, in the interview, whatever the actual way of interaction is, people are gathered and through the interaction, someone can learn things from others. The basic form of interviews is conversations, and there are other types of interviews as well. Interviews, especially face-to-face interviews, provide a direct access to information and a decent speed of receiving responses which cannot be realized in any other methodologies. Compared with survey-based research methodologies such as questionnaires, interviews can collect more extensive data of interviewees, bringing more validity and reliability for data collection and analysis. In the process of conversation, after the exchange of ideas, both interviewers and interviewees can gain an understanding of the questions and answers at a deeper level. (Brenner, 1985.)

An interview is more an encounter rather than a tool, it is not always objective or rational, it just provides an incomplete view of certain things. A normal interview often starts with regular or prepared questions, then it turns into something much more like a discussion among participants. (Schostak, 2005.) It is the discussion that enables participants an easier way to share knowledge and feelings. If the interview is designed as an open-ended interview, participants can share more detailed information, and the stories of interviewees do not have to be limited by the interview question. Interviewer can ask further questions to get detailed information or change the direction of interview. (Turner, 2010.) The reason why interview was chosen as the main approach of data collection lies in its characteristic of having deeper information exchange. In regard of my study, the extensive data includes their health information, living habits, which can be collected through conversations. The aim of collecting these extensive data was to looking for potential connection between interviewees' experience as well as expectation and their lifestyle or occupation, in other words, to find potential answers to the research questions with these extensive data. Through interviews, opinions from interviewees can be better expressed, especially when given a certain theme or topic.

The major way of choosing interviewees in this study was based on the "snowball sampling" method, or "referral sampling", which claims a method that new potential

research subjects are the acquaintances recommended by previous participants who share the same properties for the research interest, the referral chain established by the first group of interviewees. Due to the limited access to research subjects, it is difficult to locate the study sample, young people who have wearable device. If new interviewees are recommended by the existing interviewees, it reduces the degree of difficulty for data collection, increasing the efficiency of finding appropriate interviewees (Biernacki & Waldorf, 1981).

With the global expansion of Internet, more and more social research has adopted Internet as its research medium. Internet is becoming an innovative approach to researchers to investigate human communications and experiences (James & Busher, 2012). The Internet changed the context where research can be conducted, with the introduction of Internet, the research design and methods can nowadays be more flexible in comparison with the conventional ones, breaking the restriction of time and space. There is an increasing popularity in academic communities to use online interviews as the source of data collection. Conventional face-to-face interviews are being adapted and transferred to online environment. (James & Busher, 2012.)

Interviews through Internet can be roughly sorted into two types: synchronous interview and asynchronous interview. Online interviews enable visual discussion on-to-one or in groups. Asynchronous approaches such as e-mail can help researchers gather textual data which does not need to transcribe the conversation. (James & Busher, 2012.) Due to the time difference and other factors, internet interview is very useful for data collection from users located in different countries (Kazmer & Xie, 2008). Another advantage of internet interview is the concealing contexts of online discussions. Online conversations provide instant and flexible forms which shorten the psychological distance between both parties in the interview and increase their sense of involvement. The anonymity of internet makes it easier for participants to share their stories. (James & Busher, 2012.)

In this study, two interviews were conducted through Internet. Interview 7 was done through WeChat Audio, an online instant message App, and interview 8 was conducted through Skype video call, as I was in China at that time period. The time zone difference in the interview scheduling has to be taken into account, as some interviewees were not living in Finland, i.e. China and other countries. The asynchronicity of internet interview provides an appropriate solution to this issue. Besides, online conversation brings more freedom and confidence to participants, both wearable device users and other young people, who are not willing to express or too shy to share their feelings about wearable devices in face-to-face conversations. Since online conversation can provide the similar function as face-to-face interviews, sometimes even more effective than conventional ones, both internet interview and conventional ones are utilized in my study.

Table 2 shows basic information of all the interviewees, including their age, gender, nationality, country of residence and interview method. Nationality were related to culture background, country of residence represents context of use, which would possibly become the internal factors affecting user experience. Interview 7 and 8 were conducted through Internet, as I was in China at that time period. Interviewees were encouraged to share their experience openly and honestly.

Table 2. Basic information of interviewees.

Number	Age	Gender	Nationality	Country of Residence	Interview Method
1	20	Male	Finland	Finland	Face to Face
2	21	Female	Finland	Finland	Face to Face
3	22	Male	Vietnam	Finland	Face to Face
4	24	Male	China	Finland	Face to Face
5	21	Female	Finland	Finland	Face to Face
6	21	Male	China	China	Face to Face
7	23	Female	China	Finland	Internet
8	32	Female	Finland	Finland	Internet

According to Arhippainen (2009), what an interviewer does to understand the feeling of interviewee is to be a good listener, making interpretations of what interviewees say and try to fully understand them by speculating what they were thinking. Sanders (2002) explained that implicit knowledge, such as the change of emotions and psychological states in the course of using wearable devices, is not easy or impossible to express through words, empathy can help gain a better understanding of the tacit experience from interviewees. (Sanders 2002.) In this study, in order to know user experience of wearable devices, it was significant to capture explicit experiences and feelings from their utterance.

DiCicco-Bloom and Crabtree (2006) pointed out the importance of considering ethical issues in the interview. First is to decrease the risk of unforeseen harm and to protect the privacy, such as the information of interviewees. With the declaration of ethical issues, it is much easier to explain the original idea of the study to interviewees. The risk usually lies in the unpredictable process when interviewees mention their personal information and interviewer report the information to the interviewee. Lastly, with consideration of ethical issues, the risk of using data in the research is decreased as well. (DiCicco-Bloom & Crabtree, 2006.) Just as Chadwick (2001) pointed out, for individuals, ethical risks existing in any kind of research. James and Busher (2012) held the similar idea, they indicated that researchers need to make sure that the information of research participants is well-protected, so that the research benefits are not gained at the expense of participants' engagement. Thus, it is important to get the consent from interviewees when they took part in the interview, clarifying that the participation is voluntary, and they can quit the interview at any time if they want to. (James & Busher, 2012.)

The most important thing about ethical issues throughout the whole interview is the protection of interviewee's anonymity. When the information is shared by some reason, any information related to the interviewee must remain anonymous. Last but not the least, researchers are not allowed to use interviewees for their private interests. (James & Busher, 2012.) Additionally, DiCicco-Bloom and Crabtree (2006) indicated that

researchers need to provide psychological support to their interviewees in the case that interviewees come into any psychological problems during the interview. In my interview, empathy is needed to arouse sympathy with interviewees, which facilitates interviewees to share their stories and feelings, and also helps to gain more understanding of their emotions.

In my study, the design of interview questions was categorized in three themes (Appendix A): the experience towards wearable devices (if the interviewee has the experience of using wearables), the feeling of wearables, and interviewee's expectation of future products. Although some questions in these three categories were prepared beforehand, the follow-up questions were further than the prepared ones, depending on the answers of interviewees. Before interviews started, a consent form (Appendix B) was delivered to the interviewees, claiming that their personal information and the content of the interview will be strictly protected, and the goal of the research was explained to them as well. The consent form was referred from two templates: interview consent form template from school of geosciences, University of Edinburgh, and interview consent form template from Stanford University (School of GeoSciences – Ethics Committee, 2013; Consent for Participation in Interview Research, n.d.)

Interviewees were asked to write down their contact information in case there are supplement questions after the interview. The whole interview was audio-recorded and transcriptions were done after interview. Among eight interviews, four interviews were conducted in Chinese, and the rest were in English. I translated the Chinese interviews into English when doing transcriptions. Next, three interview themes will be introduced in more detail.

Theme 1 Experience towards wearable devices

Experience only comes from the person who went through a certain event in the flesh (Sanders, 2001). From user experience perspective, this study aims to explore factors for creating positive emotions when users were using a wearable device. In this section, after interviewees shared their basic information, such as age, occupation and hobbies, questions related to user's experience of wearable devices were asked. User experience derives from using the device in different context and situation, hence, in this part of interview, usage scenario of wearable devices is one of the focusing point.

As is shown in table 3, among eight interviewees, as one interviewee did not have any wearable devices (interview 4), the aim of doing which is to see the impact of wearable devices on users and their expectations, also the reason of why interviewees did not use wearable devices. The rest columns of the table will be introduced later.

Table 3. Detailed information of interviews

Number of Interview	Did they have wearable devices?	Emocards showed?	Description text showed?	Video first or questions first?
1	Yes	Yes	Yes	Videos
2	Yes	Yes	Yes	Videos
3	Yes	Yes	No	Questions
4	No	No	No	Questions
5	Yes	Yes	No	Questions
6	Yes	No	No	Videos
7	Yes	Yes	Yes	Questions
8	Yes	No	No	Questions

Theme 2 Feelings towards wearable devices

As Arhippainen (2009) concluded, in research related to user experience, one essential focusing point is emotional approach, since people's emotional expression can have drastic change in a very short time period. To explore emotion states and emotion changes in human-computer interaction, attentions need to be paid on the emotions at a specific moment either during the use of the product or after use. (Arhippainen, 2009) As for feeling of wearables, which comprises both physical feelings (hot, cold, pain, etc.) and emotional feelings. Apart from feeling about features and functions, attentions are also paid in interviewee's personal taste and the emotion brought by wearable device, which are so-called "non-instrumental" functions of the wearables. In this part of the interview, Emocards were applied to measure users' emotions regarding to their experience regarding wearable devices. In order to visualize and express users' emotion, especially subtle feelings, Desmet, Overbeeke and Tax (2001) proposed Emocards to help users describe their emotional responds in an intuitive and systematic way.

As is showed in Figure 4 (Desmet, Overbeeke and Tax, 2001), Emocards consists of eight emotional expressions for both male and female. These emotions derive from two basic dimensions of emotion, 'pleasantness' and 'arousal', and the emotions displayed above are in different degrees of emotions in 'pleasantness' and 'arousal'. For instance, high level of arousal emotions include excitement, low level of arousal emotions include calm. The extent of pleasant varies from very pleasant to very unpleasant. Emotions related to excitement are placed in the upper side of the graph while calm emotions, which has lower level of arousal, are placed in the lower side of the graph. And the emotions of average level are put in the middle. Horizontally, emotions from left to right in the graph changes from unpleasant to pleasant. During the conversation about user experience, users can use Emocards to describe their emotional responses. By choosing one card which best

describes user's emotional response or arranging the cards in the order of relevance. As a consequence, the Emocards play a role to visualize the abstract concept of emotion. (Desmet, Overbeeke and Tax, 2001.)

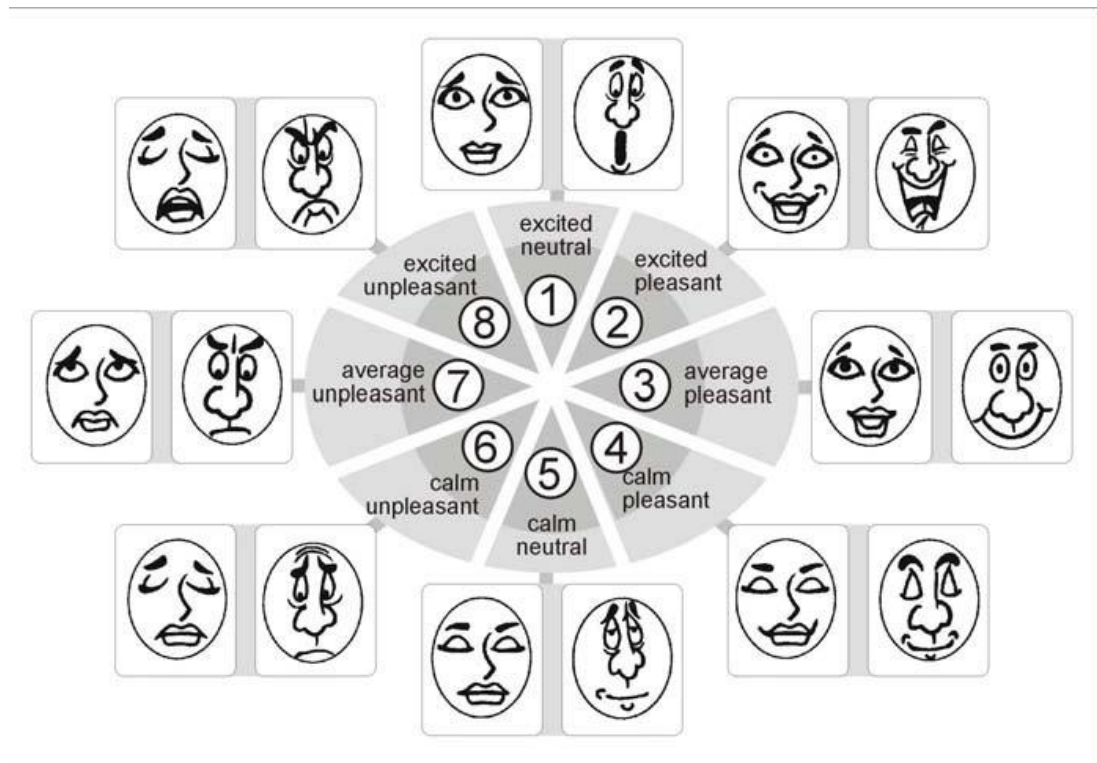


Figure 4. Emotional categories and Emocards (Desmet, Overbeeke and Tax, 2001)

In this study, participants were introduced with basic information of Emocards. Questions concerning the overall attitudes of their wearable devices, sense of achievement, the feeling of meeting with problems and the feeling of losing devices. There were on concrete cards printed for this interview. Instead, Figure 4 was shown to the interviewees with or without the text, interviewees are able describe their emotions by pointing an emotion which they think that matches their emotion the most. Before doing interviews, two pilot interviews were done in advance. In the first pilot, interviewee was given the picture of Emocards without the description text, the interviewee did not understand the meaning of the picture very much. In the second pilot, Emocards were shown with description text, interviewee still showed confusion about the meaning of the pictures. Consequently, in formal interviews, some interviewees were shown Emocards with description text while some were not. In contrast, in order to study the impact of Emocards on emotion measurement, some interviewees were not shown Emocards during the whole interview. In this study, as was shown in table 3 (columns 3 and 4), interviewee 1, 2, 3, 5, 7 were shown with Emocards and while in three of them (interviews 1, 2, 7), Emocards were marked with description text and in two of them (interview 3 and 5), Emocards were shown without description text. In chapter 4, results of the emotions selected by interviewees will be shown.

Theme 3 Expectations towards future devices

According to Arhippainen (2009), user expectations have strong influence on user experience, and this influence differs on each individual. Therefore, it is an important factor which must be considered in user-centred interaction design or user experience evaluation. If one person has some experience on similar situations, the expectation can

become more reasonable and practical. To be more specific, expectation has two impacts on user experience, it changes people's perception and reaction to a specific product. These impacts become apparent when user comes into problems in using the product. In most cases, identical to our cognition, negative expectations tend to have stronger effects on user experience compared with positive or neutral expectations. Therefore, to understand expectations before and during an interaction event does great help to user experience studies. (Arhippainen, 2009.)

At the third theme in the interviews, interviewees were shown two videos from the Internet, which showed the novel or conceptual wearable devices. The first video "Future Wearable Devices" showed some picture slides of future concepts of wearable devices such as smart glasses, artificial limb, brainwave detector (G-QUBE Tweak, 2017). The second video "5 Amazing Wearable Tech Inventions" introduced five novel wearable devices: Tap, Vufine, BioRing, HELIX and The Basslet (4TechHD, 2016). Tap is a device with which users can wear it on the fingers and type on any surface. Vufine is a mobile display and users can place it on eyeglasses with built-in magnetic. BioRing is a smart ring which enables user to check their nutrition intake and adjust diet according to the suggestions by BioRing. HELIX works as a foldable Bluetooth earphone. And Basslet, which is a wrist-worn device creating live effect to music by making vibration. Apart from videos, some questions about expectations on future wearable devices were asked.

During pilot interviews, one thing was noticed that there were some differences of whether to ask questions before or after the videos, as videos somehow had influences on how interviewees answered the questions. Interviewees tended to talk about their expectations based on the content of the videos if they watched video before they were asked questions. As a consequence, in formal interviews, some interviewees were shown the videos before questions while some were asked questions first. The last column of table 3 introduces whether questions were asked first or videos showed first in each interview. In interview 1, 2, 6, videos were shown before asking questions, for the rest of the interviews, questions were asked first (table 3).

3.3 Analysis of the data

The analysis of the interview transcriptions is explained in this section. The main methodology of data analysis adopted in this study is data-driven content analysis. Hsieh and Shannon (2005) concluded that content analysis is a very common approach to analyze texts in qualitative research, providing various type of analysis processes.

As content analysis is flexible in its form, Hsieh and Shannon (2005) pointed out three major forms: conventional content analysis, directed analysis and summative. In this study, conventional content analysis and summative content analysis were used as the explicit approach of analysis, as the analysis process in this study starts with interviews (observation), and codes are generated during data analysis. According to Hsieh and Shannon (2005), direct analysis requires a theory as prerequisite. Since this study is a data-driven study, direct analysis was not used in this study. Hsieh and Shannon (2005) also pointed out that conventional content analysis is often used as a tool to explain certain phenomenon, in which data will be read from the beginning to the end, and then codes are generated based on the information in the data. Unlike other content analysis methodologies, summative content analysis focuses on quantifying the frequency of certain words appearing in the data, which helps with latent content analysis. By exploring the meaning behind the word, summative content analysis makes interpretations of the data. (Hsieh & Shannon, 2005.)

As is introduced by Saldaña (2009), coding is the first step summarizing and condensing the core content of data. After coding, the raw data is resolved into small fragment and fragments are deciphered with short conclusion, which is the basis of deeper data analysis. During coding, characteristics of the data were found out, and categorization is the step that groups the coded data with similar characteristic into certain categories. Categories are then compared and refined with the sample data. After second cycle of coding and categorization, which is called recoding and recategorization, the outcome proposition is generated according to the relationships displayed by the categories. Generally speaking, content analysis is the disassembly and assembly of the data collected. (Saldaña, 2009.) In this study, instead of generating theories, the main focusing point is to finding out factors influencing user experience. Thus, generating categories is the final step of data analysis in this study. The categories extracted from codes derive from characteristics of the data itself. The aim of generating codes and categorizing is to reach a higher level of knowledge that suits more general situations, such as explaining more complex phenomenon (Hsieh & Shannon, 2005).

Figure 5 illustrates the process of generating codes to drawing conclusions of this study. Codes, from the left side, are derived from trimmed data, then the codes are compared and assembled into categories. Some categories might include subcategories. Consequently, the core concept of content analysis is to conclude abstract ideas from real cases, and to explain wider range of phenomenon using the categories extracted from specific situations.



Figure 5. From codes to theory (Hsieh & Shannon, 2005).

This study focuses on the content of the interviews in which participants express their experience and feelings about wearable devices, and also their expectations of future wearable devices. All of the eight transcriptions of interviews were analyzed, and codes with similar attributes were combined or sorted into same categories. The analysis point lies in interviewees' experience, including feelings, attitudes and other emotional attachment towards their current wearable devices and prospection towards future wearable devices. As for participant who do not have wearable devices, data analysis probes into the reason of why they don't have the devices. Data analysis excluded other contents which are not related to their experience.

The process of data analysis followed typical flow of content analysis. First, transcripts of interviews were gone through and contents were extracted. Based on the contents, first cycle of codes was generated, which contained conclusion of core meanings of words as well as the occurrence of the words in the conversations. Then the codes were sorted into categories and subcategories. The results of the first cycle of coding are presented in

Appendix C. In the second cycle of coding, the categories and codes were refined and simplified into a more condensed thematic result. In Appendix D, the refined categories and corresponding codes in each category are presented. As for the codes in the category “Expectations for future devices”, the numbers of interviewees mentioned for each code were recorded, since summative content analysis was adopted in this category.

4. Findings & Discussion

In this chapter, results and findings from data analysis are summarized and discussed. Results were summarized into six categories: reasons of choosing wearable devices, usability factors of wearable devices, influences on lifestyle, personal taste, relationship with the device and expectations of future devices. Each category comprised with codes that had similar attributes. Particularly, results of Emocards, including questions and interviewees' choices from Emocards, are shown in Appendix E. In Appendix E, interviews where Emocards were shown without description text were marked in the last column. After each category, there are some sentences from the interviews as examples. In each category, the results from data analysis are interpreted and compared with related studies in the area of wearable devices and user experience introduced in chapter 2.

According to Hassenzahl and Tractinsky (2006), user experience was concluded into three categories. Some of the results in this study reflected these categories well. First is beyond the instrumental. In this study, some interviewees reported that the aim of choosing was to satisfy their curiosity, or to meet with the aspiration of challenging, and some interviewees chose their wearable devices to fulfill their aesthetic need. Second is emotion and affect. The motivation brought by wearable devices, mentioned in some interviews, created positive emotions to users. Besides, when users met with features that were out of their expectations, they would gain more positive attitudes towards their devices. The third category is the experiential. In this study, some interviews reflected the importance of the context of use. For example, low-temperature climate, language environment, the current exercise that the user is doing, etc. However, in this study, some of the findings from the interviews do not fit into these categories, for example the impact of wearable devices on user's lifestyle and the influence of user's personal taste.

4.1 Reasons for choosing wearable devices

Among all the interviewees who had wearable devices, five of them mentioned "Training assistance" as one of the reasons that they bought the wearable device, which helps them keep fit, monitor their training status or remind them to do exercise regularly.

It tells me how many steps I have taken and I can use it in every exercise I do. And it tells me also how do I recover from my trainings. (Interview 4, Finnish, Female, 21)

This result is similar as the book by Dvorak (2007), in which for many users, wearable devices played a role as personal coach, giving them motivation for regular exercise (pp. 35-36).

One interviewee mentioned sleeping monitoring as the reason of purchasing the device.

I bought it just to monitor the status of my body, like sleeping status, because my sleep quality is not good, and I bought it to see what I do when I fall asleep at night. (Interview 7, Chinese, Female, 23)

One interviewee chose the wearable device simply to "fulfill curiosity". "Meeting with the sense of challenging" is also one of the reasons for choosing a wearable device.

I wanted to compete with my dad who has the most steps in the day, so that's why I had it. (Interview 2, Finnish, Female, 21)

However, one participant who does not have any wearable devices, feeling uncomfortable with wearing extra things on the body was the main reason of rejection. Similarly, one interviewee who has a smart band also mentioned the uncomfortable feeling of wearing extra things.

It is because when I'm wearing a wrist watch, I can always feel something on my wrist, I don't quite like that kind of feeling. And I when I'm doing things like washing hands, I fear that I would crash it by accident. (Interview 4, Chinese, Male, 24)

In this category, the reasons that participants chose their wearable devices varies. Some chose the devices to solve the problems in daily life and work, some chose the device to meet their psychological need. As for the reason of not using wearable devices, feedback from interviewees showed that the feeling of wearing things on the body made them uncomfortable. In the book by Dvorak (2007), he showed his vision on health and wellness maintenance of wearable devices, including motivating regular exercise, health monitoring and mood management, which was in accordance with the reason that most of the interviewees bought their wearables. Besides, one interviewee who did not have any wearable devices mentioned he would choose the wearable device to measure heart rate because he believed wearables were more accurate. This can be explained by the two strengths of wearable devices proposed by Rawassizadeh, Price and Petre (2015): wearables have fix mounted location on user's body, wearables are constantly connected to the skin. However, meeting with curiosity, as one interviewee mentioned, was not recorded in the previous work collected.

4.2 Usability factors of wearable devices

Usability is a direct factor influencing user experience, interaction modes are mostly discussed among all the factors in usability. Buttons are regarded as an acceptable interaction mode as three interviewees mentioned it, but some feel it difficult to figure out the functions of the buttons at first.

But there is only five buttons... but it's really easy to use. (Interview 5, Finnish, Female, 21)

Three out of eight interviewees regarded screen as an important approach to interact with the device and two interviewees were not satisfied with the limited size of the screen, which was similar to the study by Chatterjee and Matsuno (2008), who pointed out the generality of touch screen.

At least for me having a screen is important because I can know the time... (Interview 3, Vietnamese, Male, 22)

Because phones can do the same thing, and the screen of watch is too small for that. (Interview 1, Finnish, Male, 20)

One interviewee indicated that it is necessary for wearable devices to successfully and accurately capture the input actions from users.

Actually you can double tap the screen, but this action I don't use it quite often, because, I think, maybe it's because I didn't get the hang of it, I find it not that sensitive. (Interview 7, Chinese, Female, 23)

Only one of the interviewees commented about the battery life of their devices on their own, on the other hand three of which gave positive feedback about the battery life of their current devices when specifically asked.

They (the previous device) last like four hours so it's pretty sad, but this one lasts for a week, so I don't have to think about it and plug it in and it takes about one hour or less to charge and then it's good to go. (Interview 2, Finnish, Female, 21)

Working environment was discussed a lot by participants. One interviewee from Vietnam reported the bad language support of Vietnamese characters. Emocards test shows it makes interviewee unpleasant with the bug in translation. Wearing devices in special climate was also one factor mentioned. Results of Emocard measurement indicated that interviewee had negative feelings like unpleasant emotions (Appendix E, Interview 3).

Because my band is from a small Chinese company, so when I got text in Vietnamese, it has some bugs, it doesn't appear correctly. (Interview 3, Vietnamese, Male, 20)

Yeah, the material, is not good for the cold weather...Pissed off, annoying, angry, disappointing, yeah, something like that. (Interview 3, Vietnamese, Male, 22)

Besides, the issue that interviewee 7 mentioned about the tapping gesture is similar to what founded by Schlögl, Buricic and Pycha (2015) in their user study revealing the ambiguities or confusing navigation mechanism of wearable devices. And the three factors, concluded by Motti and Caine (2016): study and understand how user work with their wearable devices, how user feel about their devices and their expectations for future products, that cause interaction problems, which were also reflected in the feedback of some interviewees.

4.3 Influences on lifestyle

Wearable devices can have certain influences on user's using habit and lifestyle, sometimes even unexpected to users. Five out of seven interviewees identified that their wearable devices did help them in their exercise by bringing motivations like exercise reminder, virtual award. Among these interviewees, however, only three bought their wearables for exercise assistance. It was found in the analysis that the sense of achievement that motivates users to exercise regularly. Result of Emocard test also showed that users had excited emotions when achieving goals with the help of wearable devices (Appendix E, interview 7).

So it's really motivating, but even though I live like a kilometer from university, I'd rather walk, like than take my bicycle because then I get more steps (Interview 2, Finnish, Female, 21)

Similar as the findings in this study, Hassenzahl and Tractinsky (2006) mentioned that by promoting user experience design, technologies can create positive emotions in users' life.

One interviewee got improved in sleeping quality, as suggested by the wrist band.

There is some help, I think, but you really have to do as it suggests. (Interview 7, Chinese, Female, 23)

Four out of seven wearable users said they have formed the habit of checking time and messages on the wearable devices, even though some interviewees bought the device not mainly for checking information. Users tend to get accustomed to the presence of their devices, confusion and anxiety are the most reported emotions when losing the device.

I would be very anxious, I would try to find it. Just although sometimes I'm not wearing it, I still hope it's beside me...I would feel that my body is being monitored all the time if I have it with me...Like something that is helping you to know more about your body all the time. (Interview 6, Chinese, Male, 21)

Opinions from users indicated that wearable device formed some using habit in some respects. Apart from solving user's difficulties in life and work, such as living a healthier lifestyle, some features in wearables also developed habits to users, like checking time and notifications, which were not expected by users. Many previous works regarded non-obtrusive interaction design as important or the next important factor for the designing of future wearable devices (Rekimoto, 2001; Motti and Caine, 2016), which stressed the importance of context of use in interaction design. In this study, it is indicated that the functions and also the design also have implicit influence on user's use habits or lifestyle in turn. Thus, the design of wearables and user's lifestyle are affecting each other.

4.4 Personal taste

As becomes evident in the interview data, personal taste affects a lot on the experience of wearable devices. Five out of eight interviewees claim that the preferred appearance of wearable device is wrist watch and extending the feeling of conventional wrist watch is the mostly mentioned reason.

I think it would be something like a watch, still, maybe it would be a different kind maybe a circle and time...I like more like simple stuff. (Interview 2, Finnish, Female, 21)

As for functionalities, the preference is strongly related to the person's character and expertise. One interview is an athlete who trains herself on a regular basis, what she likes is the heart rate monitoring feature and she expect blood pressure in her next device. Product ecosystem is also one factor mentioned by some interviewees, some product ecosystem such as Apple, Xiaomi can provide seamless continuous experience. Some interviewees pointed out that they would prefer devices which belong to the same ecosystem of their current device.

I would like to have blood pressure, or something that I can use... (Interview 5, Finnish, Female, 21)

- *Xiaomi, basically I won't consider products from other brand.*
- *Why is that? [interviewer]*
- *Because I want to make it consistent.*
- *Oh, your other devices are also from Xiaomi? [interviewer]*
- *Yes. (Interview 6, Chinese, Male, 21)*

Feedback from interviewees showed that preferences on industrial design and functionalities of wearable devices had significant connections with user's personality and expertise. Female interviewees seemed to have more preferences on the industrial design, and smart watch with round watch face is reported most by interviewees, regardless of the gender. Besides, functionalities of wearable devices had some relationship with the person's expertise, interviewees liked certain features which could be used in their professional domain. This factor was not mentioned in the previous work I reviewed for this study.

4.5 Relationship with the device

Relationship with the device reflects users' emotions and attitudes toward wearable devices. Interviewees like their wearables because they think they can add more beauty to them. Three female interviewees expressed their preference to use their wearables as fashion accessories while only one male interviewee mentioned the same opinion.

The band is more like a fashion accessory (Interview 3, Vietnamese, Male, 22)

The findings in this study is, in a sense, the same as the findings from Kim, Mansour and Lundell (2016), which pointed out that some users regard their wearables as smart jewellery.

One interviewee expressed her excitement when she competed footsteps with her father on the wrist band, even though she thinks she is not attached to physical objects very much. In Emocard test, this interviewee chose clam and pleasant as her attitude towards her wrist band (Appendix E, interview 2).

I don't get that many steps and my dad is like every day winning, so it's kind of sad, so I don't wanna compete with him anymore. (Chuckled)... and we are like "Ah, I'm more than you!"(Excited) (Interview 2, Finnish, Female, 21)

User's relationship with the devices were affected by many factors, using habit, positive emotions were among these factors.

4.6 Expectations of future devices

When it comes to the features and design of future wearable device, almost all the interviewees felt it necessary to retain the features they're using currently.

Maybe if it's possible, I would like to have blood pressure, or something that I can use some, um, maybe once a month, but it's in the same device. Something like that, maybe. (Interview 5, Finnish, Female, 21)

Four interviewees expect the design of smart ring, three interviewees prefer VR or AR headset, two interviewees like under-skin devices and two interviewees choose wrist worn devices. As for new features, integrating functions into one device is agreed by three interviewees. One athlete interviewee expects sports-related functions like blood pressure monitoring and glucose monitoring in real-time.

And the BioRing was cool, I think. Diet is really important to athletes, and to everyone else of course, but I think it's really good if you can, um, I know more

what I should eat and what I have eaten. (Laugh) (Interview 5, Finnish, Female, 21)

Both male and female interviewees like casual and comfortable industrial design. Some interviewees hope the future device can share more works from smartphones or computers. Other features like context awareness or privacy protection were also mentioned.

I think the development trend of the future device is to integrate smart devices like your phone, into a small wearable device. (Interview 6, Chinese, Male, 21)

First thing I would expect is that it must let you feel comfortable when you wear it... (Interview 7, Chinese, Female, 23)

Interviewees' anticipations towards novel wearables mainly fall in the context awareness and augmented technologies. Interviewees also described their expectations on the appearance as well as features on future wearables, such as body status monitoring, integration with phones and computers. Some anticipations on future wearables were the same as in previous work, such as context awareness, body status monitoring (Thomas, 2012; Dvorak, 2007, pp.35-36). Apart from that, with the emerging of new technology, users are now expecting more advanced technology integrated in future wearables, for example AR or VR support, under-skin devices. These features were not mentioned in previous work I reviewed, as which were limited by the development of technology at the time when these articles were published.

One aspect that was not taken into account in the related studies is the expertise of users. In this study, expertise factor has specific influences on user experience and expectations on wearable devices. Among all the participants, one interviewee who studies as a university student said that timer was very useful when doing experiments. One interviewee who works as an athlete showed passion on features like training monitoring and expected to have more body monitoring features in the future devices. Professional backgrounds brought by certain expertise is also influential on experience. As was introduced by one interviewee, who had experts on information technology, it was easier for him to figure out the functions of the device.

5. Conclusion

In this section, the findings of the study are summarized and experiences of doing scientific research including the use of specific research methods are concluded (5.1). In this study, several possible factors were found to build better user experience of wearable devices from users' perspective. Interviews were conducted with eight young people, among which seven interviewees had wearable devices in their daily life while the rest of the participants did not. By having conversations with them, their experience as well as emotions with wearable devices and their expectations towards future wearables were found out and interpreted. The findings of this study showed the different opinions of wearable devices from some young people, which mainly contains their experience with wearable device and expectations towards future wearables.

In 5.2, the implication of this study for designing future wearable devices is discussed, and 5.3 will introduce the limitation of the study. Issues of methodology and research design in this study are discussed in 5.4. The significance for future study is considered in 5.5.

5.1 Answers to research questions

RQ: What makes a good user experience for wearable devices among young people?

Based on the results of the data analysis, user experience of wearable devices was resolved into five aspects: reason of choosing wearable devices, usability factors of wearable devices, influences on lifestyle, personal taste and user's relationship with the device. The reason that users choose wearable devices represents user's initial needs on wearable devices, including demands on functionalities. Usability factor contains interaction modes, response time, battery life and context of use. Wearable devices have more or less influence on user's lifestyle: bringing motivations to users on their exercises and trainings, forming certain use habits. User's personal tastes also affect user experience of wearables, people with different character and expertise have different preferences in regard of functionalities and appearances of wearable devices. In addition, user's emotion and attitudes towards wearable devices can have effects on the relationship with their wearables, which helps to form the user experience of wearable devices. Some of the aspects were interrelated as they had some same influence factors. Personal taste would influence their reasons of choosing wearable devices, use habit and positive emotions would influence their lifestyle and relationships with wearable devices.

Sub-question 1: How users think of the user experience of current wearable devices?

People prefer features that fulfill their needs in their daily life or in accordance with their expertise. As for interaction modes, intuitive interaction style is more welcomed by users, and traditional interaction modes like button is still widely accepted by most people. Working properly in specific climate or language environment is also regarded as an important factor of forming good user experience. Wearable devices with comfortable material, plain design which continues the appearance of traditional wrist watch might be more welcomed by users, whether they do or do not have a wearable device. The motivation mechanism of wearable device brings sense of achievement and force of challenging to users, whatever in male users or female users. Also, wearable devices have

influences on users' use habits and lifestyles, and more or less, there would be negative emotions in case of losing them. Whatever the reason that users choose them, users tend to regard their wearable devices as accessories like bracelet.

Sub-question 2: What are their expectations about the experience for products they haven't known yet?

The final significant of studying user experience of wearable devices is to provide possible visions for future wearable devices, thus, user's expectations of future devices plays an important role in building better user experience for future products. Casual industrial design and comfortable material is very welcomed by interviewees, which users think can adapt more to the context of use and be less disturbing to their daily life. When it comes to future devices, users prefer minimize design like smart rings, and VR or AR headset is also expected by users very often. Finally, not all users stand for integrated devices, some users are fond of wearable devices working in some specific areas, some users even expect under-skin wearable device.

5.2 Implication

Previous studies do significant contributions to this study, as three themes of interview questions were derived from previous studies. Definition of wearable devices, definition of user experience as well as factors influencing user experience, and functionalities of major wearable system, are based on prior studies. However, not very much studies focus on user feedback of wearable devices about the perspective of user experience and future expectations. The findings of this study reflect this issue, covering three factors influencing user experience: experience, emotion and attitude considering future wearable devices.

This study collected reviews from several young people about wearable devices, which can reflect the advantages and drawbacks of current wearable devices, especially in the perspective of industrial design and interaction design, for example, data analysis in this study shows that wearable devices, while inheriting the design of conventional wrist watch, are easy to be accepted by users. Therefore, the phenomenon uncovered in this study is heuristic to future wearable devices in regard of functionalities and industrial design. With the development of microelectronic technologies, the prospective of wearable devices from users can be the reference for the design and production of next generation of wearable devices.

As founded by Rajanen et al. (2017), user experience design has its growing importance for not just end users, but also plays an important role in companies and organizations. For future wearable devices to be designed and manufactured by companies, possible factors to improve user experience design can be concluded from this study. Context of use is an important issue, as users can be from different cultural background or in different districts. Industrial design, although very subjective, has strong connection with user's emotion and aesthetic needs, and can tighten the relationship between user and wearables. In this study, the results showed that users liked wearable devices that inherit traditional wrist watch or bracelet. As for functionalities, results from this study show that the focus point of future wearables lies in context awareness, health monitoring and augmented reality. Another important factor influencing functionality design is to connect functionalities with user's expertise, whereas this connection needs more research.

5.3 Limitation

Limitations of this study are mainly methodological. Several limitations related to the source of interviewees, limited aspects of analysis, and limitations on interview questions. The interviewees were mainly Chinese or Finnish, which limits the diversity of nationality. Limited number of interviewees also resulted in data of which generalizations are not possible. When data was analyzed, it was not possible to cover all the aspects and interrelations of the feedback from interviewees. The design of interview question was also limited due to the inexperience of researcher. The questions were not holistic enough to dig out users' experience and emotions.

Among all the interviews conducted in this study, the most difficult part was to capture the emotion of the interviewees, as emotion is a significant part of user experience. As is instructed by *Interview Transcription Guidelines* (Interview Transcription Guidelines, n.d.) the audible emotional reaction of interviewees is marked with parenthesis, such as (laughter), (chuckle). However, it is difficult to guide interviewees to describe their emotions in specific circumstances as emotion is very abstract to describe and explain. Owing to the lack of experience, the design of interview questions is not able to fully dig out the emotion of interviewees in deep.

As for the order of asking questions and showing videos, pilot interviews showed that when questions were asked first, interviewees did not talk too much about their expectations on future wearable devices, instead, their answer were mainly based on their current devices and experience. In formal interviews, some interviewees were shown the videos first while some were asked questions first. The comparison indicated that videos did help them open up their mind to talk more freely, but in a sense restrained their imagination as well.

Another methodological issue in this study lies in the variations of interview design. Throughout all the interviews, three variations were introduced: whether to use Emocards or not, whether to show descriptions on Emocards or not, to ask questions first or to show videos first. The original idea of inducing these variations was to help users open up their mind and express opinions better, on the other hand, to avoid bias in the study. However, due to the quantity of variations, there were more factors influencing the data analysis and result. Interviewees' confusion of the meaning of the emotions in Emocards still exist because it is not easy to judge how much they understand the meaning of each picture in Emocards. For future studies, it is not recommended to introduce too many variations as which will add uncertainties to the study while do little help to avoid bias.

5.4 Suggestions for future studies

For future studies, the research interest might focus on the user experience from users of a wider range of age group and focusing on users' expertise to find the relationship between user experience and users' expertise, which might help manufactures to produce dedicated wearable devices for certain target user groups. Besides, the data collected in this study is still very valuable for future studies.

For future studies using Emocards, Emocards simplify the process of understanding the emotion elements which are sometimes too abstract to describe, bringing quantitative factors into qualitative research and making the data more accurate and convictive. However, the difficulties when applying Emocards into this study are also very distinct. In order to compare how Emocards measure emotions in a more objective way, Emocards were adopted in five interviews and the rest were not. In some interviews, participants do

not fully understand the meaning of each picture or the concept of “pleasantness” and “arousal”, and their choices cannot describe their real emotions very well, which might be due to the limited experience of research investigator. The description words on Emocards brought some help for interviewees to understand the meaning of each picture, as interviewees had less questions about the Emocards after reading the description words on Emocards. Also, if researchers can show Emocards in card-format instead of just showing the Emocard as in Figure 4, with more detailed explanations of the meaning of each Emocard, it would be easier and more effective for interviewees to understand Emocards and express their emotions with the assistance of Emocards.

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Appendix A. Possible Interview Questions

Basic information (Name, age, occupation)

Hobby

Theme 1: The experience of using wearable devices

- Did you use any wearable devices? Do you have or had a wearable device?
 - Why did you stop using that? (Allergic)
- What do you usually do with your wearable devices?
- Do you think it helps you do things (sport, health monitor, communication, reminder...) easier than before?
- Experiences in using wearable devices
- Did you find it easy to use the functions without the help of instruction manual when you first use your device?
- Do you have any experience that the design of the device changed your using habit?

Theme 2: The feeling of wearable devices

- Why do you choose this wearable device instead of other models or brands?
- Are you happy with your current device? Which features of your device do you like? Do you find anything that dissatisfactory of the device? (By showing interviewee emocard to help them describe their feelings)
- What if one day your wearable device got disappeared? Do you think this will affect your life?

Theme 3: Expectation of future products

- Will you still choose the wearable product from this brand if you need a new wearable?
- Definitions (In your eyes, what should a wearable device like) (to see if user mentioned some “must have” features)

<https://www.youtube.com/watch?v=uBV1MwZVBFs>

<https://www.youtube.com/watch?v=zHz0r-IDQUM>

Appendix B. Interview Consent Form

Research project title: User Experience Study of Wearable Devices (Master Thesis)
(GS3D Master Program, Faculty of Information Technology and Electrical Engineering,
University of Oulu)

Research investigator: Pan Zhang Contact Information: pan.zhang@student oulu.fi

Supervisor: Tonja Molin-Juustila Contact Information: tonja.molin-juustila@oulu.fi

Name of participant: _____

Age: _____ Nationality: _____ Gender: _____

This project is a part of the Master's thesis by student Pan Zhang, which aims to look into the user experience of wearable devices among young adults. Qualitative data collection is conducted with interview after the sign of the consent form. The data will be used for analysis in Pan Zhang's Master thesis, to seek the factors for improving user experience of wearable devices. Pan Zhang, as the research investigator, will store the audio recorded data in the encrypted storage medium. For possible future research paper, the research investigator has the right to store and use the data within two years after the consent form is signed. The data will be destroyed after the right of use is expired, the encrypted storage medium will be safely erased.

Thank you for agreeing to be interviewed as part of the above research project. Ethical procedures for academic research undertaken from University of Oulu require that interviewees explicitly agree to being interviewed and how the information contained in their interview will be used. This consent form is necessary for us to ensure that you understand the purpose of your involvement and that you agree to the conditions of your participation. To read the accompanying information below and then sign this form means to certify that you approve the following:

1. My participation in this project is voluntary. I understand that I will not be paid for my participation. I may withdraw and discontinue participation at any time without penalty. If I decline to participate or withdraw from the study, no one in the campus will be told.
2. I understand that most interviewees in will find the discussion interesting and thought-provoking. If, however, I feel uncomfortable in any way during the interview session, I have the right to decline to answer any question or to end the interview.
3. The interview will last approximately 30-60 minutes. Notes will be written during the interview. An audio tape of the interview and subsequent dialogue will be make. If I don't want to be taped, I will not be able to participate in the study.
4. I understand that the researcher will not identify me by name in any reports using information obtained from this interview, and that my confidentiality as a participant in this study will remain secure. The research investigator will protect the anonymity of the interviewee to the best of his ability.
5. Except the supervisor, faculty and administrators from the campus will neither be present at the interview nor have access to raw notes or transcripts. This precaution will prevent my individual comments from having any negative repercussions.

- 6. I have read and understand the explanation provided to me. I have had all my questions answered to my satisfaction, and I voluntarily agree to participate in this study.
- 7. I have been given a copy of this consent form.

Place and Date

Signature of Research Participant

Place and Date

Signature of Research Investigator

Appendix C. First Cycle of Coding

In this appendix, the process and result of first cycle of coding and categorization is listed, each meaning of the code is explained in detail and examples from the content of the interviews (in *italic*) are given.

Category 1: Reason of obtaining

The reason of purchasing the wearable devices is summed up within all the interviewees who have or had wearable devices.

Code 1: Exercise monitoring

Interviewees purchase their device for fitness tracking or the devices act as a fitness reminder.

I found smart watches have more features, like fitness tracking. (Interview 1, Finnish, Male, 21)

I want a something that would remind me to, you know, to get off my chair and that I sit too long and then also to record sport activities (Interview 8, Finnish, Female, 32)

I want to get into fitness and trying to be healthier and track how I'm doing like, because somedays I could just lay in bed all day and it motivates me to go outside and walk a little bit and every hour it says "you need to walk"... (Interview 2, Finnish, Female, 21)

Code 2: Training assistance

The device is purchased to monitor user's physical status during and after training.

It tells me how many steps I have taken and I can use it in every exercise I do. And it tells me also how do I recover from my trainings. (Interview 4, Finnish, Female, 21)

Code 3: Sleeping monitoring

The device is purchased for monitoring user's sleeping status and sleeping quality.

I bought it just to monitor the status of my body, like sleeping status, because my sleep quality is not good, and I bought it to see what I do when I fall asleep at night. (Interview 7, Chinese, Female, 23)

Code 4: Weather conditions

The device is purchased to fulfill user's requirements in certain, especially extreme, weather conditions.

I walk a lot, it's cold where I live, so, um, I wanted to have something that if I get like a text message or something I can just take a look at my watch and that, take out my cell phone, because the freezing weather drains the battery of the

cell phone very quickly so I keep it in my pocket so. (Interview 8, Finnish, Female, 32)

Code 5: Aspiration of challenging

The device is purchased to fulfill user's aspiration of challenging.

I wanted to compete with my dad who has the most steps in the day, so that's why I had it. (Interview 2, Finnish, Female, 21)

Code 6: Trying new functionalities

User choose the device in order to experience the functionalities of the wearable device.

And it has many functions, like heart rate monitoring, text and call notification, text reading and step counting, and sleep monitoring. (Interview 3, Vietnamese, Male, 22)

So, the reason why you changed to this watch is just to update its functionalities, right? (Interview 6, Chinese, Male, 21)

The watch is just for fun. (Interview 6, Chinese, Male, 21)

I found smart watches have more features, timekeeping and stuff like that. For example, I can use the built-in timer for cooking or use it in my chemistry experimental course, which is quite convenient. (Interview 1, Finnish, Male, 21)

I thought it is a good that it was something new. (Interview 4, Finnish, Female, 21)

Category 2: Usability

Feedback from interviewees regarding the functionalities of the wearable device is analyzed, and emotional factors are also included in the analysis. Usability in this study comprise features, performance, interaction design and other operative components.

Code 7: Interaction related feedback

This refers to the interaction modes and issues when interviewees inputting commands into the device or obtaining data from the device.

Well, this one was really easy to (use) because it has only one button (Interview 2, Finnish, Female, 21)

But there is only five buttons... but it's really easy to use. (Interview 5, Finnish, Female, 21)

Because phones can do the same thing, and the screen of watch is too small for that. (Interview 1, Finnish, Male, 20)

At least for me having a screen is important because I can know the time... (Interview 3, Vietnamese, Male, 22)

And sometimes the response time of the screen is not fast enough. (Interview 6, Chinese, Male, 21)

There is only one button and it has to achieve many functionalities, but there is only one interaction mode with the button, to click it...So it's not easy for me to figure out how to use it the first time I see it. (Interview 7, Chinese, Female, 23)

Actually you can double tap the screen, but this action I don't use it quite often, because, I think, maybe it's because I didn't get the hang of it, I find it not that sensitive. (Interview 7, Chinese, Female, 23)

Code 8: Language support issues

Problems of displaying characters of certain languages.

I think I'll keep it in English because sometimes when translating English to Vietnamese, the meaning of the word can be different, so I cannot understand what it says on the band. (Interview 3, Vietnamese, Male, 22)

Because my band is from a small Chinese company, so when I got text in Vietnamese, it has some bugs, it doesn't appear correctly. (Interview 3, Vietnamese, Male, 20)

Code 9: Performance

Problems caused by the hardware or software performance of the devices.

The cache of the watch needs to be cleaned very often, otherwise it will be slow and laggy, as I showed you just now. (Interview 1, Finnish, Male, 20)

Another thing that will make the system slow is the background apps. If I have too many apps running in the background, then it will slow down the system, so I have to close all the apps in the app switcher, like this. (Interview 1, Finnish, Male, 20)

Code 10: Battery life

Interviewees' comments about battery life of their devices.

Overall, the battery life is pretty good. (Interview 1, Finnish, Male, 20)

They (the previous device) last like four hours so it's pretty sad, but this one lasts for a week, so I don't have to think about it and plug it in and it takes about one hour or less to charge and then it's good to go. (Interview 2, Finnish, Female, 21)

...but the battery lasts more than, and this lasts for one week, and the other one...But it lasts only two days maybe, so it's pretty short (Interview 5, Finnish, Female, 21)

Code 11: Durability

Interviewees' comments about the life span of their devices.

I got it... maybe five years ago... but I still like it and it's still working. (Interview 2, Finnish, Female, 21)

Code 12: Industrial design

Problems caused by the flaw in the industrial design of the wearable device.

When I first used it, I didn't know where is the charging port, so I need to check the users' guide. (Interview 7, Chinese, Female, 23)

When sleeping because the band is made from rubber, so it's kind of annoying when wearing it to go to sleep. (Interview 3, Vietnamese, Male, 22)

Yeah, the material, is not good for the cold weather...Pissed off, annoying, angry, disappointing, yeah, something like that. (Interview 3, Vietnamese, Male, 22)

It's waterproof. (Interview 3, Vietnamese, Male, 22)

...but this is also like the sources of the problem that is the only thing I know about is that it can kind of like loose overtime, because they're rubber... (Interview 7, Finnish, Female, 32)

Code 13: Special features

Interviewees' comments about the special features of their devices.

The news app, I used it a lot, which is something surprises me. (Interview 1, Finnish, Male, 20)

I can find my phone by pressing one button on my watch, I think it is pretty cool. (Interview 1, Finnish, Male, 20)

One good thing is that, if I sit more than one hour, it gives me mark that you have sit too long, so it's good that I know I have to get moving (Interview 5, Finnish, Female, 21)

It doesn't support message reply, so you still have you take out the phone (Interview 7, Chinese, Female, 23)

Code 14: Learning cost

The time and effort spent to learn how to use the device.

...these two buttons, which I learn how to use them by reading the instructions. (Interview 1, Finnish, Male, 20)

I think so, because I have some background in IT, so I think it's quite easy for me... (Interview 3, Vietnamese, Male, 22)

Code 15: Synchronization issues

Problems in data synchronization between wearable device and smart phone.

...sometimes it cannot sync with my phone very well... (Interview 6, Chinese, Male, 21)

Sometimes when I got some notifications on my phone, but there is no response of my watch. (Interview 6, Chinese, Male, 21)

Category 3: Using habit and lifestyle

Codes in this category explore the relationship between participants' using habit with the wearable devices and their personal character as well as their expertise.

Code 16: Motivation for doing exercise

Wearable device can act as a motivator to remind interviewees to do exercises regularly.

So it's really motivating, but even though I live like a kilometer from university, I'd rather walk, like than take my bicycle because then I get more steps (Interview 2, Finnish, Female, 21)

Even though it's just only steps but, if it's like close to my goal, then it's like: Oh, I can run this far! And like two minutes' of running I can do this and it's really fun. (Interview 2, Finnish, Female, 21)

Then it can show you how many calories you consumed more than the goal you set. Then I will be very happy. (Interview 1, Finnish, Male, 20)

I was a kind of surprised of the distance I walked...That's more like satisfied, like that. So you know what is your progress today and what have you done on the day. (Interview 3, Vietnamese, Male, 22)

It's like you set a goal for yourself, and you just use it to record how much have you completed...like "Oh my god, I finally finished it." (Interview 7, Chinese, Female, 23)

I was like "I finally reached 10000 steps, I'm so happy." (Interview 7, Chinese, Female, 23)

...the watch has a vibration function to get me rise up from the chair if I work too long...That has helped me a lot. (Interview 8, Finnish, Female, 32)

Code 17: Using habit

Certain features of wearable devices can form or change a person's using habit.

I have used to check time on my watch, and if one day it suddenly disappeared I will, you know, feel strange, like there's something wrong. (Interview 1, Finnish, Male, 20)

...I just looked at how much the clock and I watched it many times I didn't understand that I doesn't have the clock in my wrist, it's very fun...And that, I'm so used to it. But I don't think it really matters in my trainings or that way, I can do without the clock also. (Interview 5, Finnish, Female, 21)

I think this will influence a little bit of my habit, I can see the messages just by lifting my wrist. (Interview 6, Chinese, Male, 21)

Nope, it won't, because I have another watch in my backpack, which is just run out of battery. (Interview 6, Chinese, Male, 21)

- *So do you think you depend on the watch a lot?*
- *Not really (Interview 6, Chinese, Male, 21)*

I would be very anxious, I would try to find it. Just although sometimes I'm not wearing it, I still hope it's beside me...I would feel that my body is being monitored all the time if I have it with me...Like something that is helping you to know more about your body all the time. (Interview 6, Chinese, Male, 21)

I think I would be check my wrist all the time, because I'm so used to it now. I think I would be a little bit confused...I will even use my phone a lot more. (Interview 8, Finnish, Female, 32)

Code 18: Sleeping quality improvement

The data collected by wearable devices can help to improve sleeping quality of users.

There is some help, I think, but you really have to do as it suggests. (Interview 7, Chinese, Female, 23)

Code 19: Frequency of wearing

Looking into how often the interviewees wore the device and how long does the interviewee wear the device.

- *So for the rest of the day you wear it all the time?*
- *Yeah, kind of (Interview 3, Vietnamese, Male, 22)*

Not much in the day, I usually wear it at night. I'm not used to wear something on my wrist, so I often use it when sleeping or in the gym. (Interview 7, Chinese, Female, 23)

Category 4: Design and preference

Codes in this category explore the relationship between interviewees' personal preference and their choices of wearable device regarding the design, both in appearance and functionalities.

Code 20: Appearance preference

Interviewees' preference towards the appearance or form of the wearable device.

I think it would be something like a watch, still, maybe it would be a different kind maybe a circle and time...I like more like simple stuff. (Interview 2, Finnish, Female, 21)

I think I'm a person who is really adaptive... I didn't choose Apple Watch because I'm not an Apple device user...Just to extend the feeling of conventional wristwatch (Interview 1, Finnish, Male, 20)

...round or square with round corner, yeah, something like that. Because it's more elegant (Interview 1, Finnish, Male, 20)

...in the moment I like in wrist, like normal clock. (Interview 5, Finnish, Female, 21)

I would probably choose something with a little less sporty design, that would, you know, look better for more outfit. (Interview 8, Finnish, Female, 32)

Code 21: Functionality preference

Interviewees' preference towards the functionalities or features of the wearable device.

I don't really want a watch that pushes a lot of messages...like that sort of interruptions (Interview 8, Finnish, Female, 32)

...for me, the simpler, the better. (Interview 7, Chinese, Female, 23)

I would buy the same type...new functionalities, but for me, I don't need them. (Interview 7, Chinese, Female, 23)

I would like to have blood pressure, or something that I can use... (Interview 5, Finnish, Female, 21)

Category 5: Relationship with the device

Codes in this category conclude the opinions that interviewees think of the relationships with their devices.

Code 22: Aesthetic need

Wearable devices somehow fulfill user's aesthetic need.

And I think it looks like a bracelet, I like it...it's pretty nice. (Interview 2, Finnish, Female, 21)

The band is more like a fashion accessory (Interview 3, Vietnamese, Male, 22)

it comes like four colors or something, which is, I think it's nice. (Interview 8, Finnish, Female, 32)

Code 24: Personal Attitudes

This includes users' personal attitude towards wearable devices.

I don't think I'm attached to my material stuff. (Interview 2, Finnish, Female, 21)

I don't get that many steps and my dad is like every day winning, so it's kind of sad, so I don't wanna compete with him anymore. (Chuckled)... and we are like "Ah, I'm more than you!"(Excited) (Interview 2, Finnish, Female, 21)

Category 6: Expectations of the future device

Codes in this category describe the expectations of the appearance and functionalities of future wearable devices from interviewees. As is designed before, the third theme of

interview is about the expectation towards future devices, and before asking interview questions, two video clips will be shown to the participants before asking them questions. However, in pilot interviews, it was noticed that interviewees tend to answer questions based on what they have seen in the videos, which is to say, their expectations towards future devices will be affected by the videos. During the interviews, in order to compare the influence of videos on interviewees' expectations, some interviewees were shown the videos before asking questions while some were asked questions first. After showing them videos, the same questions were asked again. In this category, summative content analysis was used as the main analysis methodology, the occurrence of words is recorded.

Subcategory 1: Video shown before

In this subcategory, interviewees were shown the video clips before they were asked questions.

Code 25: Hologram wearable device
(Interview 2, Finnish, Female, 21)

Code 26: Under-skin devices
(Interview 2, Finnish, Female, 21)

Code 27: Tactile experience
(Interview 1, Finnish, Male, 20)

Code 28: VR or AR headset
(Interview 1, Finnish, Male, 20)
(Interview 5, Finnish, Female, 21)

Code 29: Smart straw
(Interview 1, Finnish, Male, 20)

Code 30: Smart ring
(Interview 1, Finnish, Male, 20)
(Interview 5, Finnish, Female, 21)
(Interview 8, Finnish, Female, 32)

Code 31: Integrated functionalities into one device
It's definitely the best if one device can do all the things... (Interview 1, Finnish, Male, 20)

I think that's one of the problems that will be that who get corperate most of the things in one device. (Interview 8, Finnish, Female, 32)

Code 32: Context awareness
What I need is that the app will remind you when it thinks you need to drink water, not you manually input the instructions. (Interview 1, Finnish, Male, 20)

Code 33: Blood pressure monitoring
(Interview 5, Finnish, Female, 21)

Code 34: Causal industrial design

If I go to a party or somewhere that can't use this clock, because it's not maybe good, the style, so I can replace it with the ring (Interview 5, Finnish, Female, 21)

Code 35: Integration with phones or computers

I think the development trend of the future device is to integrate smart devices like your phone, into a small wearable device. (Interview 6, Chinese, Male, 21)

Code 36: Smart glasses

(Interview 6, Chinese, Male, 21)

Subcategory 2: Video shown after

In this subcategory, interviewees were shown the video clips after they were asked questions, and after watching the videos, they were asked the same questions again.

Code 37: Under-skin devices

(Interview 3, Vietnamese, Male, 22)

Code 38: Diverse forms of devices

(Interview 3, Vietnamese, Male, 22)

Code 39: Augmented realities

(Interview 3, Vietnamese, Male, 22)

Code 40: Integrated functionalities into one device

I think in the future, there will be even device like for watch, phone, glasses to become one. (Interview 3, Vietnamese, Male, 22)

...they tend to combine more functions together (Interview 4, Chinese, Male, 24)

Code 41: Heart rate monitoring

(Interview 4, Chinese, Male, 24)

Code 42: Wrist-worn devices

(Interview 4, Chinese, Male, 24)

(Interview 7, Chinese, Female, 23)

Code 43: Smart ring

(Interview 4, Chinese, Male, 24)

Code 44: Integration with phones or computers

Things used to be finished by phones or computers, now can be finished by the glasses, which can be more convenient. (Interview 4, Chinese, Male, 24)

Code 45: Comfortable to wear

(Interview 7, Chinese, Female, 23)

Code 46: Privacy protection
(Interview 7, Chinese, Female, 23)

Code 47: Specific functionalities
(Interview 7, Chinese, Female, 23)

Appendix D. Refined Categories and Codes

Category	Explanation	Subcategory	Codes	Explanation
Reason of obtaining	The reason of purchasing the wearable devices	Status monitoring	Exercise monitoring	Interviewees purchase their device for fitness tracking or the devices act as a fitness reminder.
			Training assistance	The device is purchased to monitor user's physical status during and after training.
			Sleeping monitoring	The device is purchased for monitoring user's sleeping status and sleeping quality.
		External environment	Weather conditions	The device is purchased to fulfill user's requirements in certain, especially extreme, weather conditions.
		Psychological requirements	Aspiration of challenging	The device is purchased to fulfill user's aspiration of challenging.
			Trying new functionalities	User choose the device in order to experience the functionalities of the wearable

				device.
	Feedback from interviewees regarding the functionalities of the wearable device		Interaction modes	Interaction modes and issues when interviewees inputting commands into the device or obtaining data from the device.
			Language support	Problems of displaying characters of certain languages.
			Performance	Problems caused by the hardware or software performance of the devices.
			Battery life	Interviewees' comments about battery life of their devices.
			Durability	Interviewees' comments about the life span of their devices.
			Industrial design	Problems caused by the flaw in the industrial design of the wearable device.
			Special features	Interviewees' comments about the special features of their devices.
				Learning cost

			Synchronization issues	Problems in data synchronization between wearable device and smart phone.
Influences on lifestyle	Influence of the wearable device on interviewee's lifestyle		Motivation for doing exercise	Wearable device can act as a motivator to remind interviewees to do exercises regularly
			Using habit	Certain features of wearable devices can form or change a person's using habit
			Sleeping quality improvement	The data collected by wearable devices can help to improve sleeping quality of users.
			Frequency of wearing	Look into how often does the interviewee wear the device and how long does the interviewee wear the device.
Design and personal taste	Interviewees' personal preference and their choices of wearable device regarding the design, both in appearance and functionalities		Appearance preference	Interviewees' preference towards the appearance or form of the wearable device
			Functionality preference	Interviewees' preference towards the functionalities or features of the wearable device.

			Ecosystem	The hardware and software ecosystem brings consistency.
Relationship with the device	Interviewees' relationships with their devices		Aesthetic need	Wearable devices somehow fulfill user's aesthetic need.
			Personal Attitudes	This includes users' personal attitude towards wearable devices.
Expectations for future device	Expectations for appearance and functionalities of future wearable devices from interviewees		Hologram wearable device	1 interviewee mentioned
			Under-skin devices	2 interviewees mentioned
			Tactile experience	1 interviewee mentioned
			VR or AR headset	3 interviewees mentioned
			Smart straw	1 interviewee mentioned
			Smart ring	4 interviewees mentioned
			Integrated functionalities into one device	3 interviewees mentioned
			Context awareness	1 interviewee mentioned
			Blood pressure monitoring	1 interviewee mentioned
			Causal industrial design	1 interviewee mentioned
			Smart glasses	1 interviewee mentioned
			Diverse forms of	1 interviewee

			devices	mentioned
			Integrated functionalities into one device	1 interviewee mentioned
			Heart rate monitoring	1 interviewee mentioned
			Wrist-worn devices	2 interviewees mentioned
			Integration with phones or computers	1 interviewee mentioned
			Comfortable to wear	1 interviewee mentioned
			Privacy protection	1 interviewee mentioned
			Specific functionalities	1 interviewee mentioned

Appendix E. Results of Emocard Measurement

Interview	Event	Emocard number	Description words showed
1	First bought the device	2: excited pleasant	Yes
	Not able to reply WeChat message	6: calm unpleasant	
	General feeling about the device	4: calm pleasant	
2	General feeling about the device	3: average pleasant or 4: calm pleasant	Yes
	Feeling when meet with difficulties	6: calm unpleasant	
3	Met with language supporting bugs	7: average unpleasant	No
	Got used to the bugs	4: calm pleasant or 5: calm neutral	
	When the strap was broken	8: excited unpleasant	
5	Feeling when the device is missing	1: excited neutral (confused)	No
	General feeling about the device	3: average pleasant	
7	When reaching goals with the help with wearable device	1: excited neutral	Yes
	When the device showed a trophy icon for finishing 10000 steps in a day	1: excited neutral	
	When walked 9000 steps in a day but haven't reached 10000 steps	4: calm pleasant	
	Feelings when the device got disappeared	7: average unpleasant	