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# Defining User Experience Principles for Developing Health and Fitness Wearables and Smartwatches

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This thesis explores the use of health and fitness wearables and smartwatches from the user perspective in order to define the user experience principles for the design and development of health and fitness wearables and smartwatches. And benefits from wearables that continuously and unobtrusively monitor health of the user and guide the user towards healthier habits, in the face of social, physical and emotional challenges of life. The proposed user experience principles assist the designers and developers to better understand user needs.

The study is conducted using the case study research approach, along six steps, from setting the objective to the evaluation of the outcome. The study evaluated the user experience when using several different brands and models of wearables and collecting qualitative data that is instrumental in the generalization of the user experience principles. Publicly available in-depth reviews, surveys and research offered important building blocks in the formulation of user experience principles. Some of the user-designers and user-developers were part of the co-creation sessions to formulate and validate the user experience principles.

The outcome of this study is five formulated user experience principles for development of health and fitness wearables and smartwatches. These principles are formulated to help the design and development teams to better meet the user needs and expectations. The next step is to apply these principles to the real-life design and development of health and fitness wearables and smartwatches, especially regarding the user experience when interacting with the wearable. It is significant since sustainable long-term engagement brings value to the whole community.

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| Keywords | User Experience, Experience Design, Human-Centred Design, Interaction Design, Digital Health, Fitness and Sustainable Wellbeing, Wearable technology |

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# 1 Introduction

The experience from the use of wearables has not yet fulfilled its potential enabled by advances in materials science, artificial intelligence, open data, analytics, connectivity and most of all in the understanding how human mind and body works. The increasing interest towards the crowdfunding projects together with the huge amount of offers from the bigger providers show that there is a need for better wearable devices and services and most of all for better experiences satisfying the higher, sometimes hidden objectives of the users of wearables. And in the future these in, on, and around the body health monitors will optimally create a seamless experience of the wearable ecosystem around the user.

Many of the current trends create a benevolent environment for the development of wearables such as Digitalisation and Internet of Things to solve some of our future challenges related to the growing amount of ageing people in the world. The European Institute of Innovation and Technology, EIT Digital with its pan-European ecosystem has Health and Wellbeing Action Line to support an active healthy ageing and independent living related innovations in the EU. 'Technology changes everything' is one of the Megatrends of 2016 according to Sitra which challenges all of us to renew our thinking to own the future, and that it is not about what machines can do but what they should do to enable sustainable wellbeing.

Healthcare industry is going through a profound transformation requiring active participation of all stakeholders, especially citizens, in Finland, the Nordic countries, Europe, and globally as well, first to reimagine the industry, and then find a way to realise it using human-centred and holistic approach. According to Sivonen, the Digitalisation Area Director in Tekes, such transformation could double the value of healthcare industry, which already is the second largest industry with the value of $4T (Tekes 2016). Figure 1 below shows contributing factors in the currently ongoing healthcare transformation. In the video, Figure 1 was explained by Koivistoinen so that, to guarantee the quality of services despite the increasing costs, the healthcare industry is forced to change. Entrepreneurial research leaders utilising all available data and knowledge enable the new growth. It is predicted that even the small entrepreneurs are able to develop sensor-based products due to the sensor prices dropping to a hundredth part. Moreover, the disappearing industry boundaries and breaking value chains will accelerate the transformation. (Tekes 2016)

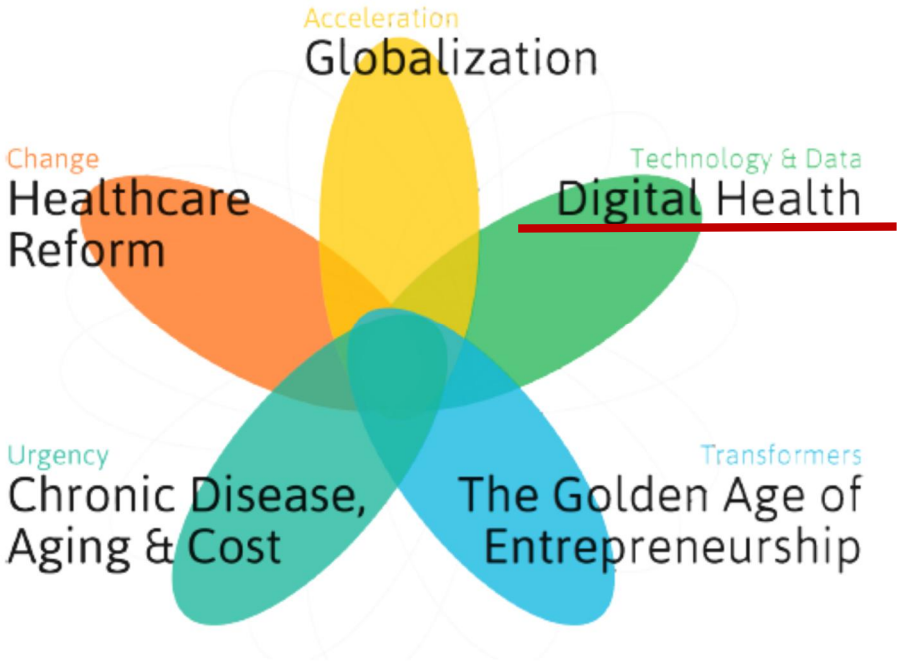



Figure 1. Contributing factors in the ongoing healthcare transformation (Startup Health 2016).

Transformation of healthcare ecosystem provides a great opportunity to create disruption that truly benefits the society and people living in it, and not just economically but also physically, mentally, and socially, and even ethically. However the challenge is huge as indicated by the statistics reported by EY:

> There is a pressing need to drive behavioural change to counter the growing epidemic of chronic diseases. Noncommunicable diseases account for 70 % of global mortality and years lived with disability and behaviours give rise to around 30 % of chronic conditions. (EY 2016).

Empowerment of the individuals and democratisation of means will eventually lead into the multitude of better and more tailored solutions to increase people's health and well-being in the society. This study will give its own share into this quest of solutions by defining user experience principles of health and fitness wearables and smartwatches that could assist in developing devices and services that could help people to help themselves in their struggle to change into healthier habits that could longer sustain their quality of living.

In order to find out the principles to guide the future development the current users need to be asked about their experiences and their expectations and wishes. Those findings combined with the current knowledge of the four important subjects: health and

wellbeing, health behaviour change, health and fitness wearables and smartwatches, and user experience design process will provide the basis for creating the principles. Those principles will then be further groomed, discussed and validated to come up with the final proposition of the principles ready to be tested in the development of the future health and fitness wearables and smartwatches outside of this study. Potentially those principles could be generalized to help in other kind of developments as well. To start with the following subsection will describe the key concepts in more detail to make reader more familiar to the context of this study.

## 1.1 Key Concepts

*Experience design (XD):* An umbrella term for the product and service design (PD and SD), and user experience (UX) and user interface design (UID) (Oliveira 2011).

*Human-centred design for interactive systems:* Design activities throughout the life cycle of computer-based interactive systems concerned with ways in which both hardware and software components of interactive systems can enhance human-system interaction. (ISO 9241-210 2010)

*Principle:* A fundamental truth or proposition that serves as the foundation for a system of belief or behaviour or for a chain of reasoning / A rule or belief governing one's behaviour. Morally correct behaviour and attitudes. (Oxford dictionaries: Principle). The (customer experience) principles "are drawn from psychological theory and validated in the experience of using the principles as a design consultant". (Watkinson xii: 2013).

*Wearables:* Miniature electronic devices capable of interacting with their user directly or indirectly through other electronic devices, with the help of software applications designed for specific use. Wearables may be worn by the bearer i.e. the user under, over, or in clothing, or be themselves clothes, or even inside the body as implanted, thus allowing sensory interaction and enhancement of human capabilities by mediating reality. See 'wearable computer' for broader explanation and history (Everything explained today 26 May 2016). And see also broader

explanation of bearable, body-worn, or body-born computer, and history of 'wearable computing' (Mann 26 May 2016).

*Health and Fitness Wearables:* Wearable ecosystem of devices with sensors and software applications built specifically for health, fitness and wellbeing improvement.

*Health:* The ability to adapt and to self-manage, in the face of social, physical and emotional challenges. (Huber et al. 2011).

*Fitness:* A good health, especially good physical condition resulting from exercise and proper nutrition. (The free dictionary: fitness)

*Wellbeing:* The balance point between an individual's resource pool and the challenges faced (Dodge et al. 2012: 229-230. Cited in: Jackson 2013: 6).

## 1.2 Study Background

During the Technology day event in the University of Helsinki in September 2015 'Jewellery' presentation of Christian Lindholm and discussion with him afterwards on the challenges in the wearables domain triggered the idea of choosing wearables as a thesis topic. The researcher of this Thesis has been developing embedded electronics devices and systems within building automation domain during the past two decades so wearables seemed to fit well into my past activities and expertise area. The researcher also has some experience in developing devices for a system used in hospitals, and has been, occasionally, following the progress in the field of the development of medical devices during the past two years. So the researcher of this Thesis has been clearly interested to learn more about the topic.

Due to her current industrial management Master's studies, the researcher has become even more interested in the customer experience and service design, and decided to view the challenge from the user perspective, and at the same time learn more about the interaction design as well. Choosing the wearables and smartwatches related to the health, sports, and fitness seemed to be the obvious choice since health is the only field with plenty of wearable offers for consumers, and health is also an easily approachable topic that everyone can relate to. The next choice was related to the most

important vital signal to monitor, that in her opinion is the heart rate, and after that the position on the body where to wear a wearable, with available options of wrist or chest, of which I chose the wrist, to have just one device not two for the task. After that was the tricky part of finding a company with an interesting product offer, to support and sponsor the study. After time consuming attempts to make that approach work, the multi-company, multi-product, and purely user experiences based approach was chosen instead.

Eventually, the researcher found out that one of her informants had connections to the health related start-up communities and in one of those, in HealthSPA, and again her initial inspirer, Christian Lindholm, who is HealthSPA's co-founder which to her is the sign that also he considers that wearables have lots to offer in solving the challenges in the healthcare domain and the same time in providing good future opportunities for the companies worldwide as well as in Finland.

## 1.3 Design Challenge

Prevention of health issues and scarcity of resources forces to look for solutions with the users and from the users, instead of treating chronical illnesses in the hospitals in the future. By reducing such behaviours, prevention could make a big difference. Wearables were used in helping to change people's behaviours into the healthier ones, and after that sustaining healthy way of living, then wearables should be used all the time. However, according to Endeavour Partners' (Jan. 2014), many users stop using wearables after some time, indicating that challenges exist in the long-term engagement and adoption of wearables, and potentially also in sustaining the healthy behaviours.

People might also forget to take the wearable or some of the wearable modules with them when they go to exercise, or devices are not ready to be used when needed due to lack of charging the device on time. The aesthetics of devices might not suit to be used in all situations which is limiting the using time. Also possibilities to customize the looks with changeable accessories seem to be limited. Monitoring sleep and daily activities provides valuable indication of person's health status and capabilities to tackle daily challenges, so increasing the using time could be of value to user. There seems to be plenty of improvement potential for the optimal user experience.

## 1.4 Objective, Outcome and Scope of the Study

Objective of this study is *to propose a set of user experience principles for the development of health and fitness wearables and smartwatches*. Outcome of this study is a set of user experience principles that could be used in the further development of specific services. These principles provide different perspectives to frame the problem to be solved, so that user experience in its many facets will always be as a basis of prioritising and choosing between contradictory choices during the design and development process of health and fitness wearables and smartwatches.

The scope of this study is limited to the products offered to the consumers, so medical devices are placed out of the scope of this study. The main focus is in the experiences of users using wearables and smartwatches for health, sports, fitness and wellness related services. Since user's overall goals are to sustain wellbeing and healthy behaviour, and changing habits which can decrease quality of life in the short- or long-term, the important areas to gain the existing knowledge is ways to support behaviour change process, and factors affecting to the health and wellbeing, and also how to measure those. Also the human-machine interaction is of interest since quality of it will make a difference in success or failure of habit change and in fulfilling other user needs.

Products and services used by the interviewees and informants is considered in more detail in analyses, even if it is mostly the experiences and not the products and services as such that form the main focus of this study. Even if the product and service providers' views are not within the scope of this study, providers are still the ones to realise the user needs. So their capabilities and visions matter but not entirely limit the future needs, since new players with other kinds of capabilities and visions are constantly entering into the market, and might be able to fulfil the future needs of users better than the existing players. Applying and not just research for the sake of research is the aim in this study, at least applying after the thesis if possible. However, in order to create something new, one must break free from old ways of thinking and open the mind for unconventional ideas as well. No implementation without first imagining it. 'How' comes much later, and deployment might sometimes wait for more viable, feasible, or desirable factors to emerge.

# 2 Method and Material

This section describes the research plan starting from the overview of the research approach, its steps, and data collection and analyses methods, and finally considering means to ensure validity and reliability of this study.

## 2.1 Research Approach

The research approach used in this study is a qualitative case study. One definition of a qualitative case study is given by Baxter and Jack (2008: 544) as follows:

> Qualitative case study is an approach to research that facilitates exploration of a phenomenon within its context using a variety of data sources. This ensures that the issue is not explored through one lens, but rather a variety of lenses which allows for multiple facets of the phenomenon to be revealed and understood.

The phenomenon to be explored is user experience and the context is the health and fitness wearable ecosystem. Interviews and discussions provide direct sources of data and indirect sources of data are gained from reviews and support questions and answers. Different types of users are interviewed and several brands and models investigated for better understanding of the phenomenon.

Multiple case study in which each user story will form a case, describes better this study. Ensuring variety across cases is considered as strength in the multiple case study by Anaf et al. (2007) and Stake (2000, 2006) that was quoted in Lauckner et al. (2012: 4) as the following citation describes:

> Multiple case study with variety across cases ensures richness and depth in order to understand the shared phenomenon of interest.

Choosing informants with different demographics and expertise levels is expected to increase case variety. Secondary sources of data will further increase versatility and understanding of the user experiences. Additionally this study tries to clarify reasons for user to adopt and use particular wearable and its effect on user's wellbeing. Yin (2009: 12) describes the data decisions as follows:

> Decisions could relate to individuals, organizations, processes, programs, neighbourhoods, institutions, events.

Decisions in this study relate to the lifestyle of the user but also to the environment including relationships with the family and friends that affect those decisions.

The intent of this study is to gain insight into and understanding of a particular phenomenon achieved by studying individuals i.e. cases. Thus, this study uses the instrumental case study type which Stake (1995) that was quoted in Baxter and Jack (2008: 549) describes in the following way:

> Instrumental is used to accomplish something other than understanding a particular situation. It provides insight into an issue or helps to refine a theory. The case is of secondary interest; it plays a supportive role, facilitating our understanding of something else. The case is often looked at in depth, its contexts scrutinized, its ordinary activities detailed, and because it helps the researcher pursue the external interest. The case may or may not be seen as typical of other cases.

By analysing each case in its context and aggregating decisions and experiences of individuals, multiple facets of the phenomenon are revealed providing insights what experiences matter to the user most and what impact they have for the wellbeing of user and how findings could be formulated into the activity-centred user experience principles applicable in the design and development of new products and services.

Since research process is an attempt to acquire deeper understanding of a particular phenomenon and to become an expert in the studied subject it is essential to acquire right kind of knowledge that is the context-dependent knowledge as Flyvbjerg ((2006) 2013: 5) explains:

> Common to all experts, however, is that they operate on the basis of intimate knowledge of several thousand concrete cases in their areas of expertise. Context-dependent knowledge and experience are at the very heart of expert activity. Such knowledge and expertise also lie at the center of the case study as a research and teaching method; or to put it more generally, still: as a method of learning. Phenomenological studies of the learning process therefore emphasize the importance of this and similar methods: it is only because of experience with cases that one can at all move from being a beginner to being an expert.

It is important to start with the data collection instead of the theory to make sure that real life cases are basis of the proposal, since user as an experience expert is an essential source of learning for a developer. Thus inductive reasoning is used in this research. In addition to that a developer especially one who is not a user will need the support of the existing theory to gain enough expertise in order to build a new theory or as for this study new set of principles specifically related to the development of the health and fitness wearable ecosystem. The next subsection explains in more detail how this study in practice is going to achieve that goal.

## 2.2 Research Design

The research design of this study contains six steps, starting from the definition of an objective, continuing with the analysis of the current state, and then creation of the conceptual framework, and after that developing the proposals from draft to final design, and finally evaluation of the whole process. Each step name is also the output of the step whereas the content of that output and most of the time actions to create that output is described inside the green box in Figure 2 below.


Figure 2. Research design of this study.

The text highlighted with red, inside the green boxes in Figure 2 above, indicates the data collection and its purpose. Despite the linear flow of the study the backward arrow from Design to Draft step indicates the possible second round of drafting and designing to further optimise the proposal in case that the validation necessitates it and time given for the study allows it.

The first step limits the scope and gives the direction for the following steps of the research design by setting the objective. And the last step evaluates whether the objective is met with the outcome and whether the actual research process followed the planned research design. So the first and last steps create the framework for the research process whereas the steps in between are the actual study of the phenomenon.

In CSA step, the current state of the health and fitness wearable ecosystem is derived by analysing experiences of users, first, by interviewing users, and then, by identifying experiences from the online sources. The aim is to interview fifteen users to derive good and bad user experiences or gains and pains from using different devices and services. Then services provided by some of those brands informants use are looked upon to gain insight of their offerings and the quality of their service. Different wearable selection guides and reviews are used to get an overall view of the market and what it has to offer for the potential user. The data collected in this step is called Data 1.

In CF step, the conceptual framework is built from the literature providing deeper understanding of the context. The factors contributing to health, fitness and wellbeing will be studied and how those are measured by the health and fitness wearables and smartwatches as well as the ways to change health behaviour.

In Draft step, the first set of user experience principles is drafted. Data 2 is collected in two co-creation sessions with selected informants. Ways to provide better experiences is discussed in the light of the findings in CSA step and knowledge acquired in CF step.

In Design step, the final set of user experience principles is formulated. This set is based on the validation of the first set of user experience principles from Draft step. Few informants are selected to give feedback that is collected as Data 3. The following subsection contains description of data collection, overview in Table 1, and details in Table 2.

## 2.3 Data Collection and Analysis

Most of the data is collected through face-to-face interviews and discussions, partly through video conferences, and partly having multiple informants present at the same time. Additional secondary data has been gathered from the publicly available sources in the internet like Facebook, Kickstarter and company websites providing user feedback, and articles and reviews related to the use of wearables. The interviews for the current state analysis is conducted in a semi-structured way allowing richer user stories to prevail from the currently used to the previously used devices and services. The discussions during the proposal building are thematic discussions with planned topic but otherwise unstructured and open for emerging ideas. Also feedback for the final pro-

posal is kept as open discussion of the validity of the proposed principles for the planned purpose.

Collection of data is conducted in three stages, (Data 1) during the current state analysis, (Data 2) during the proposal building, and (Data 3) after the proposal building to validate the proposal. Table 1 below contains the data collection overview explaining in details data collection methods and purpose of data analysis and in which section data is analysed in more detail.

Table 1. Data collection overview.

| Data | Content | Data source | Data Type | Purpose of Analysis |
|---|---|---|---|---|
| **Data 1** Section 3, CSA | Identifying key challenges in the user experience. | Users face-to-face or skype meetings. | Interviews (primary data) and unsolicited feedback (secondary data) from the users. Analysis of user stories. | *Identification of the experiences users have had, drivers for the use, use patterns and impact it has had for their wellbeing.* |
| | | Tests, Research and also in Facebook, Twitter, Kickstarter, and other web sites for sharing user reviews. | Use tests, use research, performance metrics (secondary data). Performance tests and metrics analysis, user reviews. | *Identification of the systematically collected, compared and analyzed user experiences, and metrics used for measuring it. And selected user reviews.* |
| | | Company websites, Kickstarter campaigns. | Brands, models, features, services, instructions (secondary data). Provider service analysis. | *Identification of the support vendors provide for users in their evolving user experience. Identification of brand promises.* |
| **Data 2** Section 5. Building the Proposal | Determining enhancements for the user experience. | User-developers and user-designers | Workshops and discussions of the draft proposal and ingredients for the enhanced user experience in the different use cases. | *Co-creation and grooming of the draft proposal with other user-developers in order to achieve better design proposal.* |
| **Data 3** Section 6, Validating the Proposal | Validating the final proposal. | User-developers and user-designers | Feedback discussions. | *Revision of the solution against the feedback to test the feasibility of the proposal.* |

Preparation for collection of Data 1 started already at the end of 2015 by looking for providers of the wearable devices capable of continuous heart rate monitoring without the chest strap and water resistance to allow 24/7 use. Two companies were selected as potential sponsors, first one was a Finnish start-up company, and the second one was a small US company recently acquired by a bigger company. However at the end neither of the companies had resources to provide time for the interviews in a required

time frame, and thus as described in the previous section this study took a new direction to use multiple cases instead of one by collecting experiences from users of several different brands. However, user feedback to those two companies available from the online sources is included as a secondary data, as described in Table 1 above. Other sources of secondary user data are different reviews and purchasing guides to complete the view of the amount and quality of products and services available in the market. Also company websites providing support and additional services for the users of some of the brands used by the informants are included as a secondary data. First good and bad experiences were written for different items. Then data was grouped under four main categories and several subcategories.

Data 2 was collected from the discussions with the selected user-developers who are interested in further developing wearable product and service offer they are currently using or developing. Collected data was analysed and findings were arranged under categories identified during initial draft building. Colour coding was used to indicate importance of the findings. Data 3 consists of feedback from selected user-developers to finalised set of user experience principles. Email was mostly used in communication but one of the user-developers validated proposal in the face-to-face meeting.

Interviews started at the end of February and lasted until middle of May, having only two longer gaps of two to four weeks between different data collection steps as can be seen from Table 2 below. Length of the interviews varied from 10 minutes up to 3 hours. For group discussions, the same duration time is given to all participants and it does not reflect the amount of time given to express their opinions. In case participant arrived later or left earlier that time is taken away from the total group discussion time for the participant. Those shortest interviews were *ad-hoc* interviews planned to be extended later but never found time for it afterwards. Time required for the interview was also dependent on the length of the use history ranging from beginners to those with 16 years of experiences from different products and services. Section 3 will provide more details of those experiences i.e. the content of the data.

Table 2. Data collection details.

| Data 1 | Informant background | Date | Length | Meeting type | Record |
|---|---|---|---|---|---|
| 1 | Functional analyst, Marketing | 29.2.2016 | 15min | face-to-face | notes |
| 2 | Design teacher, Product development | 10.3.2016 | 1h 20min | skype-video | video & audio |
| 3 | Project Manager, Industry | 19.3.2016 | 1h | face-to-face | audio |
| 4 | User Experience, SME | 22.3.2016 | 36min | skype-video | video & audio |
| 5 | Secretary, Ministry | 28.3.2016 | 35min | face-to-face | audio |
| 6 | Worker, Place | 30.3.2016 | 10min | face-to-face | notes |
| 7 | Test Engineer, Industry | 30.3.2016 | 1h 17min | skype-video | video & audio |
| 8 | Business Manager, SME | 31.3.2016 | 3h | face-to-face, group | audio |
| 9 | Student, Design | 31.3.2016 | 1h 50min | face-to-face, group | notes |
| 10 | Student, Environmental | 31.3.2016 | 2h | face-to-face, group | notes |
| 11 | Software developer, SME | 31.3.2016 | 2h 10min | face-to-face, group | notes |
| 12 | Student, Primary school | 1.4.2016 | 26min | face-to-face | audio |
| 13 | Worker, Shop | 5.4.2016 | 15min | face-to-face | notes |
| **Data 2** | **Informant background** | **Date** | **Length** | **Meeting type** | **Record** |
| 9, 14, 15 | Team developing wearable device and services | 12.4.2016 | 2h | face-to-face, group | audio |
| 8 | Business Manager, SME | 14.4.2016 | 2h 30min | face-to-face, group | audio |
| **Data 3** | **Informant background** | **Date** | **Length** | **Meeting type** | **Record** |
| 10 | Student, Environmental | 11.5.2016 | 2h 22min | face-to-face | audio |
| 2, 8, 9 | Data providers | 13.5.2016 | - | email | notes |

As mentioned earlier in Section 2.2 in step 2 description informants represent different age groups, nationalities, ethnicities, markets and use purposes and patterns. Most of the informants were Finns from Finland but also two Americans one of which lives in Qatar and another in U.S., one French from France (previously living in Denmark and just about to move to Canada), and two British, one Swiss, one Singaporean, one Indian, and one Russian living in Finland. I also had appointed time to interview one Finnish living in Italy but due busy work schedules that was never realized. Ages of informants varied from 15 to 55 years. Using informants from different cultural backgrounds and from different age groups is helping in the data triangulation even if the most important thing is to have informants with different use history. Informants' use history is discussed in more detail in the section 3 below. In Table 2 above also occupation of the informant is given in the background column. Most of the interviews were recorded to audio, and some even to video, and most of the times notes were taken even during

the interviews. Recordings were replayed to collect more notes after the interviews, and for the key information the timestamp was written down to speed up further research of data.

## 2.4 Validity and Reliability Plan

This study uses the following validity and reliability plan to ensure that the research is conducted in a transparent, defendable, and rigorous manner, and also that the data is authentic without researcher's misinterpretations, and that the chosen methods are appropriate for the chosen objective.

*Validity* consists of internal, construct and external validity according to Quinton and Smallbone (2006: 125-140). Internal validity means following plan and external validity refers to usability of results in another similar study, whereas construct validity is for testing validity of theory. *Reliability* is achieved by unbiased handling of data so that another person in another time could draw similar conclusions based on it.

In this study, the researcher has no experience of using a wearable and thus is less likely to have bias to raise one brand over the other or favour one service provider more than another. Enough detail is given of each of informant's use of a specific wearable in order to allow the later use and interpretation of the data for different type of purposes. However there will always be difference in the way each informant acknowledges and expresses their experiences that will affect to the quality of the data. Also the time is of essence since recent memories are more detailed and trustworthy than older ones thus current use should be weighted more in the study than the use history. By making each interview as pleasant and open as possible for the informant, and by asking clarifications from the informant in case of ambiguity, and by recording interviews and taking notes will data shared be of value and its handling more reliable. Additionally using the secondary data sources unifies the terminology used in this study to simplify comparisons between informant experiences and to make data more readable and thus more easily understood by the reader as well as by another researcher.

# 3 The Current State Analysis of User Experiences from the User Perspective

This section analyses the current state of the health and fitness smartwatches and wearables from the user perspectives, and identifies strengths and weaknesses i.e. positive and negative user experiences.

## 3.1 Overview of the Current State Analysis

The current state analysis (CSA) started in December 2015 first with the study of available products in the market, tests and reviews, and then with the interviews in February 2016. Nearly nine hours of interview data from 13 informants was recorded either in the audio or field notes, and later mapped into the list of sub-themes. Use history contained more than 27 different device models of different brands and several different phone and web applications from the past 12 years. However most of the user experiences were within the past four years. Table A2.1 in Appendix 2 contains further details of different models used by informants. In Section 3.2 the brands and models used by informants are analyzed in more detail based on the interviews and publicly available sources of information from the providers of devices and services.

Use patterns, expectations, experiences, factors affecting to the adoption of devices and services, and also impact of use to users' wellbeing were requested and answers analyzed. Users' imagination was also tempted by probing their wishes for the future wearables. Complete list of questions used in the interviews can be seen in Appendix 1. And Table A2.1 in Appendix 2 contains also short description of users' answers to the wellbeing impact question whether using smartwatch or wearable device and service was experienced to help in improving users' wellbeing. Answers to all of the questions are analyzed in more detail in Section 3.3.1.

## 3.2 Selecting Health and Fitness Wearable or Smartwatch

In selection of health and fitness wearable or smartwatch user can rely on the selection guides from review sites specialized in in-depth fitness wearable reviews and after that look in more detail web sites of selected providers and their resellers. Selection guides

help in narrowing down options for available wearables for more detailed purpose of use first. Starting from the user needs for the wearable is first step into the user satisfaction especially for swimming selection is rather limited and many vendors are reluctant to guarantee swimming use even if watch is water-proof for it. Some of the selection guides even provide additional information of discontinued wearables or those under development. (Best Fitness Tracker Reviews). In references there is link to comparison table I created from the selection guide of Dcrainmaker containing four of the wearables used by informants to indicate how long the list of features really is that users need to include in their selection process, same comparison table Table A2.7 is also attached in Appendix 2 (Dcrainmaker 2016). Dcrainmaker has also made recommendations indicating best wearable for specific sport type (Dcrainmaker, 2. 2016).

Trust to the provider is one important selection criteria and choosing one of the biggest in the global market might offer some guarantee that support will be available for the lifetime of the wearable. Absolutely biggest in terms of shipments in 2016 is Fitbit, Xiaomi and Apple coming next and Garmin and Samsung holding the fourth and fifth place (IDC 2017). Some markets start to be saturated and even the biggest providers have difficulties to get to other markets outside their home markets (IDC 2017). Still 42 procents of all shipments in 2016 were made by others so there are plenty of smaller providers of wearables to look for more options and growth potential, for example from the crowdsourcing sites, however with smaller providers there might be higher risk of discontinuity or longer waiting time for delivery of wearable under development. However smaller companies can often get fitness enthusiast to adopt their wearable for testing and further development, for example biohacker Ben Greenfield has several podcasts related to fitness and sleep, and has long experience as ōura ring user (Greenfield 2016). Quantified-self users and sites are other source of information from early-adopters of wearable technology.

Usability for targeted use is definitely one of the most important selection criteria as mentioned earlier and there are plenty of dedicated wearables easy to choose from however selection of smartwatch is somewhat more complicated since it is a multi-purpose wearable. Fitness features have been essential for the selection of smartwatches but in the future they are not limited to those features alone but are able to expand use cases especially through applications. According to online survey of GfK activity tracking was most-wanted feature of smartwatch among smartphone users in five countries but other features like navigation, making or receiving phone calls, using

basic apps, or even telling time were preferred each in couple of countries but not in all of them (Statista 2014). Wireless connectivity through the smartphone using Bluetooth has been most used option but direct wireless connection to the internet or mobile network is already available in some smartwatches. Satellite connectivity is used for navigation currently many wearables have it in-built but some of those use gps of smartphone, and some are able to use multiple satellite systems like GPS, GLONASS, BeiDou or Gallileo to reach more satellites. For Inside training satellite is less useful.

Wrist-worn wearables are highly popular by the current and future users according to IDC and only type of wearable device predicted to break into the mainstream (Wearable-technologies 2016). IDC estimates that watch shipments will triple by 2021 and clothing shipments will reach 22,3 million units and earwear 4,2 million units and other types of wearables 1,5 million units by 2021 (IDC, 2. 2017). Forecasts from CCS Insight estimate smartwatches to pass fitness trackers in popularity by 2021 also in volume. According to Tractica smartwatch shipments in 2021 would still be less than 25 procents of overall shipments for watches so users will have possibilities to choose what to wear on their wrists even more than today. (Wearable-technologies 2017). Figure 3 below shows other than wrist-worn type of wearables like hearables, footwear and eyewear to be increasingly available in 2021. Comparing to IDC forecast for 2021 shipments close to same amount of wristbands is estimated but amount of earwear is less than half of that given by CCS Insight. Additionally estimated amount of watches is almost double to that of CCS Insight but includes other than smartwatches as well.

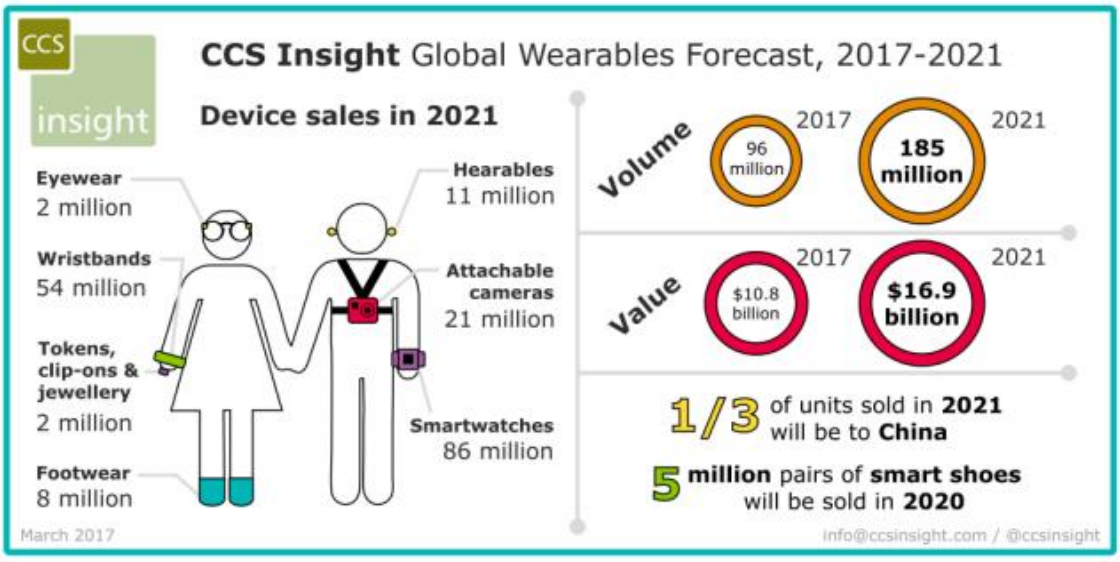



Figure 3. CCS Insight Global Wearables Forecast for next four years.

Also by 2021 third of the wearables will be used by Chinese or sold to China so maybe in the future users outside China will increasingly use Chinese selection guides as reference instead of western ones. Also growth estimates for wearable markets in Latin America in the future are promising due increasing obesity and urgent need for home care as part of more holistic approach to healthcare (Pharmaphorum 2016). Market research extending to year 2030 has been made by Research and markets for heavy users, managers and developers to get more extensive probing of the future to emerge (Prnewswire 2016).

## 3.3 Analysis of User Experiences

Users of health and fitness wearables and smartwatches of different brands, products and product form factors, and with different using purposes and use history are described in Table 3 below. In case a user has used several different products, the last used one is given first. Parallel column indicates whether those products are used in sequence or parallel. Four user types are identified to indicate driving force behind the use of product, and colour coding is used for more easily detect category, lightest shade for Fun- and darkest for Goal-driven user types, while Test- and Do-It-For-Yourself- or DIFY-driven are in between those.

Table 3. Data1 informants use history.

| User | Type | Purpose | Start | Years /device | Devices | Parallel | Brand (starting from last) | Form (starting from last) |
|---|---|---|---|---|---|---|---|---|
| 1 | Test | gym, run, dog | x | >6m | 3+ | yes | Apple, Garmin, x | watch, watch, acitvity |
| 2 | Test | run, travel, bike | 2006 | 7m, 6, 3 | 4 | no | Apple, Nike, Nike, x | watch,wrist,shoe, bike |
| 3 | Goal | run, bike, swim | 2003 | 2, 5, 5 | 3 | no | Suunto, Polar, Polar | wrist |
| 4 | DIFY | continuous | 2012 | 3 | 2 | no | Ōura, Polar | ring, wrist |
| 5 | Fun | ski, walk | 2013 | 2, x, x | 3 | yes | Polar, Omron, x | wrist,badge,badge,app |
| 6 | Fun | gym,walk | 2013 | 2 | 1 | no | Polar | wrist |
| 7 | Goal | sleep, jetlag | 2010 | 1, 2, 2 | 3 | yes | Sony, Neuro on, Jawbone | wrist, wrist, mask |
| 8 | Test | swim,run | 2011 | 6m, 1,1, 2, 2, 3, 3, 3, 4, | 10 | yes | Pebble, Meta-Watch, Polar, Adidas, Suunto, Amiigo, Pebble, Misfit, Polar, | watches, wrists, +chest straps, +shoe clip, app |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | x | | | phone | |
| 9 | DIFY | walk, bike | 2014 | x, <6m | 2 | no | x, Xaomi | chest, wrist |
| 10 | DIFY | locating | 2014 | >6m | 1 | no | Pebble+Android | wrist+phone apps |
| 11 | DIFY | notifica-tions | 2016 | <6m | 1 | no | Pebble | wrist+phone apps |
| 12 | Goal | run | 2011 | 2, 2 | 2 | no | Polar | wrist, wrist |
| 13 | Fun | walk | 2015 | >6m | 0 | no | phone | app |

Most of the brands listed in Table 3 are already mentioned earlier but some less known brands like Amiigo and MetaWatch might be less known. Following subsection describes experiences of users in more detail.

### 3.3.1 User Experiences from the Interviews

The use purpose varied from sleep monitoring to tracking skiing performance. Also use patterns varied a lot but more details of different users consider the same sub-theme differently more detailed sub-theme should be used to include both views. The data is divided into both good and bad user experiences are listed under these sub-categories to columns of good and bad experiences i.e. strengths and weaknesses in providing satisfying product and service experience by the wearable. This list is further summarized into a set of findings of most urgent user needs and most delightful experiences that will then guide the search of the existing knowledge and the proposal building. Due limited time full transcription of interviews by noting each question and answer separately into the field notes will not be done. However, audio recordings can be listened to several times to ensure the informants' words and intent are made visible in the analysis.

Researcher's own experience in the development of the small embedded products and systems will both help in understanding the domain but also introduce a risk of assuming more than data provided from the interviews. To avoid it those experiences or opinions of user that are neither good nor bad are in the analyses left in neutral black coloured text, whereas green is used for good and red for bad experiences.

Findings from informants are summarized into three main themes of (1) Interaction, (2) Long-term use and (3) 24/7 use. Subsequently, each main theme is divided into the separate tables, each with three sub-themes. Text colour indicates the type of experience, green being good one and red bad one and black one something in between or

merely opinion of informant not directly related to experience from use of wearable as such. All quotes from informants can be found in Appendix 2. First Table A2.2 where quotes from each informant is given separately for all themes and second Table A2.3 where quotes from informants are grouped according to user type or use-driver into four groups, and finally three tables, Tables A2.4, A2.5 and A2.6, one for each theme with sub-themes where quotes from informants are grouped according to user type or use-driver for further use in development when there might be need to create user profiles.

Theme 1 can be divided into three subthemes of (a) control, (b) feedback and (c) communication As seen from Table 4 below in which. Subtheme (a) and (b) indicate direction of interaction and subtheme (c) points to connectivity, data and its sharing.

Table 4. Summary of results for *Theme 1, Interaction*.

| Users | Interaction – control | Interaction – feedback | Interaction – communication |
|---|---|---|---|
| All | **1. Automatic functionality and optimisation for frequent use cases like upgrades, up- and downloading of data and programs, charging of wearable, and other wearable-specific actions.**<br><br>**1. new ways to control are error prone and means to recover are not always obvious**<br><br>**2. new designs for small screen and differences between brands complicates control**<br><br>**3. limited control of data f.ex. export, error correction**<br><br>**4. for some users it is still not always easy or fast enough to do basic use cases** | **2. use of other than textual and graphical feedback like sounds, light and vibration as well as different intensities of those**<br><br>**5. raw measured data available from Neuro on sleep mask but user needs to find how to use that data from other sources**<br><br>**3. personalised advice depending on the readiness score and different main screen in app for different users based on automatically collected use information from Ōura ring**<br><br>**6. feedback is not smart enough and moving smartphone functionality like notifications to wearable aggravate issues** | **4. use of standards like ANT+ or Bluetooth for wireless communication between wearable and its accessory gives user more accessories to choose from different manufacturers**<br><br>**5.communication between parts of the system is automatic, and data is not lost due temporary lack of connection**<br><br>**7. full functionality of wearable depends on the operating system of smartphone and both functionality of smartphone and communication with it**<br><br>A. possibility to use 3rd party platforms for extra context-related information, community support and data management like We Are Curious-platform, cloud-based personal data aggregating and tracking platform with cloud account of Ōura ring.<br><br>**8. limited ways to manage and share data collected from all wearables and brands used**<br><br>B. interaction design cycles get shorter and interaction more versatile (people - devices, people - environment, people - people) |

As seen from Table 4, *Interaction* with wearables is getting smooth with automated basic functionality and offer more options for communication. However, with new functionality and new users interaction could be further simplified. Some interesting results discussed include the following observations.

First, in the *Control* part, challenges come on the other hand from lack of intuitiveness to use wearable and on the other hand from lack of routine in doing tasks. This is discussed in bad experiences No 1, 2, 3 and 4. No 1 is related to new voice control and recovery of failure which both could be easier to do. For Informant 2 voice control was not entirely bad experience:

> "Clearly spoken voice control works well for little things and talking to wrist-worn watch is convenient like saying "Hey Siri set a one minute timer" while running on the treadmill, but it is difficult to fix/recover from error in voice control since typing is not possible." (Informant 2)

No 2 means that user can get lost when navigating between screens but still get easily back to main menu, so not so big nuisance, but differences in logic between vendors makes control more difficult. No 3 relates to ownership of data for transfer, often vendors do not offer means to transport data from vendor application but sometimes it is possible thru smartphone apps. Also sensors sometimes fail to detect activities or have false detections that user is not able to correct manually. No 4 points to difficulties of users that leave uploading data to computer for family members due threshold to handle such basic functions independently. Good experience No 1 shows that lot of basic functionality has already been automated in many wearables, but still users with different levels of technical expertise require different kind of support to gain confidence in controlling wearable.

Second, in the *Feedback* part, challenges come from maturity of offered new features. This is discussed in bad experiences No 5 and 6. No 5 relates to crowdfunded product offered for backer to use for co-creation so user has more patience to wait better feedback with future software releases. No 6 refers to functionality moved directly from smartphone to wearable like notifications distracting user who turned those off. No 6 also refers inaccurate data which in some cases could be due comparisons between data from different wearables used same time but often cause confusion and lack of trust to wearable but is explained by Informant 8 accordingly:

> "Measured data is for noticing trends not for comparison of absolute values from wearables of different brands." (Informant 8)

Feedback is probably the most interesting part of the interaction due to its significant meaning to the user. Good experience No 2 shows that users are delighted of new non-textual or graphical ways to get feedback, as mentioned below:

> Wake-up during light-sleep with vibration, repeating every 10 minutes if not stopped from button in Sony band is the main reason I still use it. Neuro on sleep mask uses also light for it which is good since I have photosensitive eyes. *(Informant 10)*

In addition to that feedback that is adapted based on use feels more personal, as in good experience No 3 from Informant 4, as quoted below:

> "After some days use of Ōura ring the information given by smartphone app at least in the main screen is different for different users so if user did not sleep well personalised activity targets would tune activity target and advice more rest and not push to more activity giving kind of relevant and actionable information for user." (Informant 4)

Meaningful feedback, suiting for the level of user is always better than giving same advice for all no matter what is the level of expertise in the topic.

Third, in the *Communication* part, problems come from interoperability between different brands and functionality offered in cross-brand apps or third party service integrations. This is discussed in weaknesses No 7 and 8. However, the experience is better when user use matching wearable and smartphone brand for app, for example:

> I rather use Sony app with Sony band since Android app does not have all the functions available. *(Informant 7)*

Still export of own data to other than brand app or brand web site might not be possible prohibiting user to combine own data from different sources into one location and in worst case might cause loosing of historical data when changing from one brand to another. Some brands offer peer-to-peer sharing or sharing in the social media easily from their site. Some brands support collection of aggregated data from other brands as expressed in Opinion A. Whereas Opinion B indicates that complexity of interaction is increasing and design cycles getting shorter which might have unwanted side effects in lack of privacy so that user tracking happens by default and ethical aspects must be considered as Informant 2 expressed below:

> Decision making is tough and have consequences so ethical aspects need to be taken care like why and to what end designed or data collected? *(informant 2)*

On the other hand good experiences No. 4 and 5 emphasize the use of connectivity standards to guarantee interoperability of different wearables and accessories and also

to make recovery from connectivity issues more automatic so that data will not be lost. The full summary of results can be found in Table A2.4 in Appendix 2.

Summing up, problems related to *the Interaction theme* are often related to the speed of development of the heath wearables and smartwatches. Speed of development is fast so the priorities are often placed to support own brand rather than cross-brand development. By now, some applicable standard communication protocols are already in use that could simplify the reusability of some of the accessories available across different brands. Part of the problem is speed of development and eagerness to get user feedback early on, which leaves some *less technically-savvy people unhappy and always requires extra effort to interpret raw data while waiting for fine-tuning of some functionalities* in the future releases.

Next, the analysis focused on the questions of long-term use of the products. The summary of results is shown in Table 5 below. As seen from Table 5 below, the results of analysis of *Theme 2, Long-term use* include:

Table 5. Summary of results for *Theme 2, Long-term use*.

| Users | Long-term use – start | Long-term use – stop | Long-term use - impact |
|---|---|---|---|
| All | **1. get as a gift or buy a wearable available in the market with best feature-price ratio for use purpose even if it means switching to a new brand**<br><br>**2. unplanned opportunity to buy a wearable immediately especially with reduced price or with peer recommendations or with brand knowledge and trust**<br><br>**3. get as a gift or buy a wearable available in the market and use provided tools and resources to design, develop and test the app to use**<br><br>**4. try free smartphone app or simple wearable, drop use, and design, develop and test new type of wearable for the market**<br><br>**1. buying or considering to buy a new version of wearable while knowing it is not really needed or it is not usa-** | **2. no adoption – limited usefulness due malfunction or failure, or disappointment in expectations or promises**<br><br>**3.discontinued use - health and fitness plans not followed or wearable broken in misuse or by accident or by unknown reasons**<br><br>**4. replace wearable every year or according to renewal cycle for wearables**<br><br>C. change in life require change in health and fitness habits and use of wearable<br><br>**5. long-term use discontinued temporarily or permanently – initial need fulfilled but oth-** | **6.health and fitness habit enhancement and adaptation to changes in daily life**<br><br>**7.makes benefits visible even from small changes in health and fitness behaviour**<br><br>**8.helps to establish new healthy habits based on measurements**<br><br>**9. measuring adds meaning to the training**<br><br>D.dream wearable helps to understand how own body works effortlessly without need to pay attention to wearable itself<br><br>**10.help in daily life beyond fitness use and readily available wearable feature set**<br><br>**11.experimenting and enjoying wearable technology as essential part of daily life**<br><br>**12.frequent and regular use provide shared experience with** |

| | | | |
|---|---|---|---|
| | **ble for long-term**<br><br>A. crowdfunding innovative wearables or accessories despite waiting time and risks involved<br><br>B. testing wearables or apps under development in other companies | **er feature use possible, or wearable even if still functional reaches its end-of-life after long-time or heavy use** | **family and colleagues at work**<br><br>***5.requires extra effort to manage multiple wearables and apps***<br><br>***6.disappointment due failure in promised functionality*** |

As seen from Table 5, some features were highly evaluated by the informants. For example, reasons to start and stop using one particular wearable or ways their life was improved by it. This analyses included investigation around three sub-teams: (a) Start, (b) Stop and (c) Impact. Some interesting results discussed include the following observations.

First, in Start sub-theme good experiences No 1, 2, 3 and 4 indicate different ways users have started to use wearable. Whereas weakness No 1 points to short renewal cycle caused by new versions of wearables coming into the market and making user to think they need to buy new smartwatch each year. Options A and B indicate other ways to start using wearable like interest to support crowdsourced development or participate in development by testing wearables during development.

Second, In Stop sub-theme bad experiences No 2, 3, and 4 give reasons for not adopting wearable or discontinuing use of it. Reasons to stop using wearable were varying from broken device to new better version of wearable replacing the old one in even cyclical fashion as Informant 2 mentioned:

> I hope I am not going to buy new 1000 dollar smartwatch every years even my current update cycles are for phone 1-1,5 years and computer 2-3 years. Corporate-centred overproduction and overconsumption is happening and I am participating in it by already thinking of buying next model because Apple convince me that I need it even before it is manufactured.

Also, from Opinion A was obvious that with the time needs were evolving so that moving caused change of hobby or during particular period there was less time for training than earlier. Informant 4 even referred that the lack of long-term engagement was similar than with other fitness devices:

> Long-term engagement is critical there is plenty of fitness devices not just wearables people buy and then do not use long-term.

Like the New Year wishes people do not always commit to which puts more emphasis into the impact of use. However good experience No 5 indicates that such change is expected in life and if there is another feature or features available then use of wearable might still continue or restart in future if needed.

Third, In Impact sub-theme, good experience No 6 – 12 indicated that impact of use was at best when reasons to buy the device were met like when training or sleep efficiency was improved. As Informant 7 mentioned:

> I managed to double my deep sleep while sleeping about 2hrs less combined night (6h25min) and daytime nap (25min during lunchtime) and this customization period to adjust my biological clock took about 1 month. Recovery from shifting my sleep time with one hour between 22 and 07 is now 2-3 days and not 2-3 weeks as it used to be.

But even less big improvements in the wellbeing that just made real-life moments more enjoyable by using wearable were enough to encourage long-term use when expectations of efficiency were not the highest priority. Opinion D expressed the dream wearable experience to be effortless, information useful and wearable not drawing attention to itself. Bad experiences No 5 and 6 emphasise the importance of fulfilling promised functionality, and also importance to make management of several wearables and associated apps more effortless. The full summary of results can be found in Table A2.5 in Appendix 2.

Next, the analysis focused on the questions of 24/7 use of the products. The summary of results is shown in Table 6 below. As seen from Table 6 below, the results of analysis of *Theme 3, 24/7 use* include three sub-themes (a) value, (b) gaps, and (c) qualities.

Table 6. Summary of results for *Theme 3, 24/7 use*.

| **Users** | **24/7 use - value** | **24/7 use - gaps** | **24/7 use - qualities** |
|---|---|---|---|
| All | A. Mastery of activity with the help of wearable<br><br>B. Offering new options and add-ons to wearable ecosystem<br><br>C. Experimenting and enjoying wearable technology<br><br>D. Use as Gadget | E. Wearable is compromise of size, battery life and other functionality for intended use and currently gaps in 24/7 use of wearable are inevitable<br><br>***1.unsuitable consistency and/or appearance to wear 24/7 and/or for the use purpose of wearable***<br><br>***2.lack of functionality for 24/7 use if not for intended use***<br><br>***3.too short battery life and/or charging time and method or difficult way to replace battery*** | F. Wearable needs to fit into the daily life not people adjust their life for wearable<br><br>**1.fit of wearable is enhanced with fitting service (ring) or easily changeable parts (bands, straps)**<br><br>**2.robustness of wearable is enhanced by increasing water and temperature resistance and feedback perception in varying conditions**<br><br>**3.Preferences of different types of users are satisfied with adequate offer of choice in models, bands, straps, holders, modules, price ranges, accessories, platforms,** |

| | | | |
|---|---|---|---|
| | | | **connectivity, apps, configurations, watch faces and modes to use wearable**<br><br>**4. Holistic approach to health of user from 24/7 data collection** |

As seen from Table 6, some interesting results discussed include the following observations. First, in value sub-theme different user group prioritized the benefits of wearables differently indicated with Opinion A, B, C and D emphasizing that each group require different approach from provider to fulfill their expectations of good experience.

Second, in gaps sub-theme Opinion E indicates that there is trade-offs between battery life and functionality and size of wearable which often means frequent charging is needed. Bad experiences No 1, 2, and 3 point out that sometimes size is problem and sometimes the lacking functionality and often charging or taking shower require taking off wearable.

Third, in qualities sub-theme Opinion F emphasizes that wearable needs to fit into the daily life of user and not the other way round. And good experiences No 1 – 4 show that some wearables do manage to both fit and be robust, and that there is increasing amount of possibilities to customize wearable to better match identity of user. Also holistic approach to health of user from 24/7 data collection is more and more possible due to functionality available for 24/7 use. The full summary of results can be found in Table A2.6 in Appendix 2. Next, the analysis focused on the user feedback collected from Social media and web-sites and different user experience surveys.

### 3.3.2 User Feedback from User Experience Surveys and Support Sites

According to Endeavour Partners' internet-based survey to thousands of U.S. citizens in 2013, 10% of adults had activity trackers, but half of those stopped using them in less than 18 months, and third of those used them less than six months. They also claim that sustained engagement is an important success factor for wearables and that behavioural science could provide answers how to achieve that. (Endeavour Partners 2014:2-5) In five point scale twelve criteria was used to evaluate wearables:

> Our research suggests that a low score in just one area can limit initial adoption, ongoing use, and ultimately, long-term engagement. Some companies under-

> stand this better than others. Polar Loop, for example, scores well on three key behavioral criteria of habit formation, social motivation, and goal reinforcement. It is too early to know whether this attention to behavioral psychology will translate into success in the market. (Endeavour Partners 2014: 13)

Polar Loop had only two criteria with less than four points: out-of-box experience and integratability so errors in setting up system and possibilities to integrate data with other personal data from other sources. As comparison Nike Fuelband SE had same points in habit formation, social motivation and integratability but less points in goal reinforcement and more points in out-of-box experience. Figure 4 below indicate differences in two consecutive Nike Fuelband versions. The lower one, SE or second version is shown in the right side with additional colour option being the only visible change between versions. Additions in SE version were collected from the Pocket-lint web page and lower set of criteria where improvement has happened is indicated with start or two stars if bigger improvement happens. Purpose is to show how few additions mostly invisible to human eye make big difference in use criteria.

Lifestyle compatibility get biggest improvement due calibration that do not allow cheating by tracking activity merely due moving hands without legs, and also Bluetooth low energy that automatically transfers data to smartphone or pc helped. Selectability, adoptability or differentiation of brand and model is improved thanks to new colour options. Water resistance and sleep tracking features affected to overall utility and habit formation since using 24/7 is now viable. Social motivation improved due possibility to share data directly to Facebook through Nikeplus.com or to Move app. Water resistance improved habit formation. Lower picture on the right side shows web page where configuration can be change so that some of the four options to show with white leds can be disabled if user wants. One of the user-developers interviewed recommended use of Endeavour Partners research but they were not yet able to collect long-term user experiences due recent release of their first crowdfunded product.

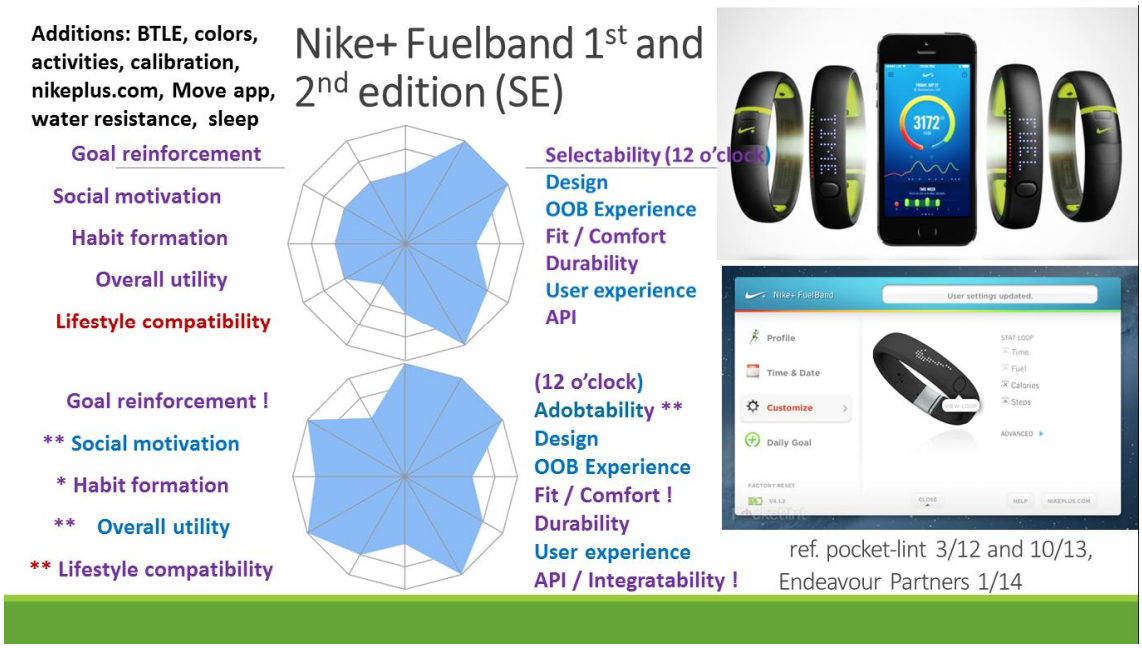



Figure 4. Comparison between Fuelband versions using twelve criteria from Endeavour Partners research (Endeavour Partners 2014) and updated features and images from reviews (Pocket-lint 2012 and 2013).

Looking for the discussions in the Basis Facebook site several users wished to have integration with another application they used to log their data with. Also some of the users seemed to provide workaround how to do that prior provider managed to satisfy this kind of user need. Agents were used to advice users and ease up the work load of the customer support. In general, questions related to the integration of devices and software versions seemed to be very common, especially synchronization and compatibility between phone and smartwatch or wearable device.

Importing and exporting data between different applications to aggregate different data in order to get correlation between different factors of health and wellbeing seemed to be common problem. Partially problem is in traditional closed platform thinking where customer retention within a certain platform is having higher priority than opening platform for other players. Partially problem is in resources to create new interfaces and test that such integrations work well enough despite different algorithms used in calculating the biofeedback values. Many companies already use standard transfer formats like csv for export and import of data in a raw format. But there is still lot to do to make the management of own data from different sources easy for the user.

Looking for the cheap activity bands directly purchased from China through Finnish importer and online shop there seemed to be quality or robustness problems where sensor gets easily detached from the band in certain situations. If intention is to be able to change bands and also use sensor module separately this is acceptable. But downside is that sensor module could easily get lost during normal use and thus band would get useless without it. Still due low price also lower quality level seemed to be more accepted.

Looking for the problems of the customers of a very small form-factor devices like rings it seems that some confusion can arise from the lack of user feedback from the device itself in cases of connection problems with the mobile phone or other kinds of problems like low battery level or quality of measurement due skin contact, since they heavily depend on the ability to show that information in the mobile application. However due small size and water resistance the 24/7 use is easier. However similar problems are encountered with the chest straps that also rely on the screen device to show its data. Also most of the wearables rely on the mobile phone to visualize data. There are several ways to improve using improved applications features and guidance especially at the first setup. Most of the devices still rely on the mobile phone to visualize data.

## 3.4 Key Findings from the Current State Analysis (Data 1)

As demonstrated above, Data1 was analyzed and rearranged into three themes, *Interaction, Long-term use* and *24/7 use.* For conducting this analysis on the user experience when using the health and wellbeing wearables and smartwatches, the users were grouped according to the driving force behind their use (in other words, the archetypes of users). These types includes (a) the goal seekers, (b) do-it-your-selvers, (c) testers and (d) fun seekers which will simplify use of findings during development phase and these Tables A2.3, A2.4, A2.5 and A2.6 can be found in Appendix 2. The findings belonging to these themes were discussed above and now are summarized below.

*Theme 1: Interaction*

Interaction is considered to be Theme 1 since it is essential for the optimal user experience and it is considered to be one of the biggest opportunities and challenges in the future. Interaction is divided into three subthemes: *control, feedback* and *communication*. The results demonstrated that Group A, Goal-seekers, want reliable control in all

conditions, feedback needs to be detailed and accurate to help them achieve their goals, communication concentrates for the essential only no need for sharing data with others. Group B, DIFYers, are ready to take more risks in control and feedback to experiment and communication especially with the developer community is essential. Group C, Testers, require more from control and feedback but are also interested sharing their reviews with others. Finally, Group D, Fun seekers are curious but expect control and feedback to be clear and ready to use and communication typically happens with friends and family.

*Theme 2: Long-term use*

The analysis demonstrated that the Long-term use is a big issue with wearables so reasons why users stop using devices and why they start using them are of interest forming subthemes together with the impact of use. Group A, goal-seekers are careful selecting their wearable to fit their target use so they are less likely to drop out unless the wearable no longer is needed for its original use case and new goals are not reached with help of it. Impact, even small, is appreciated and expectations are not unreasonable and usually met due thorough consideration at the point of purchase. Group B, DIFYers, expect big opportunities and expendability from wearable and they are ready to do their share of work with new features. Their expectations are high but they are ready to solve the obstacles with the help of the developer community. Group C, Testers, are less loyal for a certain brand, ready to try all the new wearables in the market if possible. However they might drop out or use very little particular wearable if it fails to fulfill their high criteria. They are fascinated of potential of wearables in their daily lives and will be ready to buy new ones as they emerge.

*Theme 3: 24/7 use*

The analysis of user experiences related to this theme demonstrated that the users consider usability around the clock, where quality and versatility of wearable needs to be high. For Group A, goal-seekers, the wearable is the means to an end, no more. However reliability, robustness and mastery of intended use purpose is required more than need to use it around the clock. For Group B, DIFYers, they would love to use wearable around the clock but do understand and tolerate limitations. For Group C, testers, the wearable or wearables need to fit for their lifestyle and it is visible part of it but not around the clock use is demanded. Finally, for Group D, fun seekers, the gaps are nuisance and complexity reduces the enjoyment of using wearable. They easily

start with the free apps and might be willing to move for payed ones if it is not too expensive to do that.

# 4 Existing Knowledge on Designing User Experiences in the Domain of Health and Wellbeing Wearables and Smartwatches

This section discusses the existing knowledge in designing and improving user experience, and key factors affecting to user experience in health and wellbeing devices.

## 4.1 Introduction to Health, Wellbeing and Fitness Devices: Wearables and Smartwatches

*Health and fitness wearables* can be described as a wearable ecosystem of devices with sensors and software applications built specifically for health, and wellbeing improvement. Most simple applications are dedicated to measure and monitor movement or activity by counting steps, like in activity meters, pedometers, and fitness bands. More complex multi-purpose applications measure and monitor also bio-signals like heart rate, breathing, blood pressure, body temperature, skin conductance, brain (neuron) activity, and muscle activity or strength. Also applications for measurement and monitoring of altitude and location, used for more accurate distance calculations and proximity detection, might be offered especially in the sport watches.

Health and fitness consumer devices or Do-It-Yourself (DIY) or Do-It-For-Yourself (DIFY) devices, are currently less regulated than medical devices, which gives the developers a lot more freedom to experiment. The difference is often in wording of intended use, which for the health and wellbeing wearables is formulated as not to be of diagnosis, treatment or prevention of diseases but rather wellness related. To get a good overview of the current discussion on the difference between the medical and welling devices, see Wexler's study of regulation of transcranial direct current stimulation (tDCS) devices for broader understanding of the complexity, and especially discussion of and references to a draft guideline "'General Wellness: Policy for Low Risk Devices'[78]" from the FDA published in 2015 and addressing the regulatory status of health-related wearable technology devices (2015).

### 4.1.1 Perspectives to Health and Wellbeing for Designing Devices

*Health* is the ability to adapt and to self-manage, in the face of social, physical and emotional challenges. Positive health state consists of six dimensions: bodily functions, mental functions and perception, spiritual or existential dimension, quality of life, social and societal participation, daily functioning. (Huber et al. 2011) Direct measures of

health are affect, pain, mobility, cognition, and as less agreed upon also vision, hearing, sexual functioning, dexterity, digestion, skin and disfigurement, bodily excretion, speaking, breathing, fertility, energy and vitality, sleep, communication. Indirect measures of health are *self-care, usual activities*, and less agreed upon also interpersonal relations, social functioning and participation. The health state valuations, however, quantify level of health, not quality of life, wellbeing or utility, and therefore do not directly applicable for wellbeing and fitness devices.

Sustaining wellbeing requires constantly balancing resources and challenges. Psychological, social and physical resources need to keep up with the psychological, social and physical challenges (Dodge et al. 2012 cited Jackson 2013: 6). Wellbeing could also be approached through the interdependent subjective, relational and material dimensions (White 2008:10 cited Jackson 2013: 7). Material dimension, namely the availability of services and amenities, plays an important part in wellbeing.

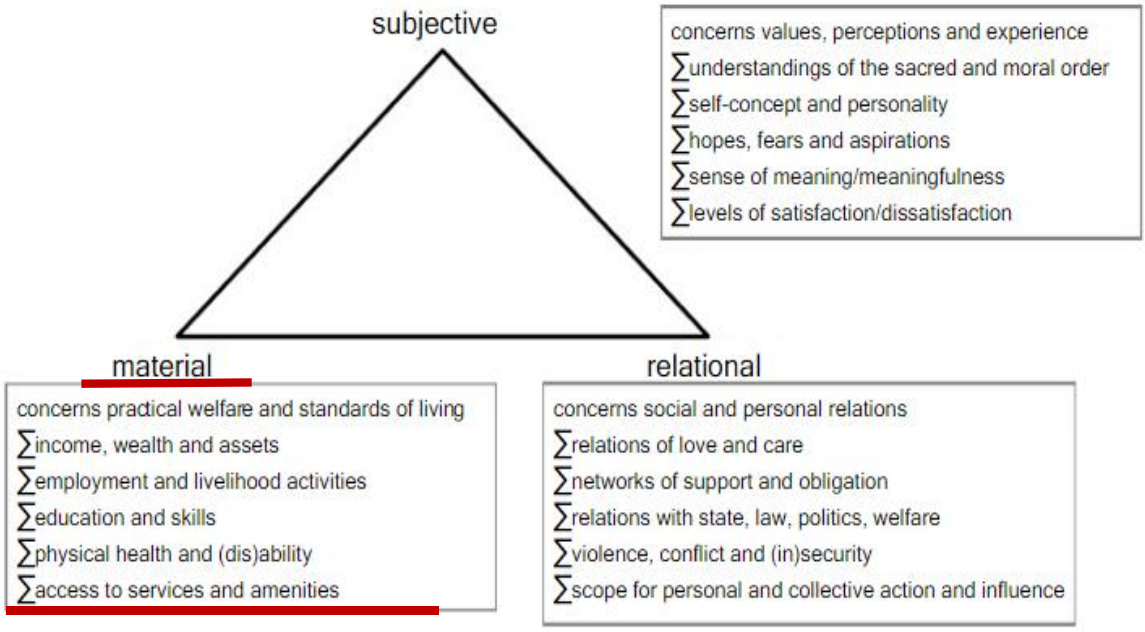



Figure 5. Material dimension (access to services and amenities) as part of sustaining wellbeing (White 2008:10 cited Jackson 2013: 7).

Many factors affect to the health and wellbeing of a person, with the important of monitoring them ever growing in importance. How each person's body reacts to different triggers is unique, so baseline values need to be measured first, and then changes to those baseline evaluated, to learn the dynamics. It is through self-quantification that

person is able to learn the ways to improve own health and wellbeing, even the small unobservable changes in it.

Summing up, sustaining wellbeing while at times growing up and then growing old, and all the time trying to adapt to changing stressors requires access to services and amenities when needed. Health, wellbeing and fitness wearables and smartwatches provide the user with this access to services and amenities, on a very personalized and continuous level.

### 4.1.2 Parameters to Measure for Health and Wellbeing Wearables and Smartwatches

*The autonomous nervous system (ANS)* consists of sympathetic and parasympathetic parts, in other words the accelerator and the brake pedal parts, where the sympathetic nervous system controls the flight or fight response, and parasympathetic nervous system calms us down. Figure 6 below shows how the inner organs and pupils are affected by the ANS.

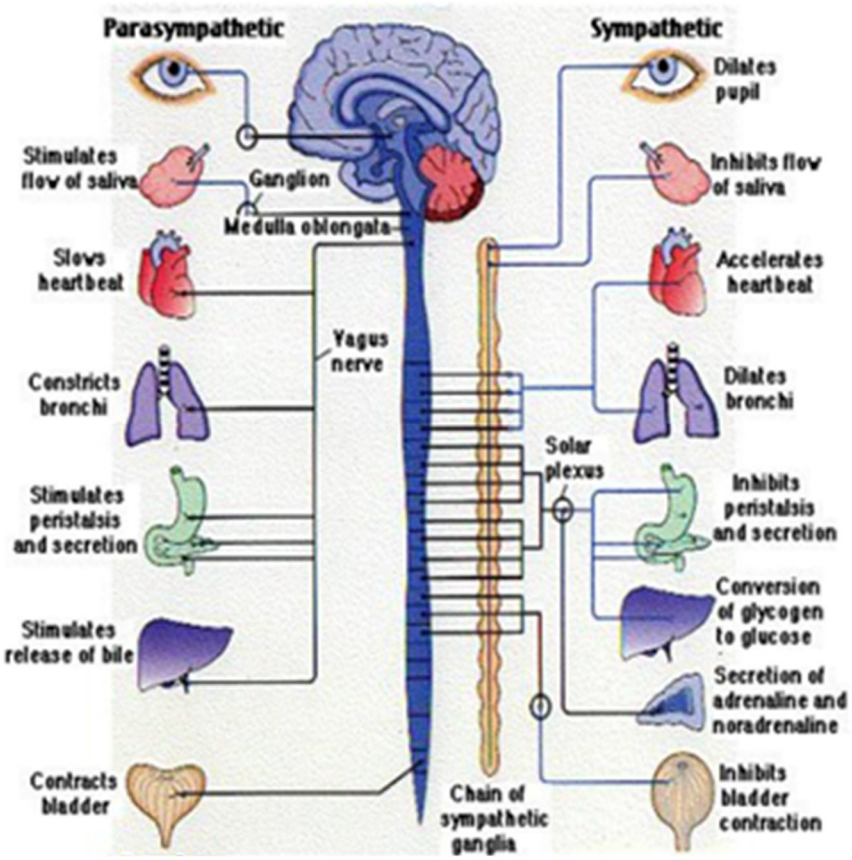



Figure 6. Functions of different parts of the autonomous nervous system (Collier 2012: 3).

As important to notice for this study, the sympathetic nervous system accelerates the heartbeat and the parasympathetic nervous system slows the heartbeat down. Keeping those two parts of the system in balance is important to the wellbeing, as well as for designing the measurements of it.

*Heart rate variability (HRV)* can be used as an indicator of this balance, showing the ability of the nervous system to respond and recover from physical or psychological stressors. Stress can be positive, giving energy to complete tasks, so it is only when it causes negative reactions that it becomes harmful. Table 7 below contains different stress factors divided into external and internal physical factors and psychological and social factors, showing how complex issue stress is, especially, if several factors are present at the same time.

Table 7. Different stress factors (Firstbeat 2014: 7).

| Physical factors (external) | Physical factors (internal) | Psychological factors | Social factors |
|---|---|---|---|
| Alcohol and other drugs | Acute infections | Work stress | Presentation |
| Medications | Chronic diseases | State anxiety | Giving speech |
| Stimulants e.g. coffee | Pain | Strain | Fear of social situations |
| Hangover | Burnout | Negative feelings | Pressure |
| Extensive training | Overtraining | Fear | Lack of social support |
| Physical workload | Tiredness | Excitement | |
| Sauna | Pregnancy | Depression | |
| Sleep deficit or jetlag | Digestion | Psychological disorders | |
| Temperature, humidity | Dehydration | Relationship problems | |
| Noise, illuminance | | Traumatic events | |
| Altitude | | Sorrow | |

Similarly, calculation of HRV is not a simple task since HRV has a circadian rhythm and it is also dependent on the age and gender. Pietilä's studies referred in the Firstbeat whitepaper (Firstbeat 2014: 9) expresses that in the following way:

> To sum up, the results showed that HRV, recovery during sleep as measured with stress balance, the proportion of stress, and energy expenditure decrease with increasing age. In both genders, high physical activity level and low BMI were related to good recovery during sleep, a low amount of stress, and high en-

> ergy expenditure, and to higher HRV among men. Men had more stress, but also more health-promoting physical activity and better recovery during sleep than women.

So high HRV means the body is resilient to the stress, and chronically low HRV is an indication of systemic health issues either psychological or physical nature. The ways to measure HRV are described below.

Measuring HRV provides a great holistic view on the health, and the second and most widely used is *activity* or *movement* measurement (discussed in Section 4.1.3). For measuring the HRV, the neural interaction between brain and heart responsible of HRV is well described in the following way: "The normal variability in heart rate (HR) results from the descending (efferent) and the ascending (afferent) activity occurring in the two branches of the ANS, which act in concert, along with mechanical, hormonal and other physiological mechanisms to maintain cardiovascular parameters in their optimal ranges and to permit appropriate adjustments to changing external and internal conditions and challenges." (Heartmath n.d.) Figure 7 below shows relation between heart rate, respiration and heart rate variability.

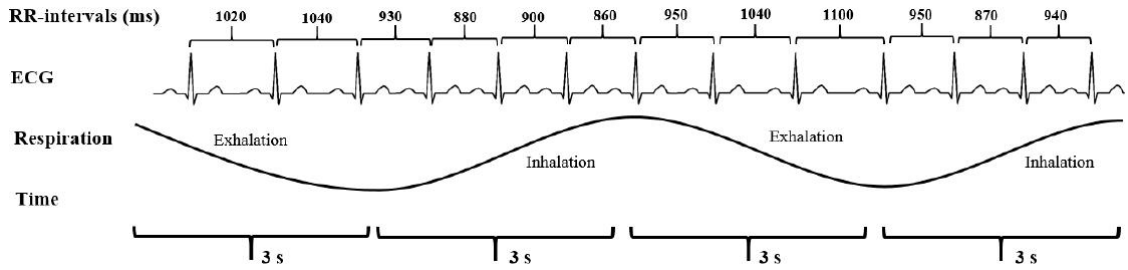



Figure 7. Electrocardiogram (ECG) exhibiting respiratory sinus arrhythmia (RSA). Heart rate increases and thus the time between successive RR-intervals gets shorter during inhalation (inspiration) and longer during exhalation (expiration). This fluctuation in the time between the successive RR-intervals is called HRV (Heartmath n.d.).

So taking a deep breath in and out will increase the HRV and it also has a positive effect on blood pressure. Also it is clear that increase of HR does not automatically increase HRV or vice versa, but the natural relationship between HR and amount of HRV exists and called *cycle length dependence*, meaning that less variability occur at higher HRs, while at lower HRs there is more time between heartbeats, so variability naturally increases, but if variability does not increase that is an indication of heart problems.

Measurement of HRV can be done in time domain, that is simplest to calculate, or frequency domain, which provides means to adequately quantify autonomic dynamics or determine the rhythmic activity generated by the different physiological control systems (Heartmath n.d.). Depending on calculated statistical parameter, either 24 hour measurement or 5 minute window are typically used in time domain to quantify the amount of variance in the interbeat interval (IBI). Standard deviation (SDNN) where all cyclic components are measured uses generally a 24 hour measurement, and root mean square of successive differences (rMSSD) which is a reflection of Vagal Tone is generally calculated on 5 minute window, and the mean of the standard deviations (SDNN Index) uses both so that a 24 hour measurement is divided into 288 five-minute segments for calculation of average of these 288 values (Heartmath; Collier 2012).

An Electrocardiograph (ECG) is traditionally used for measuring heart rate, and recently also Infrared light (IR) is used to optically measure heart rate. For measuring movement, accelerometer is used, as well as other devices, discussed in more detail below.

### 4.1.3 Parameters to Measure in Physical Activities; Help in Self-Regulation and Monitoring Progress

*Daily physical activity* is one of the best ways to boost brain, heart, and gut functions and sustain cellular metabolism, joint mobility, muscle and bone strength, and flexibility of the body. Exercise counteracts stress and stalls aging, even the study of telomere-dependent and telomere-independent ways of cell aging, and the influence of stressors continues (Rehman 2014). According to the UKK-institute healthy adults should have weekly aerobic physical activities several times a week and in total from one hour 15 minutes to two hours 30 minutes depending on the intensity of training, and also have muscle strengthening and balance training twice a week to sustain good level of health (UKK-institute 2009:1).

Different measuring techniques that are used in the consumer wearables, and positions on the body to wear the device, are shown in Figure 8 below.

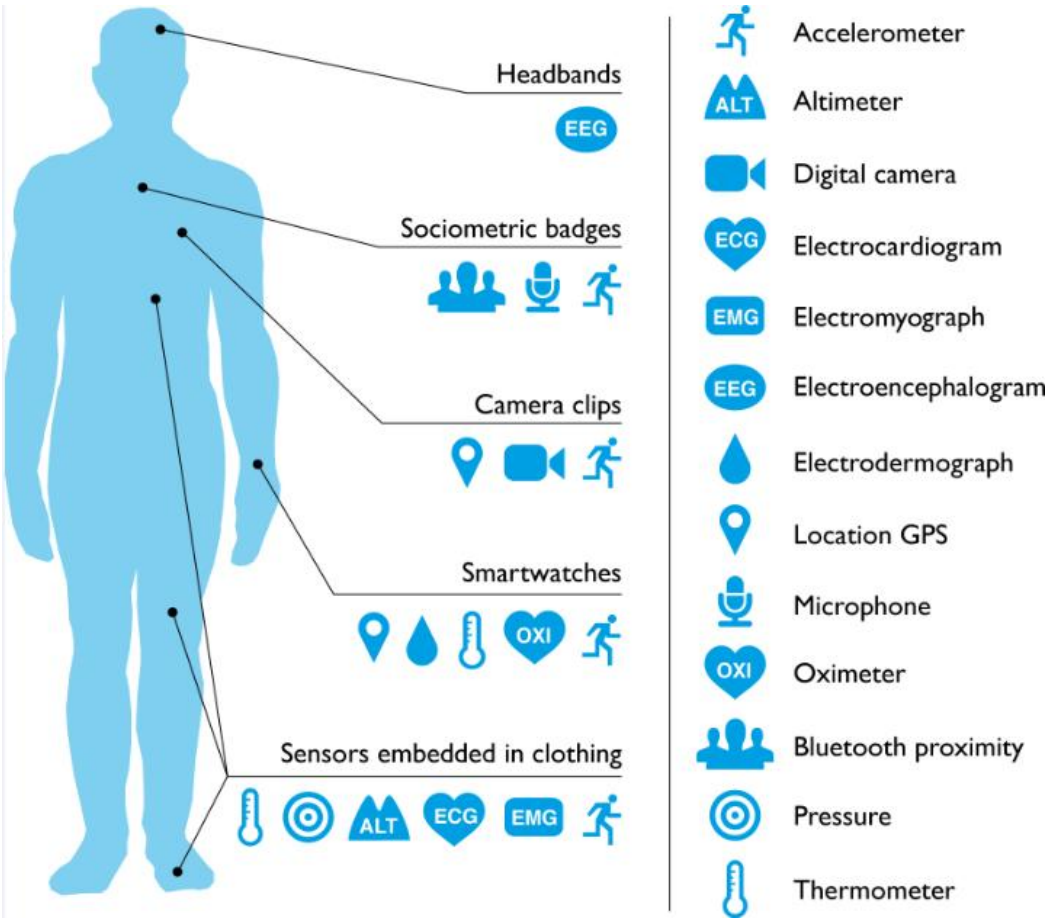



Figure 8. Parameters that consumer wearables can measure (Piwek et al. 2016).

Many devices use combination of different sensors to reliably detect user activity. Also GPS location detection is very popular and included in most of the sport watches. However, many smartwatches use mobile phone's GPS location detection rather than in-built one. Electromyograph (EMG) is used to measure muscle contraction caused by electrical activity in the muscle. Patches are also commercially available for measuring ECG or EMG. A thermometer, an electrodermograph (EDG) and a galvanic skin resistance (GSR) can be used also to detect stress reactions, since lower temperature due decreased blood flow to your skin of fingers, or increased perspiration and sweating on the wrist could be signs of stress and anxiety.

In addition to HR and HRV, *heart rate zones* (HRZ) are used in training to maximize the effort and zones are calculated from the *maximum heart rate* (MHR) which can be approximated with the following way: MHR starts out at 220 beats per minute and falls by one beat each year, or to be exact after 30 years it falls by half a beat each year. Fat burning zone is in between 50% and 60% from MHR and training on this zone im-

proves endurance and aerobic capacity. Aerobic zone is in between 60% to 70% from the MHR and training in this zone is good for the cardiovascular system and for strengthening muscles. Steady State zone is in between 70% and 80%. Anaerobic zone is between 80% and 90% and in this zone the body develops its ability to handle lactic acid i.e. waste, which makes it the focus for users with fitness purposes.

*Oxygen consumption* is also used in the physical activity calculations. During the physical activity the oxygen consumption ($VO_2$) increases i.e person's metabolism changes, and also after the exercise excess post-exercise oxygen consumption (EPOC) happens. The maximum oxygen consumption ($VO_{2max}$) level i.e. cardiovascular training response decreases with the age by 0,365 ml/kgxmin every year to the minimal value of 35 at the age of 65. So it is important to train 20-40 min three times a week depending on the intensity of the exercise to sustain the good level. (Lundström 2010: 1)

Figure 9 below shows how such training affects to the body by improving different biosignal values from decreased resting blood pressure to the increased good HDL cholesterol after three to six months training.

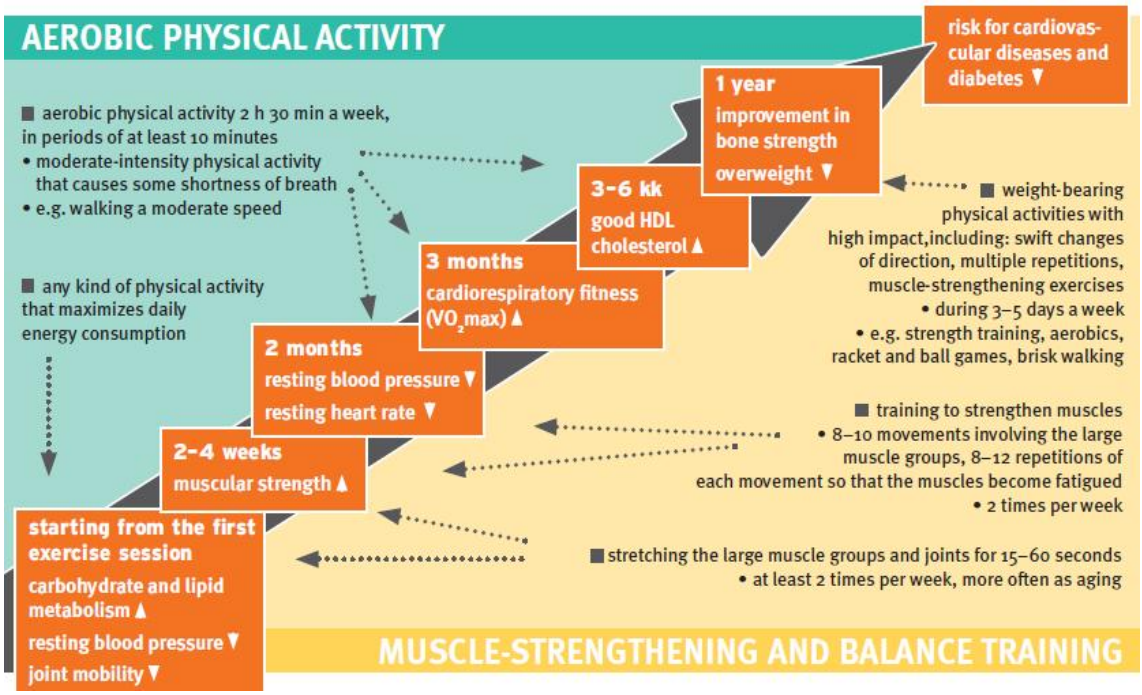



Figure 9. Time frame for biological changes due activities (UKK-institute 2014: 1).

Figure 9 points to the importance of longitudinal observations and analysing the dynamics of physical activity, as well as measuring and evaluating the results, which health and wellbeing wearables are able to provide.

As important to notice for this study, those wishing to exercise, especially in case of high-risk patients, need to do a fitness test or fill-in the physical activity readiness questionnaire to determine readiness to HIIT (ACSM 2014). Moreover, when exercising, they need to constantly monitor the activity level. This is where the health, fitness and wellbeing wearables become a must for such cases. Adding repetitions or length of exercise also adds to the importance of health, fitness and wellbeing devices since they are able to accumulate such information and present the dynamics and reports for the users. Moreover, such devices can even provide guidance in the endurance and increase intensity of exercise in the high-intensity interval training (HIIT). These are some of the areas and measurements where the health, fitness and wellbeing devices could be used.

Sustaining health requires sometimes person to change unhealthy behaviour to a healthier one. Relapses happen most often straight after the change. And also social factors not just individuals own ability to initiate and maintain the change matter. The Integrated Theory of Health Behaviour Change (ITHBC) used in person-centered interventions to increase knowledge and beliefs, self-regulation skills and abilities, and social facilitation (Ryan 2010). As the name suggest it integrates several models. Figure 10 below shows how self-regulation skill and ability is supported by knowledge.

As known from the works of Bandura and Carver and Scheier, person-centered intervention provides tailored information based on a focused assessment. Person chooses goal and ways to enact the goal and then monitors own behaviour related to that goal. Also feedback is provided comparing behaviour to national recommendations and to own current behaviours. The Transtheoretical model (TTM) of Prochaska and DiClemente (as cited Hänsel 2016) describes behaviour change as a linear process with gradual change from one stage to the other with varying support requirements to succeed in transition to the next change level. With each stage intention to change within next six months increases from being non-conscious to problem and not wanting to change to maintaining changed behaviour beyond the first six months. So, in the first stage, support effort is channelled into raising consciousness about the problem, and in

the last, into raising self-control and self-efficacy. Model is very popular and widely used in interventions (West 2009).

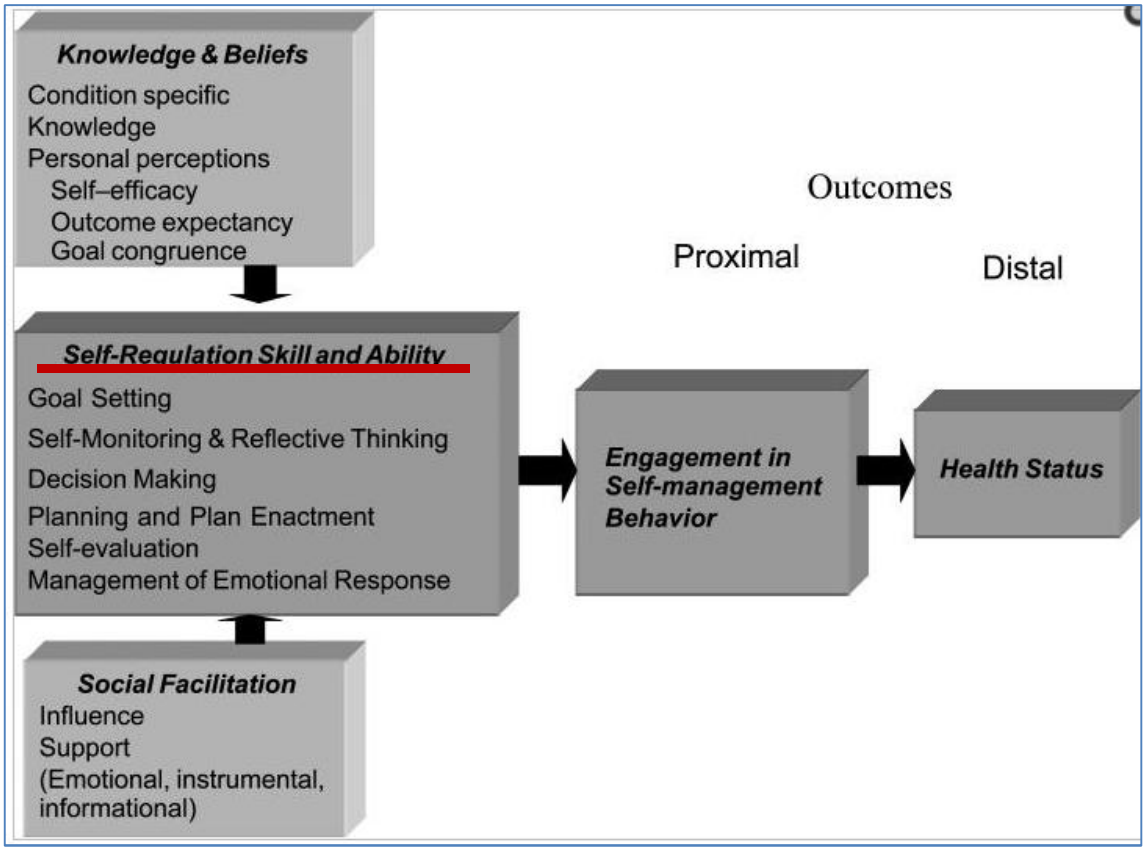



Figure 10. Integrated theory of health behaviour change (ITHBC) (Ryan 2010).

Summing up, health, wellbeing and fitness devices: wearables and smartwatches find a wide area of application that relate to purely health targets to a wide wellbeing and fitness targets. There is also a number of important parameters for measurements already identified, as well as the devices and techniques to measure them, also by wearable and smartwatches. Since such measurement are already possible and can be done by these devices, the questions now arises of how user-friendly they can do it, and what are the ways to design and improve the user experience while using them. Since the benefits are multiple, the popularity of the devices seem to be very dependent of the quality of user experience that they provide. This makes this topic of user experience design the next focus of this study.

## 4.2 Overview of Experience Design

An experience design could be described as an umbrella term for *the product and service design*, and *user experience* and *user interface design* (Oliveira 2011). But it could be even better described to be the result of gradual and constant change in the design field and in the society, focusing increasingly on empathy towards users, stakeholder collaboration and holistic view to problem solving (Beer 2015). Figure 11 below shows the evolutionary path from participatory design in 1960s to the user-centered design (also known as UX), meta-design, service design, human-centered design, and finally to the latest design theory, design thinking.

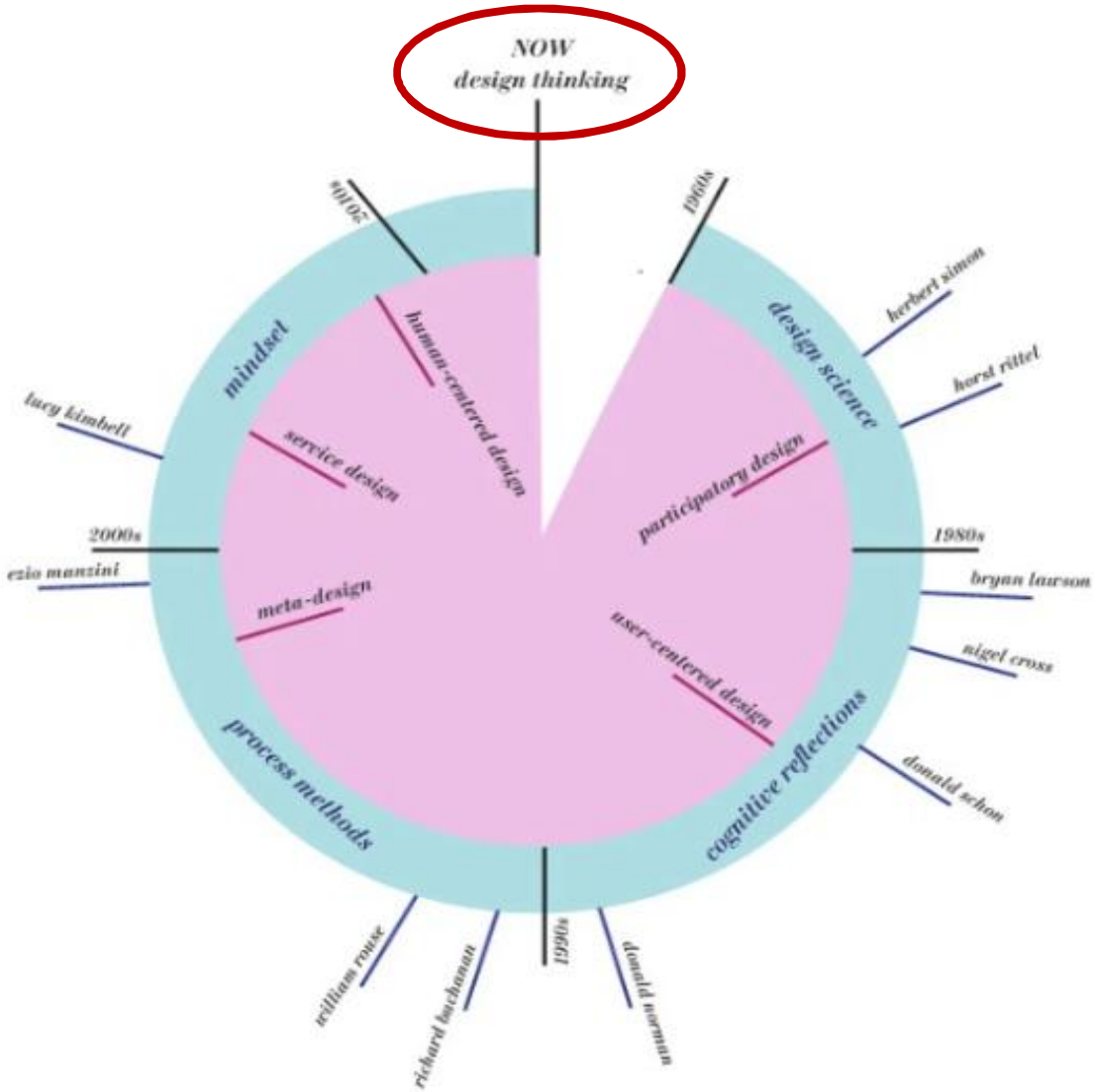



Figure 11. History of Design Thinking. The outer circle (blue) signifies the shifts in design theory along the timeline. The inner circle (pink) signifies the methodological shifts in design practice over time (Russo 2015).

Russo (2015) chose the circular graph to highlight how opposing sides of circle reflect one and other i.e. current mindset movement's interest in cognitive reflections in design

theory during the 1980s, and the methodical inquiry into process methods of the 1990s reflects interest in design-as-science trend in the 1960s. Also both Norman, design critic and cognitive scientist who got his name on the circle in Figure 11 above, and Tim Brown, the CEO of IDEO, reflect the past, present and a little future as well, and on their behalf define design and design thinking. Norman (2010) describes the design thinking as a useful myth since creativity and thinking a fresh is not limited to designers alone:

> Design thinking is a public relations term for good, old-fashioned creative thinking.... Design methods can be applied to any problem: organizational structure, factory floors, supply-chain management, business models, and customer interaction…It means stepping back from the immediate issue and taking a broader look. It requires systems thinking: realizing that any problem is part of larger whole, and that the solution is likely to require understanding the entire system. It requires deep immersion into the topic, often involving observation and analysis. Tests and frequent revisions can be components of the process.

Hassenzahl (n.d) explains design of (user) experience through Philips' Wake-up light and 'bird song' alarm, as follows:

> This is the challenge designers and vendors of interactive products face: Experience or User Experience is not about good industrial design, multi-touch, or fancy interfaces. It is about transcending the material. It is about creating an experience through a device.

Hess (Hassenzahl n.d) would even non-materialise "device" and use broader meaning instead in his comments to Hassenzahl:

> I have chosen to read his use of "device" in its perhaps secondary but broader meaning - "a plan, scheme, or trick with a particular aim," rather than as a material object. I don't view experience design as contingent upon having an object (digital or material) with which to interact, though I can understand the argument of being device-centric given the implications of there being a *user*. But a user of a service might engage solely through conversation, with the designed "device" being *flow*. An experience designer's ultimate output is a plan itself, with all its conditions and contingencies. The success of the experience lies in the thoroughness and thoughtfulness of the plan.

In other words, an experience designer is a facilitator of design thinking. The role of an experience designer is to bring together diverse teams and stakeholders to collaboratively address problems holistically, in a human-centered manner, using design thinking approaches. "Learn from people, find patterns, define design principles, and make principles to tangible prototypes, and iterate relentlessly are the key elements of design thinking process" (Daylight Design 2015). This is the statement from Daylight Design, the company that designed HopeLab's Zamzee activity tracker to get kids and their families to move more using motivating goals and rewards, and support from games,

peers, family and community. Kids participating to Zamzee trials moved 59% more during the six months trial period, and those at the highest risk due to sedentary lifestyle also managed to increase their activity, girls by 103%, and overweight kids by 27%, and key enablers of such a high impact, were recognition of accomplishments, positive experiences and social connections, however without comparisons or competition between kids, but more fun and engaging interactions (HopeLab 2016).

Another example of a powerful change in experience design is Unicef's Power band i.e a kid-friendly wearable-for-good i.e. fitness band that helps kids to help other kids (also designed by Daylight Design), and it is one example of rewards based on altruistic actions and empathic motivators besides the health benefits associated with increased activity. Such holistic experience design changes the whole picture of experience design, to pose and solve problems, and to deliver a meaningful, engaging, and superior experience to the users. "Amazing things happen when we are able to see through each other's' eyes" (Oliveira 2016) what happens and what can happen, and it can be helped and facilitated by devices.

### 4.2.1 Experience Design Process and Tools

*Experience design* makes difference if compared to the Service design (SD) and the human-centred design (HCD). Experience design stresses the perspectives that further shift attention from the company and service to *the user* in attempt "to put human in the centre of focus, to empower the user, and to design social systems instead of service systems with empathy, collaborating directly with all of the stakeholders to gain direct understanding of audience" (Oliveira 2016). The service design process is somewhat more known than the experience design, therefore this reference was needed to illustrate the difference.

The *design process* is sometimes visualized through the Double diamond with alternating divergent and convergent stages produce shape of two diamonds (Design Council 2008). Original Double diamond was created to be used in industrial product design and there are several different modified versions for software product and service development and even project management or agile and lean software development phases have been fitted to the process (Nessler 2016). According to Nessler first diamond is for designing the right thing and second diamond is for designing things right (Nessler 2016). Modified versions of Double diamond could also draw diamonds in

different lengths or shapes instead of two identical shapes to emphasise focus and other design or project variables (Dunne cited in Nessler 2016). Figure 12 below shows one of those updated double diamond versions from Naaja King.

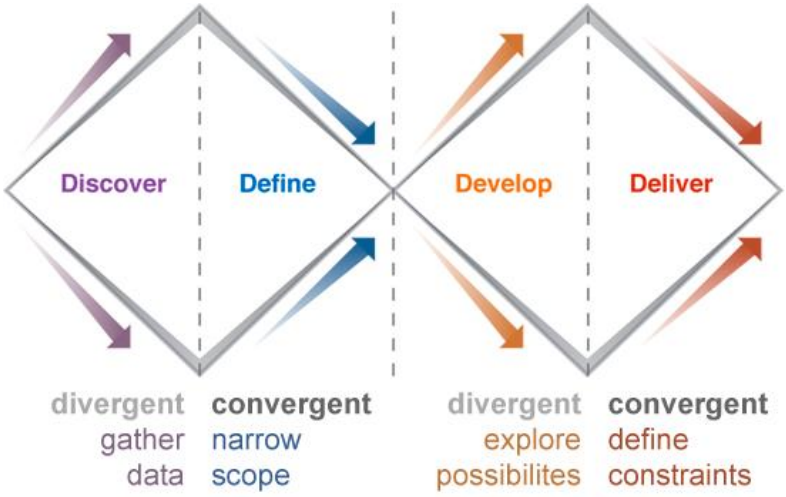



Figure 12. Double diamond Experience design process (Naaja King 2012).

Figure 12 shows the experience design process with *Discover, Define, Develop* and *Deliver* stages. Each stage has its own distinct tools to use.

DISCOVER

Different research skills are used to define the objectives, research questions and interested parties and personas to frame the challenge using similar tools than in the service design toolkit (SDToolkit, ). Creativity is used to invent the future as first phase in the design thinking process of IDEO. And most of all as Design council defined it "…try to look at the world in a fresh way, notice new things and gather insights." (Design Council 2015) Team building is also one aim and collecting the data from the users and letting users validate ideas, and occasionally act as referees solving team disputes. *(Beer 2014)*

DEFINE

This phase is for scoping the design to define details of design challenge and to find three requirements per design challenge answering to questions, who does what and why. KPIs and prioritized requirements are determined for the following phases in the design process. (SDToolkit, ) Or as this phase is described by Design Council in the following way: "…in which designers try to make sense of all the possibilities…The goal

here is to develop a clear creative brief that frames the fundamental design challenge." (Design Council 2015)

Importantly, the extensive user research is included in this phase, and so is the synthesising of findings. Through a collaborative process, patterns were identified, and unique opportunities for what people needed, wanted and personally experienced developed. Communication is essential also in this phase to agree on vision, to which purpose design tools like journey map are helpful. Choosing the right methodology to approach even non-routine situations can make a difference. Early buy-in on decisions and decision making process across entire organizations is one of the benefits of Design Thinking. *(Beer 2014)*

DEVELOP

This phase is again diverging to look for different solutions and concepts and refining them. Prototyping helps to concretize what works and what does not work, and it is also an easy way to get the precious feedback and validate ideas to build trust. Prototypes could include value propositions, staged-content, wireframes, sketched interactive prototypes, staged activities, high-fidelity interactive prototypes, graphic designs, interviews, interaction design, and business design.

Another description of design phase points to the stage as: "…where solutions or concepts are created, prototyped, tested and iterated. This process of trial and error helps designers to *improve and refine* their ideas." (Design Council 2015) Benefits of validated rapid prototype iterations are in improving group efficacy, and belief in group's ability to successfully complete the task. Also such thorough *refinement process* guarantees better production-readiness and quality at the end of the project.

In other words, it is at this stage that the design of use experience gets improved.

> "Designing screens of wearable and mobile apps and web applications in wireframe tools allows all stakeholders to understand and agree on the functionality, appearance and interaction options. Some of those tools are made for online collaboration allowing faster feedback loops".

According to Christian Lindholm, the co-founder of the Finnish health ecosystem booster HealthSPA and CEO of Koru, the wearables should be more like fashion accessories or jewelry reflecting user's identity and being customisable to fit for different

occasions and outfits to be used equally by both men and women. This calls for special tools to make such customization possible.

Figure 13 below shows some of the available user interface elements for Apple watch app design that can be used with the Sketch wireframe tool.

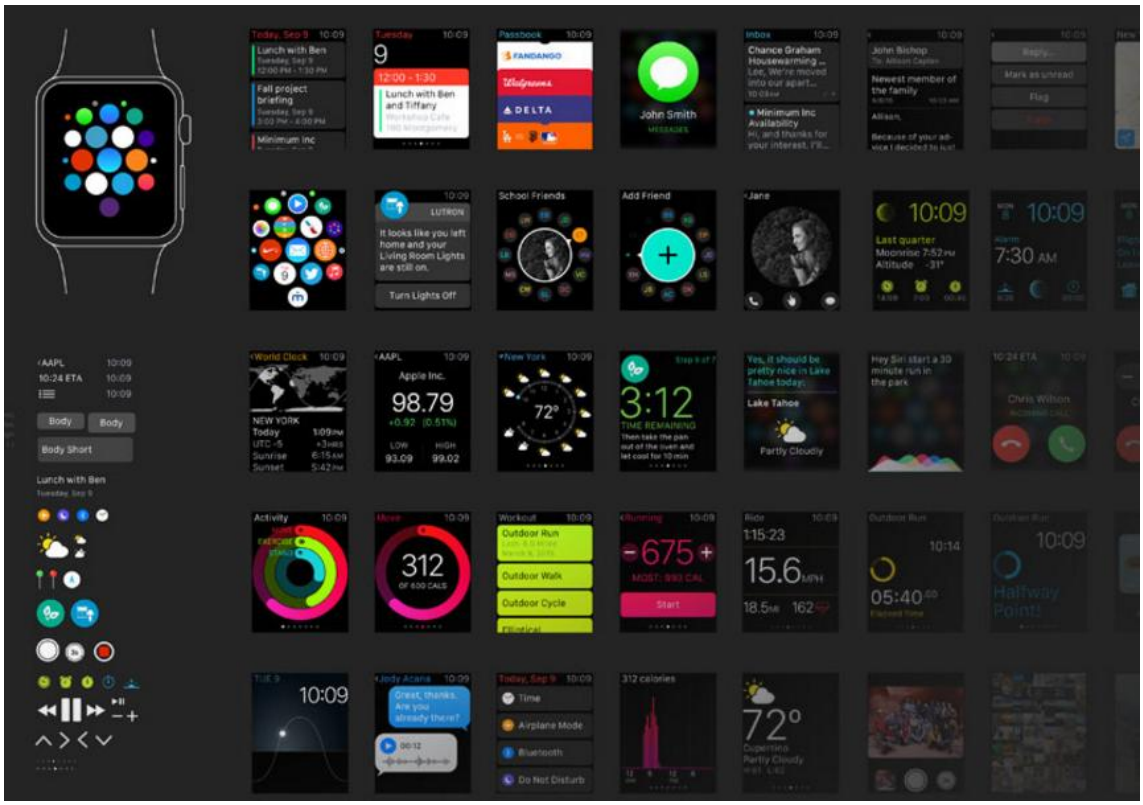



Figure 13. Free Sketch tool resources for Apple Watch UI Kit v2 (Sketchappsources 2016).

Such resources are often called libraries that can be included in the tool to drag-and-drop interface elements into the design. Developers can also create new tool functionalities that are then integrated to the tool as plug-in's, one example is the plug-in, which transforms your design into a presentation with a simple command, called MagicPresenter made to be used from Sketch tool. Tools are often platform specific, working either in Mac or Windows or Linux machines, or Apple or Android mobiles or iPad, which need to be taken into consideration in the tool selection. However also platform independent tools called Web-based platforms exists. Some tools are free, some can be purchased at one time, and many of those require monthly payments. Trial periods can be used to test the features. Some tools like Balsamiq Mockups uses hand-drawing styled elements intentionally "to encourage as much feedback as possible", it can be

used in all earlier mentioned machines and also web-based tool exist, and it can be bought one time with $79 (Creativeblog 2016). Creativity and communication matter most, not tool itself, so handwritten, directly to iPad, or with pen and paper could be as good as other tools, if they boost creativity and cooperation.

DELIVER

In this phase design concept is 'sold' to the clients and peers developing the design into the product. Presenting a good story or prototype can be effective and memorable. Sometimes building empathy in the audience to better understand ideas if they do not belong to the target market group, requires role playing from the audience. Building empathy helps to suppress own judgment, and understand the value of different design decisions. Besides that it can also be fun. (Beer 2014) Again, in the words of Design Council, the Deliver stage is: "...where the resulting project... is finalised, produced and launched." (Design Council 2015) Good communication, persuasion, and storytelling skills are essential in the successful Delivery stage.

However, for a true success, the whole product needs to be built aiming at the best user experience and following it up as various stages of the experience design process. The topic of user experience is discussed in more detail below.

### 4.2.2 User Experiences

User experiences that are common to all users of a product or customers of a service provider could be called universal experiences. Manning and Bodine call those *discover, evaluate, buy, access, use, get support, re-engage or leave* interaction steps in the customer journey (Manning and Bodine 2012: 8-9). IBM calls those *discover, try and buy, get started, everyday use, manage and upgrade, leverage and extend,* and *get support* (IBM 2016). So whether experiences are bundled together or split to more detailed ones, those experiences are useful in designing detailed steps in the interactions between user and product for its lifetime and between user and company for even longer than that.

Watkinson (2013) thinks that there is no detail that is too small to consider when creating consistent, smooth customer journeys, and that way leaves nothing to chance, as third principle of his ten design principles (2013: 35). Other principles behind great cus-

tomer experiences (CXs) are strongly reflecting the customer's identity, satisfying the higher objectives, setting and then meeting expectations, effortless, stress free, indulging the senses, socially engaging, putting the customer in control, and considering the emotions (Watkinson 2013:35-42).

User interface design offers another source of guidelines and principles which Johnson describes in his book and cites those of Norman (1983A), Schneiderman (1987), Schneiderman and Plaisant (2009), Nielsen and Molich (1990), Stone et al. (2005), and Johnson (2007). Nine principles from Johnson are (1) focus on the users and their tasks, not on the technology, (2) consider function first, presentation later, (3) conform to the users' view of the task, (4) design for the common case, (5) do not complicate the users' task, (6) facilitate learning, (7) deliver information, not just data, (8) design for responsiveness, and (9) try it out on users; then fix it (Johnson 2010: Appendix). Especially principle No 8, responsiveness of interactive system needs to be designed with care to meet real-time human interaction deadlines derived from perception and cognitive abilities of human. Those deadlines can vary from millisecond to hundred seconds, from audio gap detection to critical decision in emergency situation (Johnson 2010: 160-161). Conceptual model referred in principle No 2 helps to retain consistency and simplicity of application especially if its main component objects/actions matrix is small and dense it also allows user to learn faster (Johnson 2010: 135-141).

According to Watkinson principles create deeper understanding and provide great way to find a root cause of a problem like the 'Five Why's Analysis' of Toyota, the Japanese continuous improvement philosophy Kaizen (2013:40). Having the goal to try to develop the very best products instead of to make money has worked for Apple (Ive cited Watkinson 2013:206). IBM also focuses on users' goals, anticipating users' next moves and helping them prepare for change and gain actionable insights (2016). According to Manning and Bodine, practices mature, CX organisations excel belong to six high-level disciplines: strategy, customer understanding, design, measurement, governance and culture (2012:62-73). Bean and Van Tyne identify twelve key elements needed in delivering great CX: commit, innovate effectively, know the Do-Fors, know the market, determine the new experience, leverage new platforms, measure value of CX, ensure strong emotional connections, involve people early and often, use small responsive teams, stay connected to customers, refresh and innovate experiences (2012:125). They also point out that it matters how you think: "Large or small, experience makers

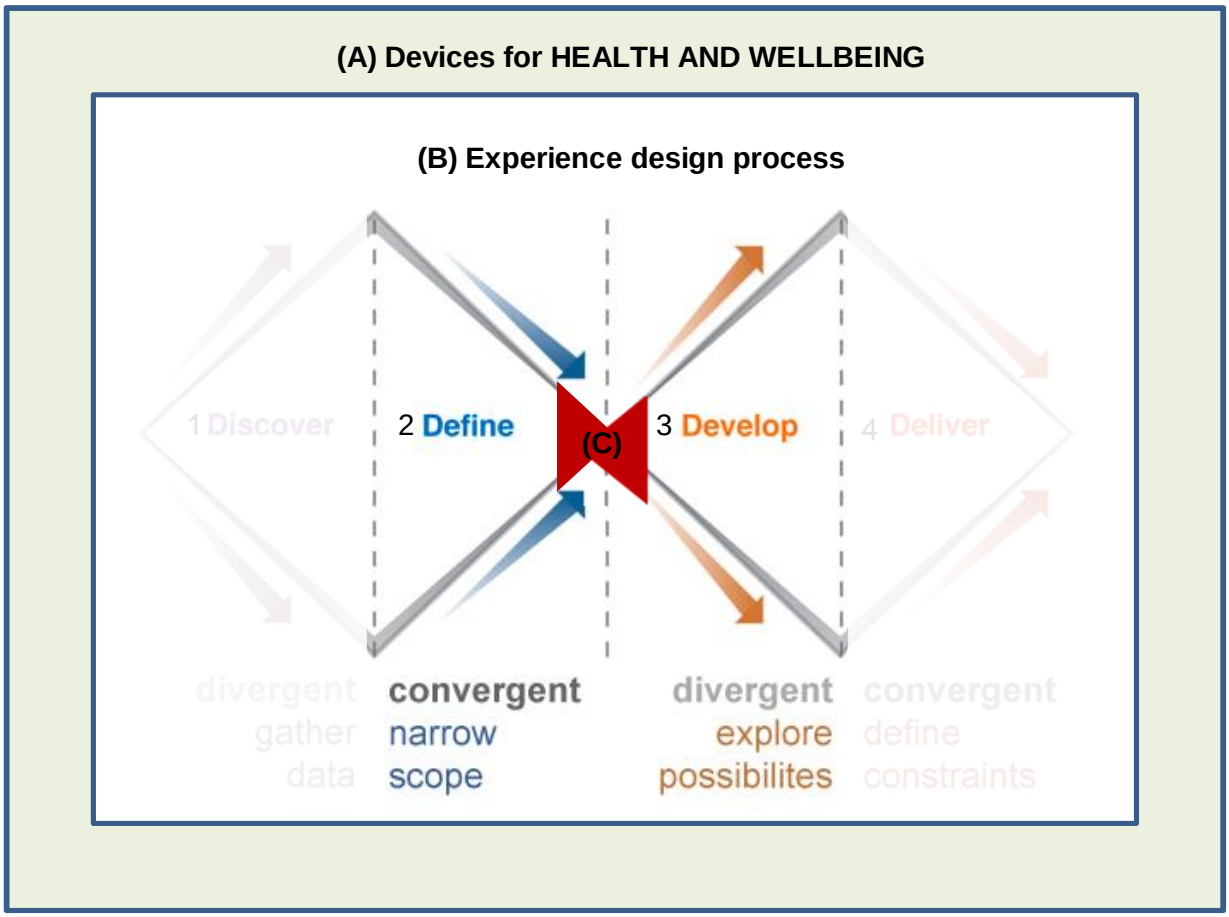
think long term…Their businesses are defined by what they Do-For customers, not by what their products or services do."(Bean and Van Tyne 2012:121)

Summing up, as demonstrated earlier, the service design approach is somewhat more familiar than the user experience design, but the difference becomes visible when comparing the SD approach to the human-centred design (HCD). The user experience perspectives are put into the centre in the experience design, and they have further shifted the design process and goals from the company and service to the user. It is done in attempt to put human in the centre of focus, to empower the user, and to design social systems instead of service systems with empathy, collaborating directly with all of the stakeholders to gain direct understanding of audience (Oliveira 2016).

## 4.3 Conceptual Framework of Designing User Experiences in the Domain of Health and Wellbeing Wearables and Smartwatches

The conceptual framework of this study contains four major parts: (a) *health and well-being* as the main application area for devices, (b) *experience design process* as the platform for defining and developing user experience, (c) *user experience* for wearables and smartwatches, as part of the user experience design.

Figure 14 below contains details of the conceptual framework for designing user experiences for developing health and wellbeing wearables and smartwatches.




| ***A. Devices for HEALTH AND WELLBEING*** | ***B. Experience Design process*** | ***C. User Experience for wearables and smartwatches*** |
|---|---|---|
| Wexler, Huber et al., Dodge et al., Jackson, White, Collier, Firstbeat, Pietilä, Heartmath, Collier, Rehman, UKK-institute, Piwek et al., Lundström, ACSM, Bandura, Carver, Scheier, Prochaska, DiClemente, Hänsel, West, Ryan P. | Oliveira, Beer, Russo, Brown, IDEO.org, Norman, Hassenzahl, Hess, Daylight Design, HopeLab, UK Design Council, Nessler, Dunne, Naaja King, SDToolkit, Lindholm, HealthSPA, Sketchappsources, Creativeblog. | Manning and Bodine, IBM, Watkinson, Toyota, Ive, Bean and Van Tyne, Johnson, Norman, Schneiderman, Schneiderman and Plaisant, Nielsen and Molich, Stone et al. |

Figure 14. Conceptual framework of this study: Designing User Experiences for Developing Health and Wellbeing Wearables and Smartwatches.

As seen from Figure 14 above, the conceptual framework contains, as its background and main area for application, points to devices (wearables and smartwatches) for use in health and wellbeing. These devices rely on the design thinking as the approach to their development, which in turn contains the experience design process at the heart of the device development.

The experience design process follows the two diamond general approach that has the expanding and narrowing areas of focus interchanging. The place for defining the user experience (generalized into guiding principles) is at the end of the *Define* stage, that leads to expansion into the *Develop* stage, with multiple possibilities for the users to utilize the inbuilt general user experience principles. The practical impact from the reflection and generalization of user experiences into the guiding user experience principles can be visible from this approach, since it, first, helps to guide the development (for the developers, at Stage 2) and later opens the opportunity to explore and creatively use the inbuilt features (by the users, utilized at Stage 3) into a diversity of feature utilizations.

# 5 Formulating the User Experience Principles for Developing Wearables

This section synthesizes findings and knowledge from the previous sections and tests ideas especially related to the continuous and long-term use, in two co-creation sessions, one with the developer team of three, second with the expert user-designer. After the discussion, the key generalized user experience principles are proposed.

## 5.1 Overview of Proposal Building Stage

For building the proposal, a number of steps was done in this study. First, the CSA pointed to the challenges as well as *key themes* in user experience. These key themes were analysed in detail and summarized into the key sub-themes for further discussion at the proposal building stage, with experts.

Second, the existing knowledge was explored around the topic of a) *health and wellbeing* as the main application area for devices, (b) *experience design process* as the platform for defining and developing user experience, (c) *user experience* for wearables and smartwatches, as part of the user experience design. It lead to the formulation of the Conceptual framework for building the proposal. The place for defining the user experience (generalized into guiding principles) was identified at the end of the *Define* stage that helps to continue into the *Develop* stage. This logic for defining the general user experience principles helps, first, to guide the development (for the developers, at Stage 2, define) and later opens the opportunity to explore and creatively use the in-built features (by the users, with the results utilized at Stage 3, again for further development).

Third, this logic was discussed with the experts during the Proposal building stage, and the results of the CSA were discussed and the five generalized principles formulated during the co-creation sessions with experts.

Since the goal of the study is to propose set of user experience principles for developers of health and fitness wearables and smartwatches, Data 1 was collected through interviews and secondary data from user experience reviews and surveys. Data 2 was collected in two co-creation sessions and Data 3 by discussing with selected user-developers. Best practice was collected from research of building blocks of user experience and health and well-being devices. Interaction, Long-term use and 24/7 use

were themes raised to further develop together with the practices of good user experience in the future development of health and fitness wearables that would be more personalized, customized, modularized to last longer in the changes of user life and to create smooth and effortless user experience 24/7.

Table 8. Overview of building the proposal for defining the user experience principles for wearables and smartwatches.

| Data | Content | Data source | Content/Findings |
|---|---|---|---|
| Data 1 Section 3, CSA | Identifying key challenges in the current user experience | 1. Users interviews<br>2. Brand information (secondary data); Tests and reviews (secondary data) | User Experience analysis (summary of findings and categorizing them into user experience themes) |
| Data 2 Section 5. Building the Proposal | Defining the generalized user experience principles | 2 sessions: 3+1 User-developers and user-designers | Ideation for generalized user experience principles (based on CSA, literature and experts' suggestions) - 5 general principles |
| Data 3 Section 6, Validating the Proposal | Validating the initial proposal i.e. principles. | 2 channels: 1+3 (meeting+emails) User-developers and user-designers | 1. Helps user with actionable insights<br>2. Gives user control<br>3. Adapts to user's changing needs<br>4. ~~Complements~~ user's life<br>5. Evokes positive emotions awakening user's senses<br>à<br>1. Helps user with actionable insights (personalization)<br>2. Gives user control (flexibility)<br>3. Adapts to user's changing needs (modularity)<br>4. Integrates into user's (real) life (customization)<br>5. Evokes positive emotions awakening user's senses (bonding and engaging) |

As the outcome of the Proposal building stage, the five generalized principles for user experience for wearables and smartwatches were formulated. They will first help the developers (between the stages 2. Define and 3. Develop) and also show multiple possibilities for the users to utilize the inbuilt features (oriented to user experience) into a diversity of feature utilizations. Results from the co-creation with experts are discussed below.

## 5.2 Key Findings from the Co-creation Sessions (Data 2)

In both sessions one of the persons were part of the earlier interviews, and in the group session two team members were new to this study, but experts in their own wearable solution development, thus contributing to multifaceted discussion on the topic.

Table 9 below shows short summary of Data 1 and Data 2 and shows their connection to principles with yellow highlighted principle number beside main theme or topic. Please look first column in Table A3.2 in Appendix 3 for full list of summarized good and bad experiences and opinions previously described in Section 3 as separate tables of Data 1. The input from the participants can also be found in Table A3.1 as form of notes from co-creation sessions.

Table 9. Summary of themes and topics and their connection to principles.

| Themes (Data 1) | Co-creation topics (Data 2) | Proposal principles |
|---|---|---|
| **Interaction – control: -> 2, 5**<br>**1. Automatic functionality and optimisation for frequent use cases**<br>**1.-4. Error prone new method, size, logic -> extra learning and error correction effort**<br><br>**Interaction – feedback: -> 1, 5**<br>**2.-3. sounds, light, vibration and personalised advice based on use history**<br>**5.-6. raw measured data and not smart or distracting feedback**<br><br>**Interaction – communication: -> 1, 2, 3, 4, 5**<br>**4.-5. use of standards and automated communication and error recovery**<br>**7.-8. Smartphone dependent functionality and limited sharing and management of data**<br>A.-B. extra 3rd party service use and faster design cycles and increased versatility<br><br>**Long-term use – start: -> 1, 2, 3, 4, 5**<br>**1.-4. Buy or get as a gift to use or add-on features or drop and develop own**<br>**1. buy wearable while knowing it is not really needed nor usable for long-term**<br>A.-B. crowdfund or test<br><br>**Long-term use – stop: -> 1, 2, 3, 4, 5**<br>**5. discontinued temporarily or permanently depending if multiple uses** | **Co-creation session 1 topics:**<br><br>**1.control with minimized interface**<br>**1.1 multifunction button -> 2**<br><br>**2.feedback without display -> 1**<br>**2.1 accessories**<br>**2.2 types**<br><br>**3.connectivity -> 1, 2, 3, 4**<br>**3.1 gsm, wifi, gps – depending on use context and differentiation**<br><br>**4.social rewards to reach goal -> 5**<br>**4.1 doing good – carbon footprint**<br>**4.2 dashboard/expertise profile**<br>**4.3 community (peer) support**<br><br>**5. size vs. battery use -> 1, 2, 3, 4**<br>**5.1 adequate charging intervals**<br>**5.2 as small as possible form factor**<br>**5.3 functionality needs**<br>**5.4 connectivity needs**<br>**5.5 rigorous testing**<br><br>**6.idle time handling -> 1, 2**<br>**6.1 customizable minimum speed – pause, stops automatically removed from average speed**<br>**6.2 power-saving options or partial limitations use cases (gsm, gps, Bluetooth, heart rate measurement, etc.)**<br><br>**Co-creation session 2 topics:**<br><br>**7.maximise use time -> 1, 2, 3, 4, 5** | **1. Helps user with actionable insights to user's wellbeing - Personalization and learning about user's life and current goal(s**<br><br>**2. Gives user control - Flexibility in use depending on the expertise level**<br><br>**3. Adapts to user's changing needs - Modularity to extend use, future enhancement by changeable parts and enhancements**<br><br>**4. Complements user's life or Integrates to user's (real) life – Customizable to the lifestyle, enforcing user's identity**<br><br>**5. Evokes positive emotions awakening user's senses – Emotions like curiosity, inspiration, joy, satisfaction, calm - Bonding and engaging the user along the journey** |

| | | |
|---|---|---|
| **and convenient to use**<br>**2.-4. no adoption or discontinued use due limited usefulness or failure or disappointment in expectations or lapse in plans or new version**<br>C. change in life require change in health and fitness habits and use<br><br>**Long-term use – impact : -> 1, 2, 3, 4, 5**<br>**6.-12. Adaptation to change, visible progress, helps with new habits and daily life, meaningful measurements, experiments and enjoyment, shared experiences**<br>***5.-6. Effort to manage multiple, disapointment due failure in promised functionality***<br>D.dream wearable helps to understand how own body works effortlessly without need to pay attention to wearable itself<br><br>**24/7 use - value: -> 1, 2, 3, 4, 5**<br>A.-D. Help to master activity, new options and add-ons to community, experimenting and enjoying technology, fun gadget<br><br>**24/7 use - gaps: -> 1, 2, 3, 4, 5**<br>***1.-3. Unsuitable consistency and/or appearance, .lack of functionality, too short battery life and/or difficult charging time, method or battery replacement***<br>E. Wearable is compromise of size, battery life and other functionality for intended use and currently gaps in 24/7 use of wearable are inevitable<br><br>**24/7 use - qualities: -> 1, 2, 3, 4, 5**<br>**1.-4.Fit, changeable parts, robustness, adjustable intensity, adequate choice, configuration options, holistic 24/7 health data collection**<br>F. Wearable needs to fit into the daily life not people adjust their life for wearable | **7.1 less charging gaps – kinetic energy, on-the-body charge, exchangeable battery**<br>**7.2. faster charging – battery size, distributed energy sources**<br>**7.3 water resistance (also straps)**<br>**7.4 use longer – modules to add, replace, etc.**<br>**7.5 use differently like Misfit Shine 2 or Moov Now**<br>**7.6 increase use cases also out of health and fitness**<br><br>**8. increase users -> 1, 2, 3, 4, 5**<br>**8.1 more competitions -> less price -> more purchases**<br>**8.2 different price ranges from low to high end offers**<br>**8.3 customizable – straps, buttons, watchfaces, use of deep and machine learning for feedback filtering**<br>**8.4 new use cases**<br>**8.5 new services and service providers**<br><br>**9. support innovation -> 3, 5**<br>**9.1 idea and need collection**<br>**9.2 empower entrepreneurship**<br>**9.3 new earning logics**<br>**9.4 new ways to sponsor**<br>**9.5 adaptation to change in income, regulation, safety, skills**<br>**9.6 openness – increase cooperation and benefits**<br><br>**10. experience improvements -> 1, 2, 3, 4, 5**<br>**10.1 automate repetitive steps in process**<br>**10.2 reduce idle waiting in process**<br>**10.3 reduce fear in process**<br>**10.4 seamlessly functioning system (not just product)**<br>**10.5 increase data aggregation possibilities – reduce lock-in**<br>**10.6 better fit for the culture, lifestyle, personal preferences**<br>**10.7 increase apps – make developing more viable (e.g. KiezelPay) and using more easy (e.g. aggregate many to one meaningful whole)** | |

In Table 9 above each principle has 12-15 themes or topics pointing to it indicating equal importance for users and experts. However more variation could be derived by going to sub-theme and sub-topic level but for clarity connections are made from main themes and topics only. Nevertheless all the themes and topics that contributed to the

proposal building are further summarized in the following sub-sections under each principle.

### 5.2.1 Helping User with Actionable Insights – Personalisation by Learning from User

Challenge here is in algorithms to learn from use and to find enough ways to personalise the experience for user. Each user is unique so totally relevant feedback is very difficult to achieve. However, simple raw data is not enough anymore, instead of it user needs assistance in setting new goal and in choosing actions to reach it. Wearables using more than one type of data preferably from continuous long-term use will have advantage in estimation of suitable goal that user is able to reach successfully and still be challenged. Few definitions belonging to this principle include:

*"Personalization*" is when the system you are using tailors itself to you and your behaviour. A good example of this is Amazon "noticing" what you are buying and changing their front page to feature similar items. Similarly main view of Ōura app will change according your readiness score based on previous day and night measurements made by your ring from your finger and sent automatically to your smartphone during the day.

*"Insight"* in medical terms is understanding or awareness of one's mental or emotional state or condition or in other context immediate and clear understanding (as seeing the solution to a problem or the means to reaching a goal) that takes place without recourse to overt trial-and-error behaviour. And then actionable insight means clear view of steps to be taken to reach goal in time. Also helpful is to consider DIKW hierarchy.

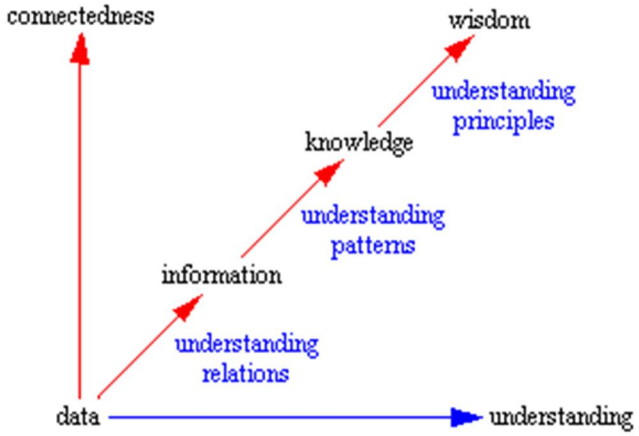



*Figure 15. Data - Information - Knowledge - Wisdom (DIKW) curve* (Bellinger et al. 2004).

*"DIKW hierarchy"* shown in Figure 15 above is the transition from data, to information, to knowledge, and finally to wisdom, and understanding that supports transition between stages with increased levels of connectedness (existing, meaning, memorised & learned, judged) in between data, information, knowledge and wisdom. Wisdom is essentially systemic, and deals with the future, incorporating vision and design. (Bellinger et al. 2004). So wisdom is highest level of connectedness and understanding and ability to judge and act on principle.

User must be able to aggregate own data from different sources if it is not feasible to provide such service this still needs to be facilitated for user as an additional 3rd party service so no lock-in in provider applications alone. Also if wearable system is not able to fully automate personalisation some manual means to tailor system is required from applications. Same way error recovery if not automated then allowing user to do it manually should be provided since errors might affect to the feedback accuracy and quality of communication.

### 5.2.2 Giving User Control – Flexibility in the Use Depending on the Expertise Level of User

Different kind of users need different level of guidance to control wearable. Also different life situations require different use of wearable. So initially wearable should offer more guidance and later more speed to do the tasks. Also more and more detailed information is required by experts fine-tuning their performance or behaviour. Children require different control choices than aged people and besides this natural growth and aging process also disabilities might limit ways to control wearable so adequate control options should be considered that suit for different types of users. And as mentioned earlier developers should not assume that all users are technical-savvy so task-specific not technology-specific concepts should be used throughout the system. Definitions belonging to this principle include:

*"Flexibility"* relates to the quality of being able to change or be changed easily according to the situation.

Wrist-worn wearables with small screen especially those smartwatches tend to replicate functionality of smartphone which is not necessarily suitable for the small screen.

Touch-screen use might make screen viewing impossible so multifunction buttons might be needed if user needs actually to see what is shown in the screen while controlling wearable. Other important factors affecting control flexibility are battery life vs. functionality, wireless or satellite connectivity options, and responsiveness of system that must be explicitly designed to meet real-time requirements of human perception and cognition as explained by Johnson (2010) and cited in Section 4 under User Experience sub-section. Currently most of the wearables connect to the network through smartphone but direct wifi, mobile or satellite connections options are available allowing more control options, better responsiveness and more functionality. Battery life, small-size and increased functionality will remain challenging for developers and trade-offs are not to be avoided. However, functional energy harvesting methods that capture energy from sun (Chen et al. 2016) or/and hand movement (Guo et al. 2016) and store it for wearable use already exists. Some solutions are even scalable and producible with mass-wearing machines so consumer versions might not take that long to emerge and developers need to consider alternative ways to power wearables.

### 5.2.3 Adapting to User's Changing Needs – Modularity to Extend Life

User have changes in life, new family, new hobbies, even the style changes during a life time and wearable should be able to adapt to these changes. Also technological advances will cause pressure to change parts of the wearable when other parts will not need too many changes. Possibility to add new sensor modules, new connectivity modules or new payment modules are examples of modular extension of use of wearable. Apps are another way to extend wearable life with new use cases. Due small size not too many apps can be fitted in wearable but ability to change those with the change in use purpose will extend use of wearable. Definition belonging to this principle include:

*"Adaptation'* is the action or process of adapting or being adapted".

Already some of the sport watches allow user to change measuring interval to better fit for type of training and then download this changed configuration to watch. Garmin even used automatically varying measuring in its sport watch taking slightly different approach than other providers of sport watches according to Dcrainmaker (2 2016).

### 5.2.4 Complementing User's Life – Customization and Identity Reinforcement

Wearable should fit the user's life and not the other way round. So straps with different colours or other customisable watch-faces or watch interface is needed to reinforce user identity. Wearable is visible and worn on body so its look and feel is very important for user. Few definitions belonging to this principle (both draft and final version) include:

*"Customization"* is when the user explicitly changes things - font size, colors, layout, etc."

*"Complement"* means to contribute extra features to (someone or something) in such a way as to improve or emphasize their qualities"

*"Integrate"* means to form, coordinate, or blend into a functioning or unified whole.

Also trust to brand and appreciation of values it represents matter in wearable selection process. Currently big providers have been buying smaller ones like FitBit bought Pebble and Intel bought Basis (both were smartwatches for 24/7 use with longer battery life than typical one day and both using e-ink type low-power-consumption display,) consequences for users were that support eventually finished and in Basis case it was due unsolvable heating problem but nevertheless it is sometimes more difficult to trust continuity of small providers as much as bigger ones.

### 5.2.5 Evoking Positive Emotions Awakening User's Senses – Bonding and Engaging the User along the Journey

Humans are driven by emotions and positive emotions make good memories enforcing bond to wearable and encouraging use of it. User will have changing goals and wearable should be able to adjust to those goals and always be helping user to reach those goals towards healthier habits. Long-term engagement requires positive success moments and empowering empathy to keep on moving despite occasional lapses from fitness and activity plans as is typical for many people with the changing seasons and stress factors priorities tend to change.

Gaming is often used as short-term reward since long-term results take long time to realise in human body after start of aerobic and strength training as indicated by UKK-institute (2012). Researcher in Stanford University got people to consider pension sav-

ing earlier by showing how they would potentially look as old, Dano (2013) suggests similar rendering of body for wearable app use to show long-term effects of obesity to get people in the path of healthier habits. Following sub-section shows principles in Figure 16.

## 5.3 Initial Proposal for Defining the User Experience Principles

This sub-section shows the initial proposal for the user experience principles in graphical form in Figure 15 below. Unfortunately numbering is missing but visible in the final proposal that is otherwise almost identical to this initial proposal. Human star in the middle indicates importance of putting user and user experience in the center of design and development process.

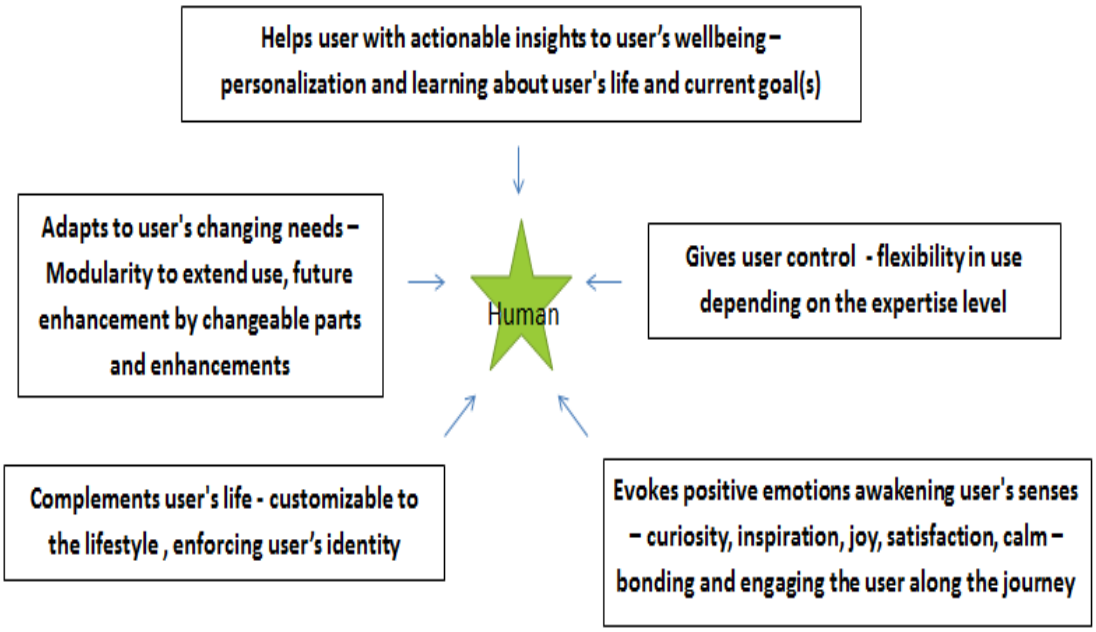



Figure 16. Initial proposal for the user experience principles for developing health and fitness wearables and smartwatches.

Those five different principles in Figure 16 above are combination from findings from users and best practices in creation of good experiences for users of interactive systems especially in relation to health and behavior change. Next section describes the validation of this initial proposal.

# 6 Validation of the User Experience Principles

This section discusses the validation of the user experience principles co-created and discussed in the previous section 5 and further developed after co-creation sessions. One of the user-developers provided feedback to many of the themes discussed in detail in the current state analysis section 3, and that feedback is visible in Table 10 below. Feedback request has been sent to all the co-creation session participants but they have not yet responded, that is the reason for the empty rows for the session 2 in Table.

## 6.1 Overview of Validation Stage

In the validation stage, selected user-developers and user-designers were asked to validate the proposed principles mainly through email except face-to-face meeting was arranged with one of the informants. Feedback and new ideas were given but no major changes were requested, merely change of wording in principle No 4 from complementing user's life to integrating into user life to express more seamless user experience. Their validation comments can be found in Table 10 below and in Appendix 4 together with email correspondence with some of the validators.

## 6.2 Further Developments to Proposal (Based on Validation) and Feedback to the User Experience Principles (Data 3)

The validation comments from the selected user-developers and user-designers to validate the proposed principles are summarized below. Numbers in parenthesis in the Category column indicate principle that comment best corresponds to.

Table 10. Validation feedback, summary of Data 3.

| Session 1 (meeting) | Category | Feedback (quotes from audio transcript)<br>Note: Participants identified both with letter and number referring to the informant number from Data 1 |
|---|---|---|
| R (10) | (1) Personalisation, (2) flexibility | Maybe just adding new data points. So many data and what you will actually do with that and what user is going to make. |
| | (1) Personalisation, (3) modularity | You can always change or add on top of what you already have and have updates from user feedback and then it becomes very complicated, maybe you made algorithm you planned to use with the data and when you get the data you realize it is not possible or not what you actually |

| | | |
|---|---|---|
| | | want to do and then you do something else. |
| | (3) Modularity, (2) flexibility | At the end of the day your product might sell but people use just half of the features and how much was spent in developing those. Modularity, especially software modularity is good. People have different likings. |
| | (3) Modularity, (4) customisation | Lifetime of devices. Miniaturization like in the ring with HR monitor. In 10 years you will not have this watch, because you have nicer ones in the market. Technology develops fast, there is steady technology that does not develop that fast. |
| | (2) Flexibility, (4) customisation | How you think about things and when you see them. Even people themselves they do not know. How people behave is far from how they actually speak that they come to do. |
| | Principles in overall | Successful product is gonna to be dependent on what team will put together on timely fashion… So at the end all of these (strict) rules they gonna be like blown away by the fact that either you compete with others or that somebody had better idea, so when you actually start doing something that is where you are going to apply these different concepts (i.e.priniciples), and you realize you are going to make ten iterations before you have something out there. |
| Session 2 (email) | Category | Feedback (quotes from emails)<br>Note: Participants identified with the letter or number in the parenthesis the same than informant number from Data 1 |
| A (2) | (4) Customisation | Change 'complements' to 'integrates', to better describe both seamless use and fashion. |
| A (2) | Principles in overall | Identified five important traits.<br>I could see them as useful in teaching down the road. |
| J (8) | (4) Customisation, (1) personalisation | Materials/tactility (strap feel, jewelry). Changing habit step by step. How to motivate those who are not self-motivated? |
| J (8) | Principles in overall | Very good points listed. Very interesting. |
| D (9) | (1) Personalisation | Use ethnography tool for mapping what is culturally important and motivating. Identify inspiration sources (role models, dreams, etc.) to amplify and accelerate the change process. Small steps, change goals. |
| D (9) | Principles in overall | Nice insights. It looks sound. |

As seen from Table 10, the validation session provided further feedback and new ideas, but no major changes were requested, merely change of wording in one of the principles from complementing to integrating into user life to express more seamless user experience. Next sub-section presents the final proposal in Figure 17.

## 6.3 Final Proposal for the Use Experience Principles

Below can be seen the final proposal of user experience principles. Notice that only minor changes has been made, first by numbering all principles from clockwise order of importance for user and in wording of fourth principle where word complements is changed with word integrate as suggested by informant 2 or A in his validation feedback.

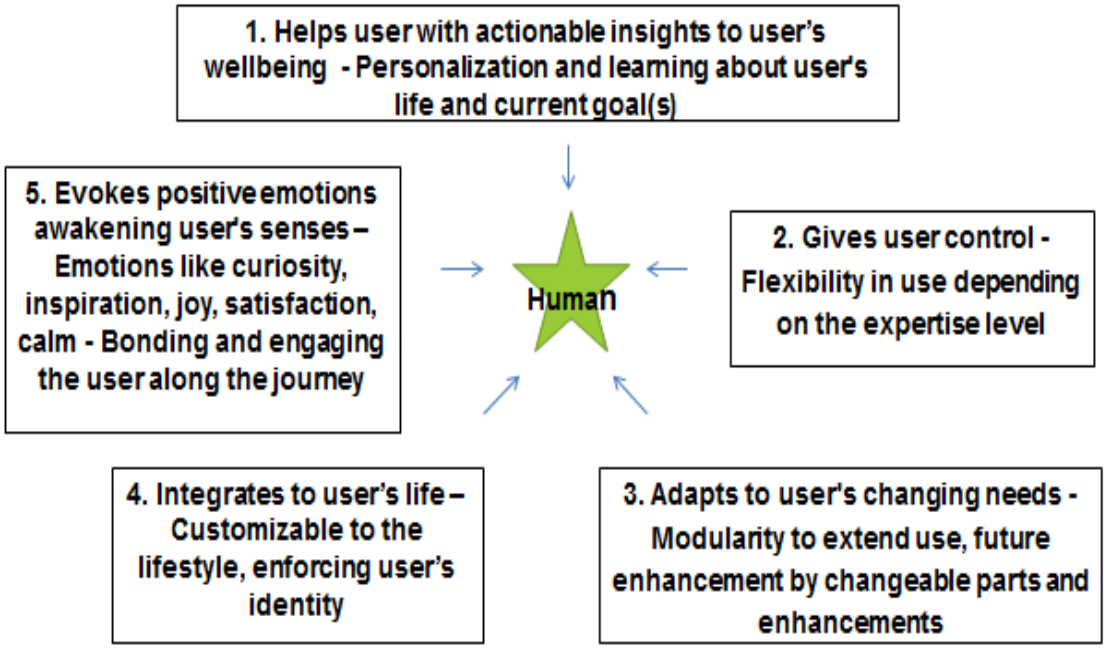



Figure 17. The final proposal for the user experience principles for developing health and fitness wearables and smartwatches.

# 7 Discussion and Conclusions

This section contains the summary of the study, next step and recommendations, and the evaluation of the research process and its outcome.

## 7.1 Summary of the Study

This thesis explores the use of health and fitness wearables and smartwatches from the user perspective in order to define the user experience principles for the design and development of health and fitness wearables and smartwatches. And benefits from wearables that continuously and unobtrusively monitor health of the user and guide the user towards healthier habits, in the face of social, physical and emotional challenges of life. The proposed user experience principles assist the designers and developers to better understand user needs.

The study is conducted using the case study research approach, along six steps, from setting the objective to the evaluation of the outcome. The study evaluated the user experience when using several different brands and models of wearables and collecting qualitative data that is instrumental in the generalization of the user experience principles. Publicly available in-depth reviews, surveys and research offered important building blocks in the formulation of user experience principles. Some of the user-designers and user-developers were part of the co-creation sessions to formulate and validate the user experience principles.

The outcome of this study is five formulated user experience principles for development of health and fitness wearables and smartwatches. These principles are formulated to help the design and development teams to better meet the user needs and expectations. The formulated principles are generalized from the real-life data on user experiences and require opening up into a list of more detailed guidance once the practical implementation starts to further check against the practical choices and trade-offs that designers and developers need to make during the design and development stages, so that best to guide towards the options that are best for users

Thus, the next step is to apply these principles to the real-life design and development of health and fitness wearables and smartwatches, especially regarding the user experience when interacting with the wearable. It is significant since sustainable long-term engagement brings value to the whole community

## 7.2 Next Steps

List of more practical recommendations for developers of wrist-worn health and fitness wearables and smartwatches giving more detailed guidance and reasoning behind each user experience principle was left outside of this study to be done as the next immediate step in the future.

In practical design and development, the first diamond of the user experience design process for synthesizing the health and fitness wearable requirements is always followed by the second diamond of the process, first by exploring potential solutions by prototyping and then fully implementing and delivering the selected one. Lean development with the *build-measure-learn* iterations can be used until the (explored or selected) solution is good enough. Instead of looking for optimal solution to deliver at the end of a long development process purpose is to create fast prototypes of multiple potential solutions for early selection together with all stakeholders, especially future users. And this is where the proposed principles can be helpful to assist the design and development teams by guiding them with the help of the already established and formulated user experience principles. Even in this current generalized form, such principles are able to help better than no guiding principles at all, especially in the situation of fast-paced agile development, or lacking adequate time or resources that can be invested in the pre-investigation of the user experience. This is what had driven the author of this Thesis to conduct this study.

## 7.3 Evaluation of the Study

The plan for making this study as valid and reliable as it only was possible for the current set-up and research process, was discussed earlier in Section 2.4. After the completion of this study it is evident that *validity* might have suffered due to a limited number of users involved into the study, which makes as big a number as the author could only involve in the limited time of a thesis research. Moreover, the one year time that passed since study finished and was published also might have added to the novelty of the results affected by this course of time. But on the other hand, the author carefully followed the development of the products in this target sector and relied the formulated principles on the most evident and firm user experiences and perceptions. Over this period of time no big leaps in wearable technology happened in one year. Finally, valid-

ity of the tools was attempted to keep as much as possible, although no testing of the outcome was adequately done during this study and needs to be continued in the next steps.

In the progress of study, the author has invested as much time as possible into documenting the research process and results in enough detail, so that to make it possible to trace it back to different informants, but without identifying those informants. To stay unbiased, the handling of material was done by recording the interviews and co-creation sessions, which the researcher was able to study again to find the right wording for quotes if ambiguity of meaning was noted. Group sessions were more difficult to record and even taking field notes during the discussions was not easy, therefore some gaps were possible in discussions, but due care was invested to restore the meaning as soon and as precisely as possible, immediately after these discussions and especially after the co-creation sessions. Therefore, it is possible to say that the researcher was able to quire reliably observe the co-creation sessions and be effectively present in idea brainstorming.

Finally, the author of this study strongly believes that, although there is an endless number of principles to look for and best practices of user experience to include into the outcome, so that to best help in design and development of new wellbeing and fitness products, those principles that are *based on human behaviour and the user needs and perceptions* will not change immediately, at least not momentarily at the present moment in time. This makes the proposed outcome useful, at least at the present moment, for those who lack this type of information when they start quite a long process of the design and development of this particular group of products. The author modestly hopes to help these group of specialists on their way to producing more user-friendly health, wellbeing and fitness wearables and smartwatches.

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E_NUJbSmPcrJu2eKVj70GgPoKzomHFusHRIqxHkIkDELALn2empi_Pv8CyIFRk-poMatB_uWEeLlW1Qwm790AEbEAEegJ6dOin_sV1zX3zGfZY1_FTf6coewZVbgFd2QThZQhdjUEgluqlyq11d4yPiIzNRQ%3D%3D&tracking_referrer=www.livescience.com [online] Available at: http://www.apa.org/monitor/2012/09/gut-feeling.aspx [Accessed 5 May 2017]

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## Appendix 1.

## Questions for the data collection of Data 1

**Research questions:**

- How to increase wellbeing?
- How can tools like wearables assist in it?
- What are needs now and in the future?

**Questions for semi-structured interviews to gather Data 1:**

- What wearable(s) do you use? How do you use it? How often?
- For what ‘job’ did you hire it to do for you? When? How? How long?
- Did it fulfill your expectations?
- Do you export/import data? Share data? With who? How? What?
- Did you change your habits because of it?
- Do you feel that it helped you to improve your wellbeing?
- Good experiences? Gains? Surprises?
- Bad experiences? Pains? Missing something? Support needs?
- What would be your dream come true wearable or wearable experience?
- Other wearable, health, wellbeing, support from family, etc.

# Appendix 2.

## Data 1 analysis (from CSA)

Table A2.1 Level 1 Analysis of Data 1 from informants

| Infrm | Driver | Background | use | since | years | device | parallel | Brand/from newest | Model | Type | more wellbeing |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Test | funct.analyst, mkting | gym, run, dog | | | 3 | yes | Apple, Garmin, x | v1, x, x | watch, gps, actvty | help with technology |
| 2 | Test | design teacher, prod.dev. | run, travel, bike | 2006 | 7m, 6, 3 | 4 | no | Apple, Nike,Nike,x | v1, Fuelband,+, x | watch,wrist,shoe,bike | little bit enjoyable |
| 3 | Goal | PM, industry | run, bike, swim | 2003 | 2, 5, 5 | 3 | no | Suunto, Polar, Polar | Ambit2S,RS300X,55M | wrist | progress visible |
| 4 | DIFY | UX, wearable app | continuous | 2012+ | 3 | 2 | no | Ōura, Polar | x, protos to v1 | ring, wrist | fit into the daily life |
| 5 | Fun | secretary, ministry | ski, walk | 2013+ | 2, x, x | 3 | yes | Polar, Omron, x | RCX3, x, x,Sportstracke | wrist,badge,badge,app | play with toys |
| 6 | Fun | worker, place | gym,walk | 2013 | 2 | 1 | no | Polar | x | wrist | training tracking |
| 7 | Goal | test engineer, place | sleep, jetlag | 2010 | 1, 2, 2 | 3 | yes | Sony, Neuro on, Jawbone | | wrist, wrist, mask | increased deep sleep |
| 8 | Test | director, SME | swim,run | 2011 | 6m, 1,1, | 10 | yes | Pebble, MetaWatch, Pola | time steel, x, V800, sma | watches, wrists, +chest strap | passionate about |
| 9 | DIFY | student, design | walk | 2014 | <6m | 2 | no | x, Xaomi | own, Miband | chest, wrist | under development |
| 10 | DIFY | student, environmental | locating, sleep | 2014 | >6m | 1 | no | Pebble+Android | | wrist+phone apps | gesture control easy |
| 11 | DIFY | sw developer, SME | notifications | 2016 | <6m | 1 | no | Pebble | | wrist+phone apps | notifications safe time |
| 12 | Goal | student, school | run | 2011 | 2, 2 | 2 | no | Polar | Ambit2R, x | wrist, wrist | ok HR zones & speed |
| 13 | Fun | worker, shop | walk | 2015 | >6m | 0 | no | | | app | activity at work |
| | | | | up to 12 years | | 27 different models at least | | | | | |

Table A2.2. Summary of findings from Data 1 (for each informant separately)

| User | Good experience | Bad experience | Future/other comments |
|---|---|---|---|
| 1 | -love standalone gps watch<br>-aggregate data from all devices into one health application | - gps watch too big for restaurant use<br>- too many separate apps | -noticed my dog was not that active while home alone (now have motion detecting camera instead for dogsitter to trigger)<br>- interested in how technology can help the everyday struggles |
| 2 | -little more enjoyable to run in a treadmill with wireless headphones (Beats) and watch (Apple) and not with smartphone (Apple) but did not even technically augment my running to be a better runner<br>-surprised how great mapping feature is (voice, vibration without looking)<br>-health app quite accurate (steps, stairs, etc.)<br>- +150 attributes to collect in health app's aggregate dashboard<br>-(Nike) did good job in creating that community for socially sharing run challenges with friends<br>-voice control works well for little things<br>- talking to wrist convenient<br>-good button layout for small screen icons<br>- most users probably do not understand the power of it – separate activity app directly run in watch and vibrate when goal is reached as reward<br>- (Nike) shoe chip was great little device that collected just | - difficult to fix/recover from error in voice control since no typing<br>- smartphone needed in the pocket for brains<br>-no manual editing false steps due f.ex standing desk work<br>- notifications from watch can be distraction – so turned those off<br>-takes some time to get used to menus/screens, so might get lost, but easy to get back to the first screen<br>- users might not realise step data is collected by default in iPhone, like Google tracks your movement and then creates traffic patterns, maybe Apple make a game of steps later<br>-privacy and civil rights are important do not want "big brother" tracking already some insurance companies and corporations kind of force you to share your data in promise of lowering premiums and giving free Apple | -within 10 years screens look archaic so students need to be prepared to understand the future digital and wired up humanistic way<br>-interaction design cycles get shorter and interaction more versatile (ppl-dev's, ppl-env, ppl-ppl)<br>-decision making is tough and have consequences so ethical aspects need to be taken care (why and to what end designed or data collected?)<br>-products and information technology need to be developed with human- and ecologically-centred way with purpose in mind<br>-dream wearable something just installed do not need to pay attention to<br>-added it to my collection of stylish watches (nr 6) that I used in rotation<br>-I do not think 24/7-use is possible, need to charge daily (even twice my phone since I use it so much)<br>- this kind of wonderful device like Apple phone not possible to build modularly, having parts separated for upgrade<br>-phone of the future could be like personal computer always on you |

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|---|---|---|---|
| | what I needed and battery lasted for 8-12 months<br>- trust Apple keep my data private and encrypted in device and iCloud, just for users, at least now<br>-I have 4 different colour straps for my Apple watch so I can change the looks matching my outfit and occasion | watch if your data show you live healthy life.<br>-criticize needing phone all the time f.ex bedroom for sleeping not reaching for phone to check up if missed something<br>-(Nike) shoe chip distance not so accurate<br>-(Nike) fuelband steps not that accurate<br>- no export of data, so data is locked in the Apple Health app or Nike (6-8 years of running data)<br>-a little disturbing that Apple share data with apps already installed<br>-I hope I am not going to buy new 1000 dollar smartwatch every years even my current update cycles for phone 1-1,5 years and computer 2-3 years<br>-corporate-centred overproduction and overconsumption is happening and I am participating in it by already thinking of buying next model because Apple convince me that I need it even before it is manufactured | f.ex carried in the pocket like personal computer<br>- currently my phone is connected with 6-8 accessories (even car is one of those), maybe my cufflinks will be accessories in the future without me knowing it<br>-open source has been there for a while but I think we will be with the Bluetooth for a while<br>-I think there already is some messaging apps in crowdsourcing so maybe there is future in there<br>-Apple told fashion is key component to wearables<br>-I do not know if smart jewellery is the thing thus is very early we need to wait few years but it is totally transformative like IoT – iCloud connected to all your stuff<br>-had to change hobby when moved so bought different device for it<br>-my running habits go with the semester – beginning more time for it, summer too hot, walk with the group once a week<br>-Apple Health app tries to be a hub like iPod was<br>-incredible same hardware with different encasing and price range between 300-10000 dollars for same smartwatch<br>-old watch manufacturers die out if they do not come on board, when wearables come mainstream and provide all price ranges (low-medium-high) |
| 3 | - measuring adds meaning to the running<br>-even small improvements visible<br>- more efficient training in the right heart rate level or speed-heart rate ratio<br>-keep condition up with less training (several years now)<br>-big physical buttons – easier to find and work even with gloves, wet hands without problems<br>- strap with device independent communication protocol (ANT+)<br>- two weeks recording without transfer to pc<br>-1-2 weeks between batteryy charges<br>-automatic upgrade of programs<br>-program downloading and charging easy with the clip<br>-best feature-price ratio for small size gps (multisport | -need speed, distance and HR (HR alone sufficient only in the beginning of running)<br>-just one training program at a time, battery optimisation with another could be useful | -changed from triathlon to running<br>- less time for training due family reasons, work and studies<br>-do not listen music while running<br>-more goalseeking training than full body wellness<br>-tired body (<8 hrs sleep) increase heart rate with 5-10 PBM<br>-enough to last 5-10 years especially when used a lot or bought used<br>-use only when training<br>-not interested of sharing data<br>-own feeling best reference of recovery not interested of HRV measurements for it<br>-due overcondition had to rest one month |

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|---|---|---|---|
| | watch) f.ex integrated recording start fast within 5-10s<br>-wrist-worn – useful, readable | | |
| 4 | -current Ōura ring focus is towards sleep and sleep improvement that then improves daily readiness related to wellbeing and daily performance in kind of physical and mental activities<br>-readiness to face daily challenges -calculation based on sleep and daily activities measured with multiple different sensors in most appropriate way to bring most value for target users<br>- OHR measurement off automatically after wake-up – due increasing battery lifetime and usefulness as a medical aspect affecting to people's daily performance so measuring OHR has less value during day than night unless you are an athlete optimising your performance by exercising according to HR<br>-charging by using physical connector is fastest which is one of the design drivers and reasons to choose that method that way also time off from finger is minimised<br>-ring box is also charger<br>-about 3 days between battery charges<br>-bluetooth connection off automatically during sleep<br>-airplane mode<br>-long time storage of data in the Ōura ring reduces need to be online even if the uploading happens automatically<br>-possible to wear Ōura ring all the time f.ex swimming, sauna, out in the cold weather<br>-beneficial form-factor especially during sleep, also people wear it quite naturally and have been for thousands of years, and it is also quite natural that it is tight fit on your finger so those are all the reasons that originally led to ring form factor<br>-daily personally tuned activity targets depending on readiness score after some | -general issue with wearables is that people stop using them that is well highlighted in Endeavour Partner survey (first part in 2014)<br>-long-term engagement is critical there is plenty of fitness devices not just wearables people buy and then do not use long-term | -all kinds of possibilities in the future to enhance service (open API to 3rd party, feedback directly from ring, etc.) but not in the current version of Ōura ring<br>-current focus is not to compete with Polar or Suunto nor targeting athletes<br>-everything is compromise of size, battery life and so on<br>- challenge is to bring all the parts (hardware, firmware, app software, sensors, algorithms, platforms, infrastructure, etc.) together so they work well together especially in such a physically small but very complex product like Ōura ring<br>-delivery to crowdfunders started end of 2015 so in coming months we start to have real long-term user experiences, I have been working with this project since 2012 (although initial direction was different) and using Ōura ring more than a year since the first protos, but I am a biased user using it for development purposes to improve current version to fullfill customer needs<br>-user-centric design process used where target group of people identified and Ōura ring features matched to suit them<br>- Ōura ring team got long background in this area<br>- Ōura ring for all not just athletes<br>- it has to be this 24/7 experience<br>- wearable needs to be a product that people can really live with, and important aspect is to fit in to the daily life not people to adjust their life to workaround (Ōura ring)<br>-possible first to get dummy fitting Ōura rings to determine the right size for perfect fit for your finger<br>-possibility to use We Are Curious -platform (cloud-based personal data aggregating and tracking platform) |

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|---|---|---|---|
| | days of use of Ōura ring<br>-message-based approach – learns about user of Ōura ring | | |
| 5 | -free app | -badge accidentally into the washing machine and get broken<br>-3x push before selections to start gps tracking in Sports tracker app are done – requires patience when wanting to get to training fast<br>-chest strap difficult (shirt off, assemble strap, suffer it pressuring) | -use different devices for different purposes f.ex Polar (HR) when skiing, Omron (steps)or Sport Tracker app (gps) when walking<br>-"toy" not goal-setting user<br>-"men like to measure", "nice to chat with colleagues"<br>- "bought from ale sales (Hullut Päivät)" |
| 6 | | -chest strap difficult (not using much due that)<br>-loading to pc difficult – left it to other family member to do | -regular use during training, walking, home<br>-wish to purchase new model with more features/measurements if family agrees |
| 7 | Wake-up during light-sleep with several different vibration options and gradually increasing intensity if not stopped from button<br>-managed to increase deep sleep time (1h30 to 2h10-3h) even total nightly sleep time reduced (8-9h to 6h25) and also have part of the sleep during the day (lunch nap) and less during the night | -difficult to get the meaning of data you get from sleeping mask – need to find other sources of information<br>-dynamical sleep phase adjustment not fully functional yet(waiting for software upgrade)<br>-(Jawbone) stopped working (built-in obsolence?)<br>-different platform operating system app not all functionalities | -studied my sleep and now need to know other things but for curiosity might use jawbone still<br>-changing sleep patterns impeded due not always possible to nap at work during breaks (depending on employer)<br>- takes 1 month to adjust biological clock<br>-dream wearable band/patch tracking nervous system to figure out how your body is behaving |
| 8 | -Misfit Shine (Indiegogo) waterproof and disc Aluminium | - strange synchronise menu structure in Adidas<br>-Polar stalling/stopping half way when swimming/training<br>-Amiigo: wait long-time delivery of Indiegogo crowdfunded product, bad communication, leave unused for 6-8 months, after which HR monitoring not functional<br>-accuracy differences when using measurements from several devices for the same thing<br>- get tired for "drink water" notifications (so called "pomodoro technique"or timeboxing) | -Pebble ambassador , meeting arranger<br>-Lumocity/Valkea tester<br>-OHR good enough for mass-market<br>-using measurements to notice trends not for comparison of absolute values<br>-traditional legacy watch is coming back |
| 9 | - | -dropped out after 2 weeks – no use counting steps | -developing own wearable for biking<br>-ubiquitous "naked approach" interesting<br>-NokNok-app changing contact information between phones is excellent for relation building |

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| 10 | -easy to send location information by turning wrist<br>-environment friendly<br>- good community support | -still improving solution | -developing own wearable for informing garbage collection locations (team won Slush with this)<br>-intention to use sleep tracking |
| 11 | - | -planning to implement solution | -prioritizing server notifications sent to watch through smartphone<br>-interested to get involved with the open source community and willing to contribute for the good cause |
| 12 | -ok to use chest strap except in the competitions<br><br>-battery charging with the clip wire ok<br>-possible to add diary entries to training data available in the web | -distance not enough<br>-difficult to change battery (Polar)<br>-do not use chest strap in the competitions | -shares information only with the coach (father) for training program planning<br>- no interest to share with others or in social media<br>-not interested of 24/7 use, just for running<br>-both smartwatches as birthday presents (ages 11 and 13), first one not new/quite old –at the beginning used just timer watch<br>-twice/year lactaat-test from finger<br>-no HRV but sometimes manually calculates 1-2 min from the resting HR in the morning to see capability to tra about to get sick |
| 13 | -free app<br>-easy to collect 10000 steps during the working day (default goal) | - | -smartphone app for counting steps at work where walk a lot<br>-considers buying a device |

Table A2.3. Summary of findings from Data 1 (related to Themes 1-3 divided to groups)

| User | Interaction (control-feedback-communication) | Long-term use (start-stop-impact | 24/7 use (value-gaps-qualities) |
|---|---|---|---|
| Group A: 3, 7, 12 | **-big physical buttons – easier to find and work even with gloves, wet hands without problems**<br>**- strap with device independent communication protocol (ANT+)**<br>**-automatic upgrade of programs**<br>**-program downloading and charging easy with the clip**<br>**-wrist-worn – useful, readable**<br>**-Wake-up during light-sleep with several different vibration options and gradually increasing intensity if not stopped from button**<br>**-ok to use chest strap except in the competitions**<br>**-possible to add diary entries to training data available in the web**<br><br>**-difficult to get the meaning of data you get from sleeping mask – need to** | **- measuring adds meaning to the running**<br>**-even small improvements visible**<br>**- more efficient training in the right heart rate level or speed-heart rate ratio**<br>**-keep condition up with less training (several years now)**<br>**-best feature-price ratio for small size gps (multisport watch) f.ex integrated recording start fast within 5-10s**<br><br>**-need speed, distance and HR (HR alone sufficient only in the beginning of running)**<br><br>**-dynamical sleep phase adjustment not fully functional yet(waiting for software upgrade)**<br>**-(Jawbone) stopped working (built-in obsolence?)**<br>**-different platform operating system app not all functionalities** | **- two weeks recording without transfer to pc**<br>**-1-2 weeks between battery charges**<br>**-managed to increase deep sleep time (1h30 to 2h10-3h) even total nightly sleep time reduced (8-9h to 6h25) and also have part of the sleep during the day (lunch nap) and less during the night**<br>**-battery charging with the clip wire ok**<br><br>**-just one training program at a time, battery optimisation with another could be useful**<br>**-difficult to change battery (Polar)**<br>**-do not use chest strap in the competitions**<br><br>-use only when training<br>-own feeling best reference of recovery not interested of HRV measurements for |

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| | **find other sources of information**<br><br>-do not listen music while running<br>-more goalseeking training than full body wellness<br>-tired body (<8 hrs sleep) increase heart rate with 5-10 PBM<br>-not interested of sharing data<br>-shares information only with the coach (father) for training program planning<br>- no interest to share with others or in social media<br>-both smartwatches as birthday presents (ages 11 and 13), first one not new/quite old –at the beginning used just timer watch<br>-twice/year lactaat-test from finger | -changed from triathlon to running - less time for training due family reasons, work and studies<br>-enough to last 5-10 years especially when used a lot or bought used<br>-studied my sleep and now need to know other things<br>- takes 1 month to adjust biological clock<br>-dream wearable band/patch tracking nervous system to figure out how your body is behaving | it<br>-due overcondition had to rest one month<br>-changing sleep patterns impeded due not always possible to nap at work during breaks (depending on employer)<br><br>-not interested of 24/7 use, just for running<br>-no HRV but sometimes manually calculates 1-2 min from the resting HR in the morning to see capability to train when about to get sick |
| Group B: 4, 9, 10, 11 | **-daily personally tuned activity targets depending on readiness score after some days of use of Ōura ring**<br>**-message-based approach – learns about user of Ōura ring**<br>**-easy to send location information by turning wrist**<br><br>-possible first to get dummy fitting Ōura rings to determine the right size for perfect fit for your finger<br>-possibility to use We Are Curious -platform (cloud-based personal data aggregating and tracking platform)<br>-interested to get involved with the open source community and willing to contribute for the good cause | **-environment friendly**<br>**- good community support**<br><br>**-general issue with wearables is that people stop using them that is well highlighted in Endeavour Partner survey (first part in 2014)**<br>**-long-term engagement is critical there is plenty of fitness devices not just wearables people buy and then do not use long-term**<br>**-dropped out after 2 weeks – no use counting steps**<br>**-still improving solution**<br>**-planning to implement solution**<br><br>-all kinds of possibilities in the future to enhance service (open API to 3rd party, feedback directly from ring, etc.) but not in the current version of Ōura ring<br>-current focus is not to compete with Polar or Suunto nor targeting athletes<br>-everything is compromise of size, battery life and so on<br>- challenge is to bring all the parts (hardware, firmware, app software, sensors, algorithms, platforms, infrastructure, etc.) together so they work well together especially in such a physically small but very complex product like Ōura ring<br>-delivery to crowdfunders started | **-current Ōura ring focus is towards sleep and sleep improvement that then improves daily readiness related to wellbeing and daily performance in kind of physical and mental activities**<br>**-readiness to face daily challenges -calculation based on sleep and daily activities measured with multiple different sensors in most appropriate way to bring most value for target users**<br>**- OHR measurement off automatically after wake-up – due increasing battery lifetime and usefulness as a medical aspect affecting to people's daily performance so measuring OHR has less value during day than night unless you are an athlete optimising your performance by exercising according to HR**<br>**-charging by using physical connector is fastest which is one of the design drivers and reasons to choose that method that way also time off from finger is minimised**<br>**-ring box is also charger**<br>**-about 3 days between** |

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| | | end of 2015 so in coming months we start to have real long-term user experiences, I have been working with this project since 2012 (although initial direction was different) and using Ōura ring more than a year since the first protos, but I am a biased user using it for development purposes to improve current version to fullfill customer needs<br>-user-centric design process used where target group of people identified and Ōura ring features matched to suit them<br>- Ōura ring team got long background in this area<br>- Ōura ring for all not just athletes<br>-developing own wearable for biking<br>-ubiquitous "naked approach" interesting<br>-NokNok-app changing contact information between phones is excellent for relation building<br>-developing own wearable solution for informing garbage collection locations using Pebble watch (team won Slush with this)<br>-intention to use sleep tracking in Pebble watch<br>-prioritizing server notifications sent to Pebble watch through smartphone | **battery charges**<br>**-bluetooth connection off automatically during sleep**<br>**-airplane mode**<br>**-long time storage of data in the Ōura ring reduces need to be online even if the uploading happens automatically**<br>**-possible to wear Ōura ring all the time f.ex swimming, sauna, out in the cold weather**<br>**-beneficial form-factor especially during sleep, also people wear it quite naturally and have been for thousands of years, and it is also quite natural that it is tight fit on your finger so those are all the reasons that originally led to ring form factor**<br><br>- it has to be this 24/7 experience - wearable needs to be a product that people can really live with, and important aspect is to fit in to the daily life not people to adjust their life to workaround (Ōura ring) |
| Group C: 1, 2, 8 | **-surprised how great mapping feature is (voice, vibration without looking)**<br>**-health app quite accurate (steps, stairs, etc.)**<br>**- +150 attributes to collect in health app's aggregate dashboard**<br>**-(Nike) did good job in creating that community for socially sharing run challenges with friends**<br>**-voice control works well for little things**<br>**- talking to wrist convenient**<br>**-good button layout for small screen icons**<br>**- most users probably do not understand the power of it – separate activity app directly run in watch and vibrate when goal is reached as reward**<br>**- (Nike) shoe chip was great little device that col-** | **-aggregate data from all devices into one health application**<br>**-little more enjoyable to run in a treadmill with wireless headphones (Beats) and watch (Apple) and not with smartphone (Apple) but did not even technically augment my running to be a better runner**<br><br>**-I hope I am not going to buy new 1000 dollar smartwatch every years even my current update cycles are for phone 1-1,5 years and computer 2-3 years**<br>**-corporate-centred overproduction and overconsumption is happening and I am participating in it by already thinking of buying next model because Apple convince me that I need it even before it is manufactured** | **-love standalone gps watch**<br>**-I have 4 different colour straps for my Apple watch so I can change the looks matching my outfit and occasion**<br>**-Misfit Shine (Indiegogo) waterproof and disc Aluminium**<br><br>**- gps watch too big for restaurant use**<br>**-criticize needing phone all the time f.ex bedroom for sleeping not reaching for phone to check up if missed something**<br><br>-I do not think 24/7-use is possible, need to charge daily (even twice my phone since I use it so much)<br>-Apple told fashion is key |

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|---|---|---|---|
| | **lected just what I needed and battery lasted for 8-12 months**<br>**- trust Apple keep my data private and encrypted in device and iCloud**<br><br>**- too many separate apps**<br>**- difficult to fix/recover from error in voice control since no typing**<br>**- smartphone needed in the pocket for brains**<br>**-no manual editing false steps due f.ex standing desk work**<br>**- notifications from watch can be distraction – so turned those off**<br>**-takes some time to get used to menus/screens, so might get lost, but easy to get back to the first screen**<br>**- users might not realise step data is collected by default in iPhone, like Google tracks your movement and then creates traffic patterns, maybe Apple make a game of steps later**<br>**-privacy and civil rights are important do not want "big brother" tracking already some insurance companies and corporations kind of force you to share your data in promise of lowering premiums and giving free Apple watch if your data show you live healthy life.**<br>**-(Nike) shoe chip distance not so accurate**<br>**-(Nike) fuelband steps not that accurate**<br>**- no export of data, so data is locked in the Apple Health app or Nike (6-8 years of running data)**<br>**-a little disturbing that Apple share data with apps already installed like being forced to share your data with corporations, insurance companies, "big brother"**<br>**- strange synchronise menu structure in Adidas**<br>**- get tired for "drink water" notifications (so called "pomodoro technique"or timeboxing)** | **-Polar stalling/stopping half way when swimming/training**<br>**-Amiigo: wait long-time delivery of Indiegogo crowdfunded product, bad communication, leave unused for 6-8 months, after which HR monitoring not functional**<br>**-accuracy differences when using measurements from several devices for the same thing**<br><br>-noticed my dog was not that active while home alone (now have motion detecting camera instead for dogsitter to trigger)<br>- interested in how technology can help the everyday struggles<br>-products and information technology need to be developed with human- and ecologically-centred way with purpose in mind<br>-dream wearable something just installed do not need to pay attention to<br>-added it to my collection of stylish watches (nr 6) that I use in rotation<br>-had to change hobby when moved so bought different device for it<br>-my running habits go with the semester – beginning more time for it, summer too hot, walk with the group once a week<br>-Apple Health app tries to be a hub like iPod was<br>-maybe (Apple) do not know where to use all that by default collected data now, waiting to come mainstream and then use your (health) patterns in a game or such (like Google maps used for creating traffic patterns)<br>- this kind of wonderful device like Apple phone not possible to build modularly, having parts separated for upgrade<br>-Lumocity/Valkea tester<br>-OHR good enough for mass-market | component to wearables<br>-incredible same hardware with different encasing and price range between 300-10000 dollars for same smartwatch<br>-old watch manufacturers die out if they do not come on board, when wearables come mainstream and provide all price ranges (low-medium-high) |

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|---|---|---|---|
| | -within 10 years screens look archaic so students need to be prepared to understand the future digital and wired up humanistic way<br>-interaction design cycles get shorter and interaction more versatile (ppl-dev's, ppl-env, ppl-ppl)<br>-decision making is tough and have consequences so ethical aspects need to be taken care (why and to what end designed or data collected?)<br>- currently my phone is connected with 6-8 accessories (even car is one of those), maybe my cufflinks will be accessories in the future without me knowing it<br>-open source has been there for a while but I think we will be with the Bluetooth for a while<br>-I think there already is some messaging apps (mesh not point-to-point connections) in crowdsourcing so maybe there is future in there<br>-I do not know if smart jewellery is the thing thus it is very early we need to wait few years but it is totally transformative like IoT – iCloud connected to all your stuff<br>-Pebble ambassador , meeting arranger<br>-using measurements to notice trends not for comparison of absolute values | | |
| Group D: 5, 6, 13 | **-free app**<br>**-easy to collect 10000 steps during the working day (default goal)**<br><br>**-3x push before selections to start gps tracking in Sports tracker app are done – requires patience when wanting to get to training fast**<br>**-loading to pc difficult – left it to other family member to do**<br><br>-"men like to measure", "nice to chat with colleagues" | **-badge accidentally into the washing machine and get broken**<br><br>- "bought from ale sales (Hullut Päivät)"<br>-wish to purchase new model with more features/measurements if family agrees | **-chest strap difficult (shirt off, assemble strap, suffer it pressuring)**<br>**-chest strap difficult (not using much due that)**<br><br>-use different devices for different purposes f.ex Polar (HR) when skiing, Omron (steps)or Sport Tracker app (gps) when walking<br>-"toy" not goal-setting user<br>-regular use during training, walking, home<br>-smartphone app for counting steps at work where walk a lot<br>-considers buying a device |

Table A2.4. Summary of results for Theme 1, Interaction (with quotes divided to groups)

| Users | Interaction – control | Interaction – feedback | Interaction – communi-cation |
|---|---|---|---|
| Group A: 3, 7, 12 | **-big physical buttons – reliability both in- and outdoor conditions**<br><br>***"no matter how big hand and whether wet or with gloves you need to reach button of Suunto watch fast and reliably when changing between triath-lon sport types (bicycling, swimming and running)"***<br><br>**-automatic functionality and optimisation for fre-quent use cases like up-grades, up- and down-loading of data and pro-grams, and charging of wearable**<br><br>**-enriching measured data with manual inputs like diary entries**<br><br>**-changing screens to fit for training in web UI of Suunto** | **-use of other than textual and graphical feedback like sounds, light and vibration as well as different intensi-ties of those**<br><br>***"wake-up during light-sleep with vibration, repeating every 10 minutes if not stopped from button in Sony band is the main reason I still use it. Neuro on sleep mask uses also light for it which is good since I have photosen-sitive eyes"***<br><br>**-situation-dependent use and feedback**<br><br>***"In the competitions where I must concentrate on going as fast as I can I never use Suunto strap or watch except for 10km run that I am less used to and so I need to check my speed from the watch by briefly glancing it time to time"***<br><br>**- raw measured data availa-ble from NeuroOn sleep mask but user needs to find how to use that data from other sources**<br><br>***"NeuroOn sleeping mask provides detailed sleep data but since it is still in the Beta stage it is giving this pure data without guidance so I need to interpret it myself and it has taken a lot of time to search help from other sources of information"*** | - no interest to share data with others except coach (if one has such)<br><br>**- use of standards like ANT+ or Bluetooth for wireless communication between wearable and its accessory gives user more accessories to choose from different manufacturers**<br><br>**-full functionality of wearable depends on the operating system of smartphone and both functionality of smartphone and com-munication with it**<br><br>***"I rather use Sony app with Sony band since Android app does not have all the functions available"***<br><br>***"Mapping feature in Apple watch is so good but for it to work I still need to have phone close by for gps."***<br><br>***"In-built gps was one of the main reasons to buy Suunto Ambit2 S, it is so fast it only takes 5 - 10s to get the gps loca-tion from satellite and start recording."***<br><br>"Own feeling is best refer-ence of recovery, I am not interested of HRV meas-urements for it."<br><br>"No HRV in sportwatch but I manually calculate 1-2 min from the resting HR in the morning to see capability to train when I feel that I am about to get sick."<br><br>**"Sportwatch can keep two weeks recordings without transfer to pc."** |
| Group B: 4, | **-least invasive way of control f.ex automatic detection or gesture con-** | **- personalised advice de-pending on the readiness score and different main** | -possibility to use 3rd party platforms for extra con-text-related information, |

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| 9, 10, 11 | **trol**<br><br>***"Ōura ring learns about user and this information is used in smartphone app designed with message-based approach to help setting relevant daily targets not just default ones like 10000 steps. Or setting Bluetooth off and heart rate monitoring on when user goes to sleep at night."***<br><br>***"Once user founds garbage out in the nature he only needs to flick, twist or turn the wrist with Pebble watch for location information to be sent for those who have interest to take care of cleaning it – fast and easy. "*** | **screen in app for different users based on automatically collected use information from Ōura ring**<br><br>***"After some days use of Ōura ring the information given by smartphone app at least in the main screen is different for different users so if user did not sleep well personalised activity targets would tune activity target and advice more rest and not push to more activity giving kind of relevant and actionable information for user."*** | community support and data management like We Are Curious-platform, cloud-based personal data aggregating and tracking platform<br><br>**-communication between parts of the system is automatic, and data is not lost due temporary lack of connection**<br><br>***"Ōura ring can store data in the ring for long time so it does not need to be connected all the time. When ring connects, it transfers data stored in the ring automatically to the connected device."***<br><br>-active participation in the activities of an open source community enhancing openness and sharing of data, APIs, programs, tutorials and other support for the benefit of all f.ex further developing programs for the Pebble watches<br><br>*"I am interested to get involved with the open source community and willing to contribute for the good cause"* |
| Group C: 1, 2, 8 | **-new ways to control like voice**<br><br>***"clearly spoken voice control works well for little things and talking to wrist-worn watch is convenient like saying "Hey Siri set a one minute timer" while running on the treadmill"***<br><br>**-new ways to control are error prone and means to recover are not always obvious**<br><br>***"difficult to fix/recover from error in voice control since no typing"***<br><br>***"smartphone needed in*** | **-use of other than textual and graphical feedback like sounds, light and vibration as well as different intensities of those**<br><br>***"surprised how great mapping feature is (voice, vibration without looking map)"***<br><br>***"most users probably do not understand the power of it – separate activity app directly run in watch and vibrate when goal is reached as reward"***<br><br>**- feedback is not smart enough and moving smartphone functionality like notifications to wearable aggravate issues** | **-limited ways to manage and share data collected from all wearables and brands used**<br><br>*"Decision making is tough and have consequences so ethical aspects need to be taken care like why and to what end designed or data collected?"*<br><br>***"too many separate apps"***<br><br>***"users might not realise step data is collected by default in iPhone, like Google tracks your movement and then creates traffic patterns, maybe Apple make a game of steps later"*** |

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| | ***the pocket for brains"***<br><br>*"within 10 years screens look archaic so students need to be prepared to understand the future digital and wired up in humanistic way"*<br><br>**- old ways to control require new design for small display**<br><br>***"good job they figured out button layout for small screen icons in Apple watch, also I am able to read screen while scrolling since crown button at the side is used for that instead of touch buttons"***<br><br>**- new designs for small screen and differences between brands complicates control**<br><br>***"takes some time to get used to menus/screens, so might get lost, but easy to get back to the first screen in Apple"***<br><br>***"strange synchronise menu structure in Adidas"***<br><br>**- limited control of data f.ex. export, error correction**<br><br>***"no manual editing false steps due f.ex standing desk work"***<br><br>***"no export of data, so data is locked in the Apple Health app or Nike with 6-8 years of running data"*** | ***"Apple health app quite accurate (steps, stairs, etc.)"***<br><br>***"Nike shoe chip distance not so accurate"***<br><br>***"Nike Fuelband steps not that accurate"***<br><br>*"measured data is for noticing trends not for comparison of absolute values from wearables of different brands"*<br><br>***"notifications from watch can be distraction – so turned those off"***<br><br>***"I got tired for drink water - notifications using so called pomodoro technique or timeboxing"*** | ***"I trust Apple keep my data private and encrypted in device and iCloud"***<br><br>***"Privacy and civil rights are important do not want "big brother" tracking. Already some insurance companies and corporations kind of force you to share your data in promise of lowering premiums and giving free Apple watch if your data show you live healthy life."***<br><br>***"a little disturbing that Apple share data with apps already installed like being forced to share your data with corporations, insurance companies, "big brother""***<br><br>***"+150 attributes to collect in Apple Health app's aggregate dashboard"***<br><br>***"Nike did good job in creating that community for socially sharing run challenges with friends"***<br><br>*"Pebble use ambassadors to arrange meetings and events to boost the sharing within the community of users and developers in hope to find new opportunities for all"*<br><br>***"Nike shoe chip was great little device that collected just what I needed and battery lasted for 8-12 months"***<br><br>*"interaction design cycles get shorter and interaction more versatile (people - devices, people - environment, people - people)"*<br><br>**-wearable is just one of the accessories of smartphone depending** |

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| | | | **on its operating system and communication with it**<br><br>***"Apple smartphone needed in the pocket for brains (of smartwatch)"***<br><br>*"currently my Apple phone is connected with 6-8 accessories (even car is one of those), maybe my cufflinks will be accesso-ries in the future without me knowing it"*<br><br>*"open source has been there for a while but I think we will be with bluetooth for a while"*<br><br>*"I think there already is some messaging apps (mesh not point-to-point connections) in crowdsourcing so maybe there is future in there"*<br><br>*"I do not know if smart jewellery is the thing thus it is very early we need to wait few years but it is totally transformative like IoT – iCloud connected to all your stuff"* |
| Group D: 5, 6, 13 | **-setting up tracking or using basic functionality like uploading data could be easier**<br><br>***"3x push before selec-tions to start gps tracking in Sports tracker app are done – requires patience when wanting to get to training fast"***<br><br>***"loading data from Polar watch to pc difficult – left it to other family members to do"*** | **-rewarding to reach default goals**<br><br>***"easy to collect 10000 steps during the working day as a default goal with app in my work phone"*** | -limited use and sharing<br><br>*"trying with free app first and just at work"*<br><br>*"Men like to measure so this (skiing performance measured with Polar) is giving one topic to chat with colleagues. I can check my HR, the dis-tance and time to see if it is time to turn back home while skiing. I use Polar watch and chest strap just for endurance training, and for walking I use Omron pedometer pocket-pod and Sport Tracker app especially if I do not know the route."* |

Table A2.5. Summary of results for Theme 2, Long-term use (with quotes divided to groups)

| Users | Long-term use – start | Long-term use – stop | Long-term use - impact |
|---|---|---|---|
| Group A: 3, 7, 12 | **-get as a gift or buy a wearable available in the market with best feature-price ratio for use purpose even if it means switching to a new brand**<br><br>***"Suunto multisport watch had best feature-price ratio for small size integrated gps that starts recording fast within 5-10s, so I bought it as a gift for myself since my old Polar watch was worn-out. So far I had used Polar watches bought from shop as new or used from friends."***<br><br>***"Need to know speed, distance and HR to run practical and goal oriented way. HR enough for the beginner who often have tendency to run too fast which might not bring the best results. HR increase of 5-10 from usual HR-speed ratio shows tiredness of body whereas decrease shows better condition. My first and second Polar required watch, chest strap and foot pod with holder to be tied to shoe laces but my latest Suunto just watch and chest strap to have all three."*** | **-no adoption – limited usefulness due malfunction or failure, or disappointment in expectations or promises**<br><br>***"(Jawbone) stopped working after 3 months normal use, no water nor aggressive environment caused it, I think it was scheduled (built-in obsolence)."***<br><br>***"Sony band supports Android app but it does not offer all functions like Sony app."***<br><br>-change in life require change in health and fitness habits and use of wearable<br><br>*"I changed from triathlon to running since I have less time for training due family reasons, work and studies and can only run in between other responsibilities."*<br><br>*"Now that I have studied my sleep, I need to know other things and spend more time with other projects. However now I have good tools in case I need to do it again later."*<br><br>**-long-term use discontinued temporarily or permanently – initial need fulfilled but other feature use possible, or wearable even if still functional reaches its end-of-life after long-time or heavy use**<br><br>***"I am now aware of my sleep patterns but since it is quite comfortable to wear Sony band I let it track my activities to the lifelog to follow trends and most of all it is convenient wake-up alarm. Also Neuro-on I might use later for jet-lag blocking. However in order to find the solution with most impact to my sleep I must use or apply them in isolation (other solutions being non-wearables like DEVA bach flower elixir*** | **-health and fitness habit enhancement and adaptation to changes in daily life**<br><br>**-helps to reach goals even if circumstances change**<br><br>***"I manage to keep my condition with less training (several years now)."***<br><br>***"It was no longer possible to nap during lunch time due work habits in France so new means to find enough rest with less sleeping time was needed again."***<br><br>***"Recovery from shifting my sleep time with one hour between 22 and 07 is now 2-3 days and not 2-3 weeks as it used to be."***<br><br>**-makes benefits visible even from small changes in health and fitness behaviour**<br><br>***"Even small improvements visible so measurement and statistics strengthens my belief that training works."***<br><br>***"More efficient training in the right heart rate level or speed-heart rate ratio."***<br><br>**-helps to establish new habits based on measurements**<br><br>***"I managed to double my deep sleep while sleeping about 2hrs less combined night (6h25min) and daytime nap (25min during lunchtime) and this accustomisation period to adjust my biological clock took about 1 month."*** |

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| | | ***or pillow mist essential oil).”***<br><br>***“It is enough that sportwatch lasts for 5 - 10 years especially when it is used a lot or bought as used like mine (Polar) was.”*** | ***“I try to fix root cause of sleep problem and to find solution with most impact so I use bach flower elixir and pillow mist essential oil mix separately to see how it affects my sleep.”***<br><br>**-measuring adds meaning to the training**<br><br>***“Measuring adds meaning to the running.”***<br><br>-dream wearable helps to understand how our body works.<br><br>*“Dream wearable could be band/patch tracking nervous system to figure out how your body is behaving*<br><br>*“Dream wearable could be glove, shirt, chip or even nanoparticle in your bloodstream.”* |
| Group B: 4, 9, 10, 11 | **-get as a gift or buy a wearable available in the market and use provided tools and resources to develop the app you need**<br><br>*“I was participating in the development of own wearable solution for informing garbage collection locations using Pebble watch (team won Slush with this).”*<br><br>*“I want to use for prioritizing server notifications sent to Pebble watch through smartphone”*<br><br>*“I intent to use sleep tracking in Pebble watch.”*<br><br>**-design, develop and test new type of wearable for the market**<br><br>*“User-centric design process used where target group of people identified and Ōura ring features matched to suit them.”*<br><br>*“Current Ōura ring focus is* | **-discontinued use - health and fitness plans not followed or wearable broken in misuse or by accident or by unknown reasons**<br><br>***“General issue with wearables is that people stop using them that is well highlighted in Endeavour Partner survey (first part in 2014) “***<br><br>***“Long-term engagement is critical there is plenty of fitness devices not just wearables people buy and then do not use long-term.”***<br><br>***-no adoption – limited usefulness due malfunction or failure, or disappointment in expectations or promises***<br><br>***“I dropped use after 2 weeks – no use counting steps”***<br><br>**-still improving solution**<br><br>**-planning to implement solution** | **- help in daily life beyond fitness use and readily available wearable feature set**<br><br>**“good community support when enhancing existing apps or creating new ones for Pebble smartwatch”**<br><br>“All kinds of possibilities in the future to enhance service (open API to 3rd party, feedback directly from ring, etc.) but not in the current version of Ōura ring.”<br><br>“NokNok-app changing contact information between phones is excellent for relation building.” |

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| | *not to compete with Polar nor Suunto nor to target athletes alone."*<br><br>*"Delivery to crowdfunders started end of 2015 so in coming months we start to have real long-term user experiences, I have been working with this project since 2012 (although initial direction was different) and using Ōura ring more than a year since the first protos, but I am a biased user using it for development purposes to improve current version to fullfill customer needs. Ōura ring team got long background in this area. We follow user-centric design process where target group of people is identified and Ōura ring features matched to suit them."*<br><br>*"I am participating in the development of own wearable for biking."* | | |
| Group C: 1, 2, 8 | **-aggregate data from all devices into one health application**<br><br>**-buying or considering to buy a new version of wearable while knowing it is not really needed**<br><br>***"corporate-centred overproduction and overconsumption is happening and I am participating in it by already thinking of buying next model because Apple convince me that I need it even before it is manufactured"***<br><br>-buy a wearable because have opportunity to do so especially after recommendation from people or brand you know and trust<br><br>*"I did not plan to buy the first Apple watch even I do like watches just for the style but I wanted to know more about the design and apps to see if they could be of use or value in product design and development projects of students howev-* | **-replace wearable every year or according to renewal cycle for wearables**<br><br>***"I hope I am not going to buy new 1000 dollar smartwatch every years even my current update cycles are for phone 1-1,5 years and computer 2-3 years"***<br><br>**-no adoption – limited usefulness due malfunction or failure, or disappointment in expectations or promises**<br><br>***"Polar stalling/stopping half way when swimming/training"***<br><br>***"Amiigo: wait long-time delivery of Indiegogo crowdfunded product, bad communication, leave unused for 6-8 months, after which HR monitoring not functional"***<br><br>***"Accuracy differences when using measurements from several devices for the same thing even knowing it is trends within rather than comparisons in-between wearables I am more likely to*** | **- experimenting and enjoying wearable technology as essential part of daily life**<br><br>***"Little more enjoyable to run in a treadmill with wireless headphones (Beats) and watch (Apple) and not with smartphone (Apple) but it did not even technically augment my running to be a better runner"***<br><br>***"I was surprised how good the mapping feature is, walking without map in hand while travelling, quickly glancing Apple watch if it vibrates to get direction, no need to get phone out pocket. Interface interaction is really nice."***<br><br>***"I think by now Optical Heart Rate monitoring is good enough for mass market. Although in*** |

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| | *er when I found out they have watch in store I bought it anyway."*<br><br>-crowdfunding innovative wearables or accessories despite waiting time and risks involved and testing wearables and apps under development in other companies or communities<br><br>*"Especially during last three years I have tested several wearables, accessories and apps and also participated in crowdfunding of some of those with both good and bad experiences."*<br><br>-Apple Health app tries to be a mobile hub like iPod was for desktop<br><br>-maybe (Apple) do not know where to use all that by default collected data now, waiting to come mainstream and then use your (health) patterns in a game or such (like Google maps used for creating traffic patterns) | ***use the one with more accurate measurements. However it is just one criteria among many."***<br><br>*"I noticed my dog was not that active while home alone (now have motion detecting camera instead for dogsitter to trigger)."*<br><br>**-discontinued use - health and fitness plans not followed or wearable broken in misuse or by accident or by unknown reasons**<br><br>*"Nike Fuelband battery run out and I did not bother to charge it."*<br><br>-change in life require change in health and fitness habits and use of wearable<br><br>*"I had to change hobby when I moved to another country, so I bought another kind of wearable for that."*<br><br>*"My running habits go with the semester – beginning more time for it, also during summer it is too hot to even walk so our weekly walk group have pause."* | ***swimming special frequency of chest strap works much better in water than wrist-worn optical measurement. I found Pebble Time Steel with swim.com app to be much better in recording swimming than f.ex. Polar V800 that stalled and stopped half way. So I use Pebble for swimming and Polar for training and have been using it for running since late 90's and Timex, Casio even before that and currently Run Keeper app as well with Nokia and iPhone."***<br><br>*"This kind of wonderful device like Apple phone not possible to build modularly, having parts separated for upgrade."*<br><br>***-disappointment due failure in promised functionality***<br><br>***-requires extra effort to manage multiple wearables and apps***<br><br>***"too many separate apps"***<br><br>***"I have not played much with Adidas."***<br><br>***"I left Amiigo for 6-8 months and found heart rate monitoring did not function anymore."***<br><br>*"Dream wearable something just installed do not need to pay attention to, to take off to charge battery and back on after."* |
| Group D: 5, 6, 13 | **-opportunity to buy a wearable that people close to you already use and recommend and with reduced price**<br><br>***"I bought Polar watch from ale sales (Hullut*** | **- discontinued use - by accident**<br><br>***"Pocket pod got accidentally into the washing machine and get broken*** | **-already routine to use regularly, no change in activity habits but impact on shared experience with family and colleagues**<br><br>***"My colleagues got*** |

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| | ***Päivät) so without planning but I knew colleagues who use such."***<br><br>*"I wish to purchase new Polar model with more features / measurements if family agrees which they do not do, yet"*<br><br>*"I consider buying a wearable not just using free app."* | | ***exited with losing weight and measuring so even I never had that problem I wanted to support them in their effort and end up buying my first wearable, the Omron pedometer, pocket pod."***<br><br>***"I never realized how many steps I take during my working day."***<br><br>***"I use my Polar sportwatch all the time when I am walking, training at home or at gym several times a week. Not the chest strap though since it is troublesome."*** |

Table A2.6. Summary of results with Theme 3, 24/7 use (with quotes divided to groups)

| **Users of Group** | **24/7 use - value** | **24/7 use - gaps** | **24/7 use - qualities (fit/comfort/form factor and quality/robustness)** |
|---|---|---|---|
| Group A: 3, 7, 12 | -very specific use area for wearable to master running, sleep, etc.<br><br>"I bought wearables (Jawbone, Sony band, Neuro on sleep mask) to influence my sleep to get more rest and more time for other thing, so not for activity tracking or setting activity goals but I will try other features like jetlag blocker when I move to Canada and next time I make my yearly travel to Japan"<br><br>"my choice of training, triathlon, made me buy Suunto, even I currently have only time for running, so I use it first of all for training intervals with either heart rate or speed and then for recording those to later study those in pc. I am not interested in 24/7 use."<br><br>"I use Suunto sportwatch only for running and then I share data with my coach/father who plan my training and competition schedule." | ***"Sony band is convenient to use so I end up using it all the time but especially for wake-up in the morning or after napping. Same time I get life log events to detect activity trends or patterns. It is easy to take off and put back on for charging for 1-2 hours every 4-6 days. Sensor module is splash water proof so perfectly fine for daily use."***<br><br>***"battery charging with the clip wire is ok"***<br><br>*"I am not interested to use sportwatch 24/7, like my father/coach nor to use it when I am running in the competition where I only concentrate to run as fast as possible. Only distances I am less accustomed to I might use watch but never chest strap in competition."*<br><br>*"Due overcondition I had to rest one month but otherwise I use sportwatch for running several times a week but not otherwise."*<br><br>***"It was difficult to change*** | ***"Sony band is convenient and splash water proof and tracks my sleep so it is possible to use most of the time and when not it is easy take off and put back on."***<br><br>*"Both Neuroon mask and Sony band have sensor module that can be separated from the band and mask, so different parts could be updated separately."*<br><br>***"I have used just one training program at a time, but battery optimisation with another one could be useful, so I could configure another for that with less frequent measurements to download into my Suunto sportwatch."*** |

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| | | ***battery in my previous Polar sportwatch (now use Suunto).”*** | |
| Group B: 4, 9, 10, 11 | - Offering new options and add-ons to wearable eco-system<br><br>*“Challenge is to bring all the parts (hardware, firm-ware, app software, sen-sors, algorithms, platforms, infrastructure, etc.) together so they work well together especially in such a physi-cally small but very complex product like Ōura ring.”*<br><br>*“Ubiquitous “Naked Ap-proach” in which user is gadget-free and environ-ment smart and connected, is interesting.”* | *“Everything is compromise of size, battery life and so on.”*<br><br>**“Ring is benefit form-factor compared to other form-factors since it is small and people wear it naturally. Wa-ter or cold is no problem so wearing all the time is possi-ble. Charging one hour twice a week is only time you need to take ring out of your fin-ger. Ring box becomes charging cradle when you connect it to the electrical outlet, physical wire is cur-rently fastest way to charge.”**<br><br>“Ōura ring measures optical heart rate only during night due battery optimisation and current focus on improved readiness i.e. wellbeing, daily perfor-mance, physical and mental activity for all not just athletes, and not competing with Polar or Suunto with HR measuring during day for tuning exercise. Considering medical aspects of people performance HR during day has less value as data than HR during night.”<br><br>**“It takes about 3 days be-tween battery charges.”**<br><br>**“I use Pebble all the time except for training I use Po-lar and for running I also use Runkeeper app with smartphone. Pebble is water *resistant so I use it for swimming together with swim.com app. Pebble also measures my sleep, passes notifications from smartphone and need to be charged only ones or twice a week. Since I am Pebble ambassador I am constantly looking for new opportunities and ideas from developers and users I meet or discuss so I am aware of new apps and accessories under de-velopment and I also pass suggestions to Pebble. ”*** | *“ it has to be this 24/7 experience, wearable needs to be a product that people can really live with, and important aspect is to fit in to the daily life not people to adjust their life to workaround (Ōura ring).”*<br><br>*“It is possible first to get dummy fitting Ōura rings to determine the right size for perfect fit for your finger as an extra ser-vice.”*<br><br>**“Readiness to face daily challenges - calculation *in Ōura ring* uses *previous day and night activities (sleep also one type of activity)* measured with multiple different sensors in most appropriate way to bring most value for target users.”**<br><br>***“I can see time all the time from e-ink display of Pebble smartwatch because it is not turned off after time-out, and backlights can be easily turned on in the dark even with the turn or shake of wrist or by pushing button.”***<br><br>***“I can easily change watch faces from the watch or from the mo-bilephone app. I could also make my own watch faces and share them or just use those that Pebble or other developers provided.”***<br><br>***“I can easily take off straps and clip on new ones, any 22cm width strap can be used with Pebble smartwatch.”***<br><br>***“Ōura ring is water-proof, heat and scratch resistant so fit for use*** |

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| | | | ***all the time."*** |
| Group C: 1, 2, 8 | - experimenting and enjoying wearable technology as essential part of daily life<br><br>*"I am interested in how technology can help the everyday struggle. I tried activity tracker for my dog too and found out it is lazy."*<br><br>***"I added Apple smartwatch to my collection of stylish watches (nr 6) that I use in rotation."***<br><br>*"I did not yet get used to having computer at wrist (Apple watch)."*<br><br>*"Products and information technology need to be developed with human- and ecologically-centred way with purpose in mind."* | ***"Garmin (standalone) gps watch is too big to use in the restaurant, no matter how much I like it for gps tracking without smartphone."***<br><br>***"I criticize needing phone all the time f.ex bedroom is for sleeping and not reaching for phone to check up if I missed something so I do not need Apple smartwatch for that either. It is enough to leave phone in the corridor just close enough to hear wake-up alarm."***<br><br>*"I do not think 24/7-use is possible, I need to charge Apple smartwatch daily (and my Apple smartphone even twice a day since I use it so much)."* | ***"Misfit Shine (Indiegogo) waterproof and disc Aluminium so very light and you can wear it many different ways."***<br><br>***"I have 4 different colour straps for my Apple watch so I can change the looks matching my outfit and occasion."***<br><br>*"Incredible same hardware with different encasing and price range between 300-10000 dollars for same Apple smartwatch."*<br><br>*"Apple told fashion is key component to wearables."*<br><br>*"Old watch manufacturers die out if they do not come on board, when wearables come mainstream and provide all price ranges (low-medium-high)."* |
| Group D: 5, 6, 13 | -use is frequent but wearable is not necessity<br><br>*"I exercise several times a week but I do not set goals. To me sportwatch is a "toy" not having impact to my wellbeing."* | **"Chest strap is difficult so I am not using it much."**<br><br>"I use sportwatch regularly for training in gym and home and for walking."<br><br>"I just use the smartphone app for counting steps at work where I walk a lot but not when I am walking my dog (small one)." | *"I use different devices for different purposes f.ex Polar (HR) when skiing, Omron (steps)or Sport Tracker app (gps) when walking."* |

Table A2.7 Comparison table of four wearables used by informants (Dcrainmaker 2016)

| FUNCTION/FEATURE | ADIDAS SMART RUN GPS | POLAR RCX3 | POLAR V800 | SUUNTO AMBIT2 R | SUUNTO AMBIT2 S |
|---|---|---|---|---|---|
| COPYRIGHT DC RAINMAKER - UPDATED NOVEMBER 27TH, 2016 @ 4:58 AMNEW WINDOW | | | | | |
| PRICE | $399 | $170.00 | $449 | $250 | $219 |
| PRODUCT ANNOUNCEMENT DATE | OCT 16, 2013 | MAR 19, 2012 | JAN 6TH, 2014 | JAN 28, 2014 | APR 29, 2013 |
| ACTUAL AVAILABILI- | NOV 1 | JUNE 2012 | MAY 2014 | MAR 2014 | MAY 2013 |

| FUNCTION/FEATURE | ADIDAS SMART RUN GPS | POLAR RCX3 | POLAR V800 | SUUNTO AMBIT2 R | SUUNTO AMBIT2 S |
|---|---|---|---|---|---|
| TY/SHIPPING DATE | ,2013 | | | | |
| GPS RECORDING FUNCTIONALITY | YES | SEPARA-TE GPS POD | YES | YES | YES |
| DATA TRANSFER | WIFI | WIND | USB, BLUETOOTH SMART | USB | USB |
| WATERPROOFING | 1ATM (~IPX7) - NO SWIM-MING | YES | YES - 30M | YES - 50M | YES - 50M |
| BATTERY LIFE (GPS) | 6-8 HOURS (UPDATED) | 1 YEAR (GPS SE-PARATE) | UP TO 50 HOURS | 25 HOURS | 25 HOURS |
| RECORDING INTER-VAL | 1S | ADJUS-TABLE | 1S | VARIABLE | VARIABLE |
| SATELLITE PRE-LOADING VIA COM-PUTER | YES | NO | SORTA, PRE-DICTIVE BUT NOT CACHED. | YES | YES |
| QUICK SATELLITE RECEPTION | SOMETI-MES, BUT NOT AL-WAYS. | GOOD VIA GPS POD | GOOD | GREAT | GREAT |
| ALERTS | VI-BRATE/VIS UAL (AU-DIO ONLY WITH HEAD-PHONES) | SOUND/VI SUAL | VIBRA-TE/SOUND/VISU AL | SOUND/VISU AL | SOUND/VISU AL |
| BACKLIGHT GREAT-NESS | CONFIGU-RABLE, GREAT. | GOOD | GREAT | GREAT | GREAT |
| ABILITY TO DOWN- | NO | NO | NO | YES | YES |

| FUNCTION/FEATURE | ADIDAS SMART RUN GPS | POLAR RCX3 | POLAR V800 | SUUNTO AMBIT2 R | SUUNTO AMBIT2 S |
|---|---|---|---|---|---|
| LOAD CUSTOM APPS TO UNIT/DEVICE | | | | | |
| ACTS AS DAILY ACTIVITY MONITOR (STEPS, ETC...) | NO | NO | YES | NO | NO |
| CAN CONTROL PHONE MUSIC | | | NO | | |
| HAS MUSIC STORAGE AND PLAYBACK | | | NO | | |
| CONNECTIVITY | ADIDAS SMART RUN GPS | POLAR RCX3 | POLAR V800 | SUUNTO AMBIT2 R | SUUNTO AMBIT2 S |
| BLUETOOTH LEGACY (PRE-4.0) TO PHONE | NO | NO | NO | NO | NO |
| BLUETOOTH SMART (4.0+) TO PHONE UPLOADING | YES (ADDED SUMMER 2014) | NO | YES | NO | NO |
| PHONE NOTIFICATIONS TO UNIT (I.E. TEXTS/CALLS/ETC...) | NO | NO | YES | NO | NO |
| LIVE TRACKING (STREAMING LOCATION TO WEBSITE) | NO | NO | NO | NO | NO |
| GROUP TRACKING | | | NO | | |
| EMERGENCY/SOS MESSAGE NOTIFICATION (FROM WATCH TO CONTACTS) | NO | NO | NO | NO | NO |
| BUILT-IN CELLULAR CHIP (NO PHONE REQUIRED) | NO | NO | NO | NO | NO |
| CYCLING | ADIDAS SMART RUN GPS | POLAR RCX3 | POLAR V800 | SUUNTO AMBIT2 R | SUUNTO AMBIT2 S |
| DESIGNED FOR CY- | NO (CAN | YES | YES | NO (BUT | YES |

| FUNCTION/FEATURE | ADIDAS SMART RUN GPS | POLAR RCX3 | POLAR V800 | SUUNTO AMBIT2 R | SUUNTO AMBIT2 S |
|---|---|---|---|---|---|
| CLING | SHOW SPEED) | | | CAN SHOW SPEED) | |
| POWER METER CAPABLE | N/A | NO | YES | N/A | YES |
| POWER METER CONFIGURATION/CALIBRATION OPTIONS | N/A | N/A | YES | N/A | YES |
| POWER METER TSS/NP/IF | N/A | N/A | NP | N/A | NO |
| SPEED/CADENCE SENSOR CAPABLE | N/A | YES | YES | NO | YES |
| STRAVA SEGMENTS LIVE ON DEVICE | | | NO | | |
| CRASH DETECTION | | | NO | | |
| RUNNING | ADIDAS SMART RUN GPS | POLAR RCX3 | POLAR V800 | SUUNTO AMBIT2 R | SUUNTO AMBIT2 S |
| DESIGNED FOR RUNNING | YES | YES | YES | YES | YES |
| FOOTPOD CAPABLE (FOR TREADMILLS) | YES | YES | YES | YES (INTERNAL ACCELEROMETER) | YES (INTERNAL ACCELEROMETER) |
| RUNNING DYNAMICS (VERTICAL OSCILLATION, GROUND CONTACT TIME, ETC...) | NO | NO | NO | NO | NO |
| VO2MAX ESTIMATION | NO | YES | YES | YES | YES |
| RACE PREDICTOR | YES | NO | YES, VIA RACE PACE | NO | NO |
| RECOVERY ADVISOR | NO | YES | YES | YES | YES |
| RUN/WALK MODE | NO | NO | YES, VIA TIMERS | NO | NO |

| FUNCTION/FEATURE | ADIDAS SMART RUN GPS | POLAR RCX3 | POLAR V800 | SUUNTO AMBIT2 R | SUUNTO AMBIT2 S |
|---|---|---|---|---|---|
| SWIMMING | ADIDAS SMART RUN GPS | POLAR RCX3 | POLAR V800 | SUUNTO AMBIT2 R | SUUNTO AMBIT2 S |
| DESIGNED FOR SWIMMING | NO | NO | YES | NO | YES |
| OPENWATER SWIMMING MODE | N/A | N/A | YES | N/A | YES |
| LAP/INDOOR DISTANCE TRACKING | N/A | N/A | YES | N/A | YES |
| RECORD HR UNDERWATER | N/A | NO | YES | N/A | NO |
| OPENWATER METRICS (STROKE/ETC.) | N/A | N/A | YES | N/A | YES |
| INDOOR METRICS (STROKE/ETC.) | N/A | N/A | YES | N/A | YES |
| INDOOR DRILL MODE | N/A | N/A | NO | N/A | YES |
| INDOOR AUTOPAUSE FEATURE | N/A | N/A | NO | N/A | NO |
| CHANGE POOL SIZE | N/A | N/A | YES | N/A | YES |
| INDOOR MIN/MAX POOL LENGTHS | N/A | N/A | - | N/A | 15M/Y TO 1,200M/Y |
| ABILITY TO CUSTOMIZE DATA FIELDS | N/A | N/A | YES | N/A | YES |
| CAN CHANGE YARDS TO METERS | N/A | N/A | YES | N/A | YES |
| CAPTURES PER LENGTH DATA - INDOORS | N/A | N/A | YES | N/A | YES |
| INDOOR ALERTS | N/A | N/A | N/A | N/A | NO |
| TRIATHLON | ADIDAS SMART RUN GPS | POLAR RCX3 | POLAR V800 | SUUNTO AMBIT2 R | SUUNTO AMBIT2 S |
| DESIGNED FOR | NO | YES | YES | NO | YES |

| FUNCTION/FEATURE | ADIDAS SMART RUN GPS | POLAR RCX3 | POLAR V800 | SUUNTO AMBIT2 R | SUUNTO AMBIT2 S |
|---|---|---|---|---|---|
| TRIATHLON | | | | | |
| MULTISPORT MODE | N/A | NO | YES | N/A | YES |
| WORKOUTS | ADIDAS SMART RUN GPS | POLAR RCX3 | POLAR V800 | SUUNTO AMBIT2 R | SUUNTO AMBIT2 S |
| CREATE/FOLLOW CUSTOM WORKOUTS | YES | PARTIAL | YES | SORTA (VIA SUUNTO APPS) | NO |
| ON-UNIT INTERVAL FEATURE | YES | NO | NO | BARELY | BARELY |
| TRAINING CALENDAR FUNCTIONALITY | YES | NO | YES | YES | NO |
| FUNCTIONS | ADIDAS SMART RUN GPS | POLAR RCX3 | POLAR V800 | SUUNTO AMBIT2 R | SUUNTO AMBIT2 S |
| AUTO START/STOP | YES | CYCLING ONLY | YES | YES | YES |
| VIRTUAL PARTNER FEATURE | YES (ADDED JUNE 2014) | NO | YES | SORTA (SPECIFY INTENSITY) | NO |
| VIRTUAL RACER FEATURE | YES (ADDED JUNE 2014) | NO | NO | NO | NO |
| RECORDS PR'S - PERSONAL RECORDS (DIFF THAN HISTORY) | YES ON SITE (NOT ON UNIT) | NO | NO | NO | NO |
| DAY TO DAY WATCH ABILITY | YES (NO ALARMS THOUGH) | YES | YES | YES | YES |
| HUNTING/FISHING/OCEAN DATA | NO | NO | NO | NO | NO |
| TIDAL TABLES (TIDE INFORMATION) | NO | NO | NO | NO | NO |

| FUNCTION/FEATURE | ADIDAS SMART RUN GPS | POLAR RCX3 | POLAR V800 | SUUNTO AMBIT2 R | SUUNTO AMBIT2 S |
|---|---|---|---|---|---|
| JUMPMASTER MODE (PARACHUTING) | NO | NO | NO | NO | NO |
| GEOCACHING | NO | NO | NO | NO | NO |
| WEATHER DISPLAY (LIVE DATA) | NO | NO | NO | NO | NO |
| NAVIGATE | ADIDAS SMART RUN GPS | POLAR RCX3 | POLAR V800 | SUUNTO AMBIT2 R | SUUNTO AMBIT2 S |
| FOLLOW GPS TRACK (COURS-ES/WAYPOINTS) | NO | NO | YES | YES | YES |
| MARKERS/WAYPOINT DIRECTION | NO | NO | YES | YES | YES |
| ROUTABLE/VISUAL MAPS (LIKE CAR GPS) | NO | NO | NO | NO | NO |
| BACK TO START | NO | NO | YES | YES | YES (ADDED AUG 30, 2013) |
| IMPROMPTU ROUND TRIP ROUTE CREA-TION | NO | NO | NO | NO | NO |
| DOWNLOAD COURS-ES/ROUTES FROM PHONE TO UNIT | NO | NO | YES | NO | NO |
| SENSORS | ADIDAS SMART RUN GPS | POLAR RCX3 | POLAR V800 | SUUNTO AMBIT2 R | SUUNTO AMBIT2 S |
| ALTIMETER TYPE | GPS | NONE | BAROMETRIC | GPS | GPS |
| COMPASS TYPE | N/A | NONE | MAGNETIC | MAGNETIC | MAGNETIC |
| OPTICAL HEART RATE SENSOR IN-TERNALLY | | | NO | | |
| HEART RATE STRAP | INTERNAL | YES | YES | YES | YES |

| FUNCTION/FEATURE | ADIDAS SMART RUN GPS | POLAR RCX3 | POLAR V800 | SUUNTO AMBIT2 R | SUUNTO AMBIT2 S |
|---|---|---|---|---|---|
| COMPATIBLE | | | | | |
| ANT+ HEART RATE STRAP CAPABLE | NO | NO | NO | YES | YES |
| ANT+ SPEED/CADENCE CAPABLE | NO | NO | NO | NO | YES |
| ANT+ FOOTPOD CAPABLE | NO | NO | NO | YES | YES |
| ANT+ POWER METER CAPABLE | NO | NO | NO | NO | YES |
| ANT+ WEIGHT SCALE CAPABLE | NO | NO | NO | NO | NO |
| ANT+ FITNESS EQUIPMENT (GYM) | NO | NO | NO | NO | NO |
| ANT+ LIGHTING CONTROL | | | NO | | |
| ANT+ BIKE RADAR INTEGRATION | | | NO | | |
| ANT+ TRAINER CONTROL (FE-C) | | | NO | | |
| ANT+ REMOTE CONTROL | NO | NO | NO | NO | NO |
| ANT+ EBIKE COMPATIBILITY | NO | NO | NO | NO | NO |
| ANT+ MUSCLE OXYGEN (I.E. MOXY/BSX) | | | NO | | |
| ANT+ GEAR SHIFTING (I.E. SRAM ETAP) | | | NO | | |
| SHIMANO DI2 SHIFTING | NO | | NO | | NO |
| BLUETOOTH SMART HR STRAP CAPABLE | NO | NO | YES | NO | NO |

| FUNCTION/FEATURE | ADIDAS SMART RUN GPS | POLAR RCX3 | POLAR V800 | SUUNTO AMBIT2 R | SUUNTO AMBIT2 S |
|---|---|---|---|---|---|
| BLUETOOTH SMART SPEED/CADENCE CAPABLE | NO | NO | YES | NO | NO |
| BLUETOOTH SMART FOOTPOD CAPABLE | YES | NO | YES | NO | NO |
| BLUETOOTH SMART POWER METER CAPABLE | NO | NO | YES | NO | NO |
| TEMP RECORDING (INTERNAL SENSOR) | NO | NO | YES | NO | NO |
| TEMP RECORDING (EXTERNAL SENSOR) | NO | NO | NO | NO | NO |
| COMPATIBLE WITH FIRSTBEAT HR TOOLS | NO | NOT FB, BUT OTHER POLAR | YES | YES | YES |
| SOFTWARE | ADIDAS SMART RUN GPS | POLAR RCX3 | POLAR V800 | SUUNTO AMBIT2 R | SUUNTO AMBIT2 S |
| PC APPLICATION | NO | PPT/WEB SYNC | POLAR FLOWSYNC - WINDOWS/MAC | MOVESLINK AGENT | MOVESLINK AGENT |
| WEB APPLICATION | YES | PPT.COM | POLAR FLOW | MOVESCOUNT | MOVESCOUNT |
| PHONE APP | YES | POLAR BEATS | IOS/ANDROID | MOVESCOUNT (DOES NOT CONNECT FROM WATCH TO PHONE) | MOVESCOUNT |
| ABILITY TO EXPORT SETTINGS | NO | NO | NO | YES (ONLINE) | YES (ONLINE) |
| PURCHASE | ADIDAS SMART RUN GPS | POLAR RCX3 | POLAR V800 | SUUNTO AMBIT2 R | SUUNTO AMBIT2 S |
| AMAZON LINK | LINK | LINK | LINK | LINK | LINK |

| FUNCTION/FEATURE | ADIDAS SMART RUN GPS | POLAR RCX3 | POLAR V800 | SUUNTO AMBIT2 R | SUUNTO AMBIT2 S |
|---|---|---|---|---|---|
| CLEVER TRAINING LINK (SAVE 10% WITH DCR10BTF) | LINK | LINK | LINK | LINK | LINK |
| CLEVER TRAINING EUROPE (SAVE 10% WITH DCR10BTF) | | | LINK | | |
| DCRAINMAKER | ADIDAS SMART RUN GPS | POLAR RCX3 | POLAR V800 | SUUNTO AMBIT2 R | SUUNTO AMBIT2 S |
| REVIEW LINK | LINK | LINK | LINK | LINK | LINK |

## Appendix 3.

## Data 2 analysis (from the initial proposal building), and Data 1 and Data 2 connection to the proposal

Table A3.1 Co-creation session - Inputs from the participants (summaries for Data 2).

| Session 1 | Participants | Use Case | Topics | Potential solution |
|---|---|---|---|---|
| | 3 | Cycling 8h, 24/7, interaction, data | chest strap without display | gloves/glasses with display, headset and use voice |
| | | | coaching mechanisms | voice, light, vibration, heat, or even visual if 'screens' from the environment to be used (ref. to "The Naked User approach" - Nordic perspective to gadget-free hyper-connected environments) |
| | | | control mechanisms | multifunction button |
| | | | motivation by doing good | calculate reduced carbon footprint/km cycled |
| | | | marketing differentiation | differentiation from wireless offers |
| | | | size vs. battery lifetime | compromise or use small form factor and afterwards set min lifetime based on rigorous tests with maximum traffic |
| | | | dashboard encouragement | amateur/intermediate/athlete levels of difficulty to keep goals achievable |
| | | | social | create supportive community |
| | | | pausing affect to avg speed | customizable min speed limit to include to avg speed |
| | | | idle time power consumption | possibility to partially limit most power hungry functions like gsm, gps, BT, HR, etc. |
| Session 2 | Participants | Use Case | Items | Potential solution |
| | 1 | Health, home, work, 24/7, long-term, data, interaction | charging gap | on-the-body charge, exchange battery, kinetic energy (size?), distributed energy sources (efficiency?), battery size vs. speed of charging |
| | | | connectivity | SigFox alternative communication protocols for low data rate esp.reporting status or as a redundant connection in failure situation (17 countries: France, Belgium, Spain, now to be in Finland too) Note! Since session, also another more 'duplex' open protocol LoRa in the unlicensed- |

| | | | | |
|---|---|---|---|---|
| | | | | spectrum, and NB-IoT in the licensed-spectrum (stronger new candidate) |
| | | | data aggregation | Apple HealthKit opened to 3rd parties, others like Polar and Suunto follow? Open source options? Or own portal to aggregate different sensors & brands, |
| | | | only partial water-resistance | change to water-resistant parts also in strap modules to keep usability level |
| | | | modularised, integrated device | no one device covers all, I do not believe startups like Chooseblocks to put all the points (blocks) together, since it is complex. However 'modular' multiple uses exist like Misfit Shine 2 disc (puck) to be used in wrist, clipped to clothes or as jewelry pendant to track activities (even swimming), give feedback (with 12 leds or vibration) or control devices (like phone selfie picture). (3-4 years until now). Or Moov Now band strapped to either wrist or ankle. |
| | | | viability and security of apps | difficult to make money with apps, brokering services like KiezelPay help with payment acceptance for Pebble apps, try and buy with billing afterwards. |
| | | | deep learning, machine learning | Used already f.ex in the Google Alert with keywords, also Utopia Analytics I just interviewed for article use to automatically remove 'expressive' comments, could be applied to lot of industries, filtering noise vs information – fine tuning keywords to get from too broad to narrow enough reception of information, find surprisingly good sources. |
| | | | physical vs touch buttons | Polar V800 tried with changeable touch (touchscreen)buttons but due errants moved back to the physical buttons. Fool proof functioning even in the harsh conditions. |
| | | | technology, competition, price, buy | Technology often drives competition which reduce prices and then lowers threshold to buy, Multiple offers from high end Microsoft Band 2 to the low end Xiaomi Mi Band. |
| | | | Design faults in straps | Changeable straps, no need to send whole watch back if one part fails, like earlier. |
| | | | Customisable buttons, watch-faces, etc. | Available already, but require app |
| | | | Automate healthcare home visits | card touch box at the building to acknowledge the visit |
| | | | demand in home care, challenges | no less demand to have (aging) people living longer in own home, tricky, get movement detectors etc. check if you are moving, many false alarms, takes time to |

| | | | | |
|---|---|---|---|---|
| | | | | develop logic, so many factors, other thing, business directed to end-customers, who is paying? |
| | | | self-check at home | blood pressure, dialyse, implanted chip, etc. how to educate user to do it properly? different cases people talk about but how much just assumptions |
| | | | prediction, prevention | first industry now healthcare – hot topic and lots of thinking going on with logic, algorithms, deep learning, etc.- go to many domains, MyData healthcare treat but not prevent –logic need other drivers/sponsors too |
| | | | stress | now people stress future, economy, etc., so any solution that help, improvement is good, often social for example this assisted living is not to leave them alone. |
| | | | Trust, regulation, community support | trust people more to have neighbour community, bartering, job banks, etc., taxable work in exchange through job banks? on the other hand governments cautious for money laundering so regulate banks not to have criminal money but affects to normal users with extra checks too |
| | | | culture | cultural in Asia more common to live with parents |
| | | | job, entrepreneur, network, experience, security, stress | government found thousand new jobs – lot of people start their own company, stressful to be entrepreneur, good network, good experiences, but hard to make money, I like things to be structured, we need mechanisms to keep peoples energy up and have security when family, need coping mechanism to deal with change |
| | | | basic salary to all (peruspalkka) | Utopia? Interested if take some stress away and give more inspiration and the same time allow time and energy for new ideas, but need motivation |
| | | | Skill evaluation frequently | Centralised do not work, overall strategy everybody contribute, people not interested problem, different experience for young and older unemployed – easy to loose spirit and feel useless and bad experience leads to bad choices |
| | | | ambassador | Pebble ‘rockstar’ free services to the group: material, information of availability, contacts, promotion of events, running little projects, doing concrete things, and then ‘shout back’ (to Pebble) what we have etc., lots of guys geeky, my is to be open and broad, close work with few developers. No competition with distribution, even promote sales or looking for B2Bs if they have need for a solution. |
| | | | systems, custom- | Systems not just products, Need to know |

| | | | | |
|---|---|---|---|---|
| | | | er needs, partner-ships | needs even customers do not shout up their problems and needs. Where to con-centrate, how to knock doors to talk to people, time consuming, and to offer. What is needed. Finding knowledge, part-ners, network to create solution. A bit like chicken and egg to find cases where technology can help and solve problems. |
| | | | design agencies | I know couple of design agencies they are relevant and go through whole process and steps and technology is just the last piece of jigsaw puzzle. |
| | | | Investing to SMEs | NordicStartupBits.com started fast cover local events, Equity investment for even small companies, in China saw two other forms: peer-to-peer/person-to-person/3 years, and loaning for business against interest, but risky if company go bankrupt-cy, China leading in this new style. |
| | | | Openness, Idea capture | Internal not focus others, open – benefit other companies too, true meaning? but I picture it like that, want to help, choose what to offer but feel good of giving |
| | | | Innovative ideas | Jylland hospital 50% new innovative ideas from nurses, kid broke hand, sit and queue in Peijas, why not turn negative to positive time by answering to some ques-tions or surveys and not just be bored, IxD awards to anesthetic education tool for kids with ambient light increase with the progress of anesthesy – as preparation and concentration to get mind of from 'scary' stuff around operation room later on. |
| | | | Coding sessions | Schools, even primary schools later with new coding inclusion in the curriculum from the first class already, now Aalto, Metropolia, Laurea, etc. could offer Pebble watches for coding sessions |

Table A3.2 Summary of themes and topics and their connection to principles

| **Themes (Data 1)** | **Co-creation topics (Data 2)** | **Proposal principles** |
|---|---|---|
| **Interaction – control: -> 2, 5**<br><br>**1. Automatic functionality and optimisation for frequent use cases like upgrades, up- and downloading of data and programs, charging of wearable, and other wearable-specific actions.**<br><br>**1. new ways to control are error prone and means to recover are not always obvious** | **Co-creation ses-sion1 topics:**<br><br>**1.control with mini-mized interface**<br>**1.1 multifunction button -> 2**<br><br>**2.feedback without display -> 1**<br>**2.1 accessories**<br>**2.2 types** | **1. Helps user with actionable insights to user's wellbe-ing - Personal-ization and learning about user's life and current goal(s**<br><br>**2. Gives user** |

| | | |
|---|---|---|
| **2. new designs for small screen and differences between brands complicates control**<br><br>**3. limited control of data f.ex. export, error correction**<br><br>**4. for some users it is still not always easy or fast enough to do basic use cases**<br><br>**Interaction – feedback: -> 1, 5**<br><br>**2. use of other than textual and graphical feedback like sounds, light and vibration as well as different intensities of those**<br><br>**5. raw measured data available from Neuro on sleep mask but user needs to find how to use that data from other sources**<br><br>**3. personalised advice depending on the readiness score and different main screen in app for different users based on automatically collected use information from Ōura ring**<br><br>**6. feedback is not smart enough and moving smartphone functionality like notifications to wearable aggravate issues**<br><br>**Interaction – communication: -> 1, 2, 3, 4, 5**<br><br>**4. use of standards like ANT+ or Bluetooth for wireless communication between wearable and its accessory gives user more accessories to choose from different manufacturers**<br><br>**5.communication between parts of the system is automatic, and data is not lost due temporary lack of connection**<br><br>**7. full functionality of wearable depends on the operating system of smartphone and both functionality of smartphone and communication with it**<br><br>A. possibility to use 3rd party platforms for extra context-related information, community support and data management like We Are Curious-platform, cloud-based personal data aggregating and tracking platform with cloud account of Ōura ring.<br><br>**8. limited ways to manage and share data collected from all wearables and brands used**<br><br>B. interaction design cycles get shorter and interaction more versatile (people - devices, people - environment, people - people)<br><br>**Long-term use – start: -> 1, 2, 3, 4, 5** | **3.connectivity -> 1, 2, 3, 4**<br>**3.1 gsm, wifi, gps – depending on use context and differentiation**<br><br>**4.social rewards to reach goal -> 5**<br>**4.1 doing good – carbon footprint**<br>**4.2 dashboard/expertise profile**<br>**4.3 community (peer) support**<br><br>**5. size vs. battery use -> 1, 2, 3, 4**<br>**5.1 adequate charging intervals**<br>**5.2 as small as possible form factor**<br>**5.3 functionality needs**<br>**5.4 connectivity needs**<br>**5.5 rigorous testing**<br><br>**6.idle time handling -> 1, 2**<br>**6.1 customizable minimum speed – pause, stops automatically removed from average speed**<br>**6.2 power-saving options or partial limitations use cases (gsm, gps,Bluetooth, heart rate measurement, etc.)**<br><br>**Co-creation session2 topics:**<br><br>**7.maximise use time -> 1, 2, 3, 4, 5**<br>**7.1 less charging gaps – kinetic energy, on-the-body charge, exchangeable battery**<br>**7.2. faster charging – battery size, distributed energy sources**<br>**7.3 water resistance (also straps)**<br>**7.4 use longer – modules to add, replace, etc.**<br>**7.5 use differently** | **control - Flexibility in use depending on the expertise level**<br><br>**3. Adapts to user's changing needs - Modularity to extend use, future enhancement by changeable parts and enhancements**<br><br>**4. Complements user's life or Integrates to user's life – Customizable to the lifestyle, enforcing user's identity**<br><br>**5. Evokes positive emotions awakening user's senses – Emotions like curiosity, inspiration, joy, satisfaction, calm - Bonding and engaging the user along the journey** |

| | | |
|---|---|---|
| **1. get as a gift or buy a wearable available in the market with best feature-price ratio for use purpose even if it means switching to a new brand**<br><br>**2. unplanned opportunity to buy a wearable immediately especially with reduced price or with peer recommendations or with brand knowledge and trust**<br><br>**3. get as a gift or buy a wearable available in the market and use provided tools and resources to design, develop and test the app to use**<br><br>**4. try free smartphone app or simple wearable, drop use, and design, develop and test new type of wearable for the market**<br><br>**1. buying or considering to buy a new version of wearable while knowing it is not really needed or it is not usable for long-term**<br><br>A. crowdfunding innovative wearables or accessories despite waiting time and risks involved<br><br>B. testing wearables or apps under development in other companies<br><br>**Long-term use – stop: -> 1, 2, 3, 4, 5**<br><br>**2. no adoption – limited usefulness due malfunction or failure, or disappointment in expectations or promises**<br><br>**3.discontinued use - health and fitness plans not followed or wearable broken in misuse or by accident or by unknown reasons**<br><br>**4. replace wearable every year or according to renewal cycle for wearables**<br><br>C. change in life require change in health and fitness habits and use of wearable<br><br>**5. long-term use discontinued temporarily or permanently – initial need fulfilled but other feature use possible, or wearable even if still functional reaches its end-of-life after long-time or heavy use**<br><br>**Long-term use – impact : -> 1, 2, 3, 4, 5**<br><br>**6.health and fitness habit enhancement and adaptation to changes in daily life**<br><br>**7.makes benefits visible even from small changes in health and fitness behaviour** | **like Misfit Shine 2 or Moov Now**<br>**7.6 increase use cases also out of health and fitness**<br><br>**8. increase users -> 1, 2, 3, 4, 5**<br>**8.1 more competitions -> less price -> more purchases**<br>**8.2 differenct price ranges from low to high end offers**<br>**8.3 customizable – straps, buttons, watchfaces, use of deep and machine learning for feedback filtering**<br>**8.4 new use cases**<br>**8.5 new services and service providers**<br><br>**9. support innovation -> 3, 5**<br>**9.1 idea and need collection**<br>**9.2 empower entrepreneurship**<br>**9.3 new earning logics**<br>**9.4 new ways to sponsor**<br>**9.5 adaptation to change in income, regulation, safety, skills**<br>**9.6 openness – increase cooperation and benefits**<br><br>**10. experience improvements -> 1, 2, 3, 4, 5**<br>**10.1 automate repetitive steps in process**<br>**10.2 reduce idle waiting in process**<br>**10.3 reduce fear in process**<br>**10.4 seamlessly functioning system (not just product)**<br>**10.5 increase data aggregation possibilities – reduce lock-in**<br>**10.6 better fit for the culture, lifestyle, personal preferences** | |

| | | |
|---|---|---|
| **8.helps to establish new healthy habits based on measurements**<br><br>**9. measuring adds meaning to the training**<br><br>D.dream wearable helps to understand how own body works effortlessly without need to pay attention to wearable itself<br><br>**10.help in daily life beyond fitness use and readily available wearable feature set**<br><br>**11.experimenting and enjoying wearable technology as essential part of daily life**<br><br>**12.frequent and regular use provide shared experience with family and colleagues at work**<br><br>***5.requires extra effort to manage multiple wearables and apps***<br><br>***6.disapointment due failure in promised functionality***<br><br>**24/7 use - value: -> 1, 2, 3, 4, 5**<br><br>A. Mastery of activity with the help of wearable<br><br>B. Offering new options and add-ons to wearable ecosystem<br><br>C. Experimenting and enjoying wearable technology<br><br>D. Use as Gadget<br><br>**24/7 use - gaps: -> 1, 2, 3, 4, 5**<br><br>E. Wearable is compromise of size, battery life and other functionality for intended use and currently gaps in 24/7 use of wearable are inevitable<br><br>***1.unsuitable consistency and/or appearance to wear 24/7 and/or for the use purpose of wearable***<br><br>***2.lack of functionality for 24/7 use if not for intended use***<br><br>***3.too short battery life and/or charging time and method or difficult way to replace battery***<br><br>**24/7 use - qualities: -> 1, 2, 3, 4, 5**<br><br>F. Wearable needs to fit into the daily life not people adjust their life for wearable<br><br>**1.fit of wearable is enhanced with fitting service (ring) or easily changeable parts** | **10.7 increase apps – make developing more viable (f.ex KiezelPay) and using more easy (f.ex aggregate many to one meaningful whole)** | |

| | | |
|---|---|---|
| **(bands, straps)**<br><br>**2.robustness of wearable is enhanced by increasing water and temperature resistance and feedback perception in varying conditions**<br><br>**3.Preferences of different types of users are satisfied with adequate offer of choice in models, bands, straps, holders, modules, price ranges, accessories, platforms, connectivity, apps, configurations, watch faces and modes to use wearable**<br><br>**4. Holistic approach to health of user from 24/7 data collection** | | |

# Appendix 4
# Data 3 analysis (from validation feedback)

Table A4.1 Analysis of Data 3 from validation discussion 1

| Theme | Feedback |
|---|---|
| Provides insights to my wellbeing | maybe just adding new data points |
| tracking steps/points per day | what is point having to tracking it all the time if I do not want to |
| sleep tracking | did not start after all |
| | I do not move much, bicycle yes, but watch is not able to detect that |
| | went fishing and all steps/points collected for the day without moving just by moving the wrist |
| | HR is good not dependent on movement of hand |
| | integrate during certain period of time |
| | it is all pretty but if you show it to other people in marketing, they will ask is this really important and needed by the customer. |
| | You should not forget that you do it for people and it is not just product you wish to sell. |
| | At the end of the day your product might sell but people use just half of the features and how much was spent in developing those. |
| | Modularity, especially software modularity is good. |
| data saving | You have week chart on the watch but you need to have app for Misfit if you want to save your data. |
| | So many data and what you will actually do with that and what user is going to make. |
| | it is going to depend on application. |
| About rules example | Rules applied by Apple and Nokia in development were discarded by Windows with Good Results - unfortunately still no win |
| | |
| too complicated? | (Like you mentioned before, that) Investors like a team which is good team together, successful product is gonna to be depend on what team will put together on timely fashion, and something that is going to work. How it is gonna look, depends on people who made and what is their background and the input that they get from other team members. So at the end all of these rules they gonna be like blown away by the fact that either you compete with others or that somebody had better idea, so when you actually start doing something that is where you are going to apply these different concepts, and you realize your are going to make ten iterations before you have something out there. |
| | Lean process, even if you have all features like Apple wearable that have all the capabilities you can always change or add on top of what you already have and have updates from user feedback and then it becomes very complicated, maybe you made algorithm you planned to use with the data and when you get the data you realize it is not possible or not what you actually want to do and then you do something else. |
| customizing - have core 1st | people have different likings - abosolutely. |
| write like yellow but take black product | How you think about things and when you see them. Even people themselves they do not know. |

| | |
|---|---|
| impossible everything for everybody | The way actually companies especially on the internet or applications see that how people behave is far from how they actually speak that they come to do stuff like that (test). |
| | It depends what is your take home message of your IM thesis - not the title but the take home message. Did you think about it? |
| | |
| | battery life is most important, also like watchface time shown as text, not to over-load brain |
| | labels in form important not to overload user brain - tried to be without and just have info in the field but it disappears when user types |
| | 25-50 active, with money often mass market customers - important to know your target customers |
| | lifetime of devices, miniaturization like in the ring with HR monitor, in 10 years you will not have this watch, because you have nicer ones in the market |
| | upgrading needed, but watch system has been designed for the platform, if you change watch you need a new platform since old do not work anymore |
| cradle-to-grave product development | technology develops fast, there is steady technology that does not develop that fast. |
| maximum number of charging (oura ring) | 3 years (use all the time) really short. How to retain customers. How to make them buy more. This kind of line of thinking. |
| product + services for long time after | With the software possible. |
| planned obso-lence | car industry cheating with emission calculations. Everybody is cheating….they cheat because competition is so hard. |
| taking risks, making errors, failing | Instead of calling it risk you could call it entrepreneurship. Many cities encourage entrepreneurs. |
| | Important to have take away message, Readers could be interested how you came into that conclusion. |
| | Also for yourself if you wish to use that knowledge to do your own product or service company |

Email letter requesting comments and feedback for validation of principles:

Hi,

Thank you again for fruitful discussions in several occasions.

Would you be kind to give a comment about the Experience Design Principles I figured out could be helpful when developing Health and Fitness Smartwatch and Wearables.

Consider human/individual/user/customer at the center of these principles that could be used as perspectives to frame the experience throughout the design and development process.

1. Helps user with actionable insights
2. Gives user control
3. Adapts to user's changing needs
4. Complements user's life
5. Evokes positive emotions awakening user's senses

For further clarifications above principles include
1. Personalization and learning about user's life and current goal(s)

2. Flexibility in use depending on the expertise level
3. Modularity to extend use
4. Customization and identity
5. Bonding and engaging

I think it is extremely difficult to change habits. Also sustaining wellbeing is an endless battle with varying resources at hand. And each person is unique in their response to activities, exercise, diet and pressure in life. Achievement is at the top of the needs pyramid while sleep is at the base, so change goals need to start from the bottom up, one change at a time with small steps towards successful habit change. Prevention is at the core of long and healthy life and wearables have potential to help in that.

Please let me know what do you think? Could you use such principles when you define more detailed use cases or requirement specifications? Or when you decide priorities?

Thank you in advance,
Johanna

….. different ending sent to A (sent separately later to get more validators)……..
Purpose is to try to see through user's eyes and then turn it into products and services that would help user to achieve his or her goals easier and make changing behavior more pleasant.

Besides that prevention is at the core of long and healthy life and wearables have potential to help in that.

Please let me know what do you think? Could you use such principles when you define more detailed use cases or requirement specifications? Or when you decide priorities?

Thank you in advance,
Johanna

Data 3 –- validation comments and feedback from emails 2-4:

Hi Johanna,

You're most welcome. It looks like you have identified five important traits. Maybe instead of "complements user's life" you might consider "integrates into the user's life," to capture both how seamless it is technologically (or strives to be) and the fashion of it (we're willing to have these high tech devices on our bodies because they're aesthetically well-designed, and, as you say, customization and self identity).

Please let me know how you finalize these pieces and whether or not you choose to publish. I could see them as useful in teaching down the road.

It's been a pleasure to connect and I wish you continued success in your research.

A

Hi Johanna

Very good points listed below. Changing habit is difficult, but step by step seems to be the way. One challenge is how to motivate those people who are not self-motivated to improve (though may create the most health costs).

Perhaps in line with point 4. I think of materials/tactility - i.e. how such a wearable might *feel* on the body - like favourite watch/straps or jewelry.

Thanks. Very interesting
Regards
J

……. reply …..
Hi J,

Thanks for feedback. Yes. senses and emotions in 5. partially overlap with customization in 4. with such tactile/material touch feeling, and with modularity in 3. with straps.

It is true that there is, according to transtheoretical model, 6 months transformation period for change to be permanent with different 'goals' from raising consciousness about the problem in precontemplation stage to maintaining good habit with high self-control and self-efficacy. In all precontemplation -> contemplation -> preparation -> action -> maintenance stages all with different change support focus.

One way to get people self-motivated is to make the long-term effects of bad habit more concrete to them. Another is social pressure in a positive way stating that 'most of the people do the right thing' so that it is understood to be a norm even before it becomes one.

Hi D,

Thanks for the link. There is interesting stuff, plugin for Sketch and Gyroscope's Health Dashboard among other things. Was that meant as a feedback to the principles, or did I missed the right message?

Br Johanna

Hei Johanna,

Good day, thank you for the nice insights that you make. It looks sound and I generally agree that habit-changing is extremely difficult.

I like to add two points, for your consideration.

1) In personalization and learning about user's life, ethnography might be a useful tool to map out what is culturally important and motivating to the user.

2) While I think it is important that change goals are mostly small steps, identifying what inspires the person (be it a role model, dream, etc.) may amplify and accelerate the change process. How a wearable can do this, I am not too sure yet J

Good luck for the wrap up of the thesis!

Regards,
D