Abstract

Wearables were supposed to be the next booming business, but to date the hype around wearables is not yet reflected by consumers' adoption of wearables and the attrition level (discontinued use) is high. Basically, the market has trouble reaching mainstream.

The aim of this thesis is to investigate how to improve the diffusion, in personal use, of wrist-worn wearables in the Netherlands. 20 semi-structured interviews with wearable users in the Netherlands, from half 2016, are used to find out their experiences. The research of this thesis was not a linear phase-to-phase process, but rather a process of moving back and forth between the different phases of the analysis. A thematic and sentiment analysis is used to analyse these interviews. In the first chapter diffusion literature and context related literature can be found which are tailored to the outcomes of the interviews. Secondly, a chapter regarding a market research, of the time of research, with paragraphs such as features of the wearables, usage rate, privacy issues and promotion from developers can be found. Also the developments in the meantime, from starting point half 2016, are displayed. After this the results of the analysis of the semi-structured interviews can be found. This contains a paragraph with the results of the sentiment analysis (and additional information) and a paragraph with a thematic analysis, which displays the different themes found within and between questions from the semi-structured interviews. The discussion contains the results of preceding chapters. Ending the report with a conclusion regarding what could be improved in the wearables at the time of research, a view on the developments in the meantime and the future.

The results of this report show producers of wearables should, regarding the time of this research, add more relevance, reliability, ease-of-use, addressing privacy issues and foster habit (using it all and every day) in order to make wearables a success.

Meanwhile, since the time of this research there have been some developments in the market: the market growth faltered, but the wearable developers added different factors to their business which looks promising, to a certain extent at least (and differs per brand). They added more relevance and to some extent ease-of-use, fostering habit and reliability. But, there is still room left for improvement within these subjects to make it a success and reach mainstream, especially regarding privacy with the increasing privacy breaches (even though a new European privacy law has entered force).

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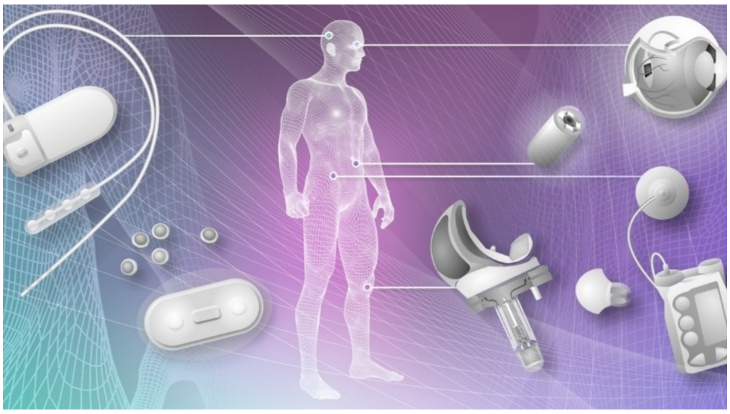
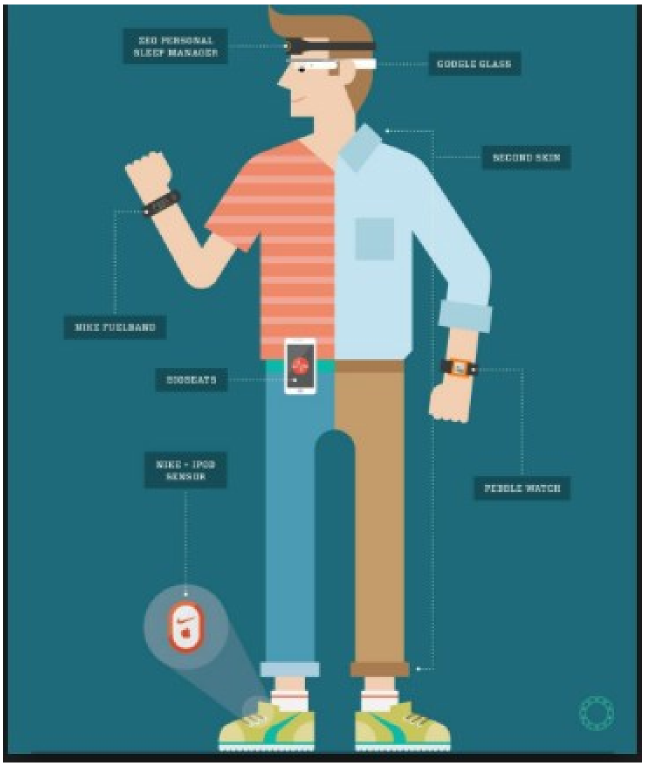
Master Thesis

The diffusion of wrist-worn wearables in the Netherlands





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Introduction

People increasingly tend to proactively look after their health (Bandura, 1991). In recent years, commercial technologies have emerged for automatically collecting data that can assist in self-regulation. The usage of wearable self-tracking technology has recently emerged as a new big trend in lifestyle and personal optimization in terms of health, fitness and well-being. Wearables in this report mean wrist-worn wearables for personal use, which for example monitor number of steps taken, distance travelled, speed and pace, calories burnt, heart rate, hours slept and dietary information. Sales of wearables were rising every year in the years before 2016. In the last quarter of 2016, 23 million wearables were sold worldwide and it was expected that this number would increase to 213 million by 2020.

Yet, despite wearables offering unforeseen capabilities for supporting a healthier lifestyle, market adoption of wearables is still low. Four years ago, wrist-worn wearables were supposed to be the next big thing; they were going from a nerdy dream to a mainstream reality. None of that happened. In fact, it was the opposite. The market for wearables has proved to be volatile, claiming victims much faster than we saw with the companies that went bankrupt following the introduction of the iPhone (Kovach, 2016). The abandonment rate is substantial and there is no broad diffusion yet. Hence, it is important to determine factors which factors of wearables are good and not good (yet). Yet, there is still little known about how to improve the diffusion, in personal use, of wrist-worn wearables in the Netherlands. Due to this, individuals may not reap the promised health and fitness benefits, society is unable to curb widespread health problems - such as rising obesity levels - and companies may not reap the benefits of the data on which the valuation of the internet of things (IoT) industry is premised (Ledger, 2014).

Hence the importance of an independent study to investigate the actual users of wearables in order to make wearables a success and give an explanation for the ‘failure’ so far.

1 Method

1.1 Research question

How to improve the diffusion, in personal use, of wrist-worn wearables in the Netherlands?

1.2 To answer this question we need to fulfil the following points:

1. What is the state of the art literature of diffusion?
2. How is the diffusion at the time of field research and what are the developments?
3. What are wearable users currently thinking about wearables?
4. How does the predicted potential actually come to a diffusion?

1.3 Aim of this research:

The aim of this research is to determine the sentiment, regarding multiple themes, among the users of wrist-worn wearables in the Netherlands. Furthermore, eliciting factors/emerging themes which could be of importance to the wearables users. The goal is to give indicators for companies which factors have to be addressed when launching wrist-worn wearables for general health and fitness purposes on the Dutch market. Determining factors important for pre-adoption as well post-adoption in order to make people adopt, continue to use and/or repurchase or so called diffusion. There will be made sense of the different factors as much as possible, but it has to be considered as an explanatory way and no casual way.

1.4 Research methods and analysis

Myers and Newman (2007) mention "The qualitative interview is the most common and one of the most important data gathering tools in qualitative research" (p.3). The type of qualitative interview was a semi-structured interview, which is able to collect meaningful experiences related to the theme of the research. It is also the most used type in qualitative research in information systems (IS). In a semi-structured interview there is an incomplete script, but usually some pre-formed structure that the interviewer follows (Myers & Newman, 2007). This was also the case in this research.

97 semi-structured interviews, obtained from the University of Twente, with wearable users/owners will be used. These interviews are based on the PRIMA method. It is designed to determine the success of ICT innovations, and is helpful to determine the adoption process of consumers. It is based on multiple adoption and diffusion models. For more information see page 10.

These interviews have been executed all individually by students of the University of Twente, around may/June/July of 2016, among a widespread array of respondents with different characteristics as displayed in figure 1.

There has been a drilldown process to make the group more homogenous. The more heterogeneous the group you interview, the more interviews you have to take. The semi-structured interviews, with the help of some factors from literature, are filtered with several drilldown factors as displayed in figure 1.

Eventually 20 interviews are left over, where some characteristics pop up such as the majority being high educated, experience with technology and ICT and voluntarily adopted.

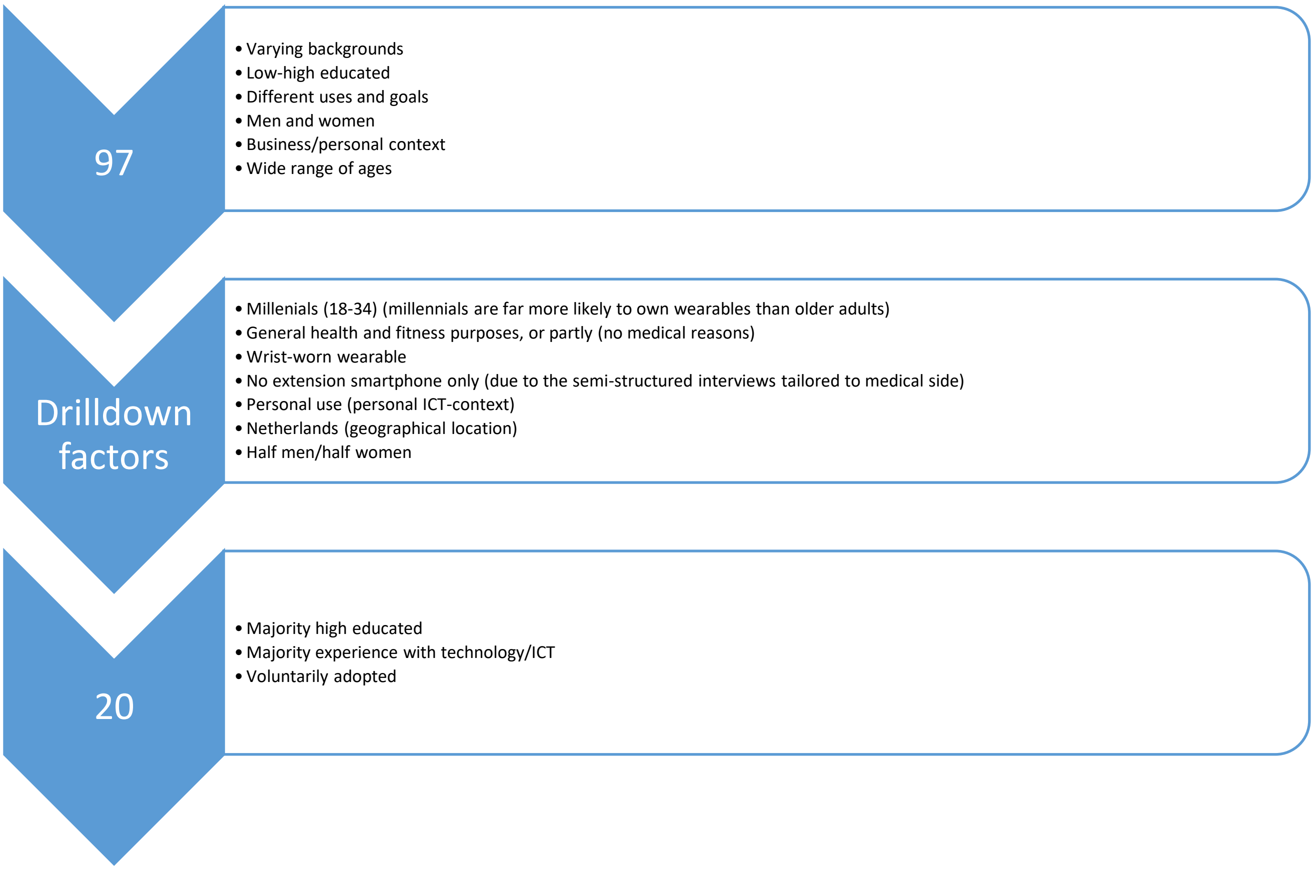

Figure 1: drill down process semi-structured interviews

Regarding the validity of the 20 interviews: the group has been made as homogenous as possible to have little need for a big sample and make it more generalizable. In qualitative research there is no standard for exact numbers needed for validity. According to Braun and Clarke (2006) it is important to tell the complicated story of the data which convinces the reader of the merit and validity of your analysis. Extracts need to be embedded within an analytic narrative that compelling illustrates the story that you are telling about your data, and your analytic narrative needs to go beyond description of the data, and make an argument in relation to the research question. It is important that the analysis (the write-up of it, including data extracts) provides a concise, coherent, logical, non-repetitive, and interesting account of the story – within and across themes. The research must be executed well: have well-documented audit trail of materials and processes, multidimensional analysis as concept - or case-orientated and respondent verification.

The qualitative data will be analysed with a sentiment analysis with the help of the coding process based on the method proposed by Miles and Huberman (1994). The analysis is divided into three different procedures: data reduction, data display and conclusion drawing/verification. This method was the base for the sentiment analysis. Coding was chosen for the data reduction due its ability for viewing the answers given by respondents and their opinions on various aspects. The responses from the respondents of the interview were assigned one of five labels, ranging from very positive (++) to very negative (- -). The data has been statistically processed in Microsoft Excel to generate an insight into the responses, and on the same time making graphical presentation possible.

Furthermore a thematic analysis has been used to elicit factors beyond the structured part. Thematic analysis is according to Braun and Clarke (2006) a method for ”identifying, analysing and reporting patterns (themes) within data” (p.79). It organizes and describes the data set in rich detail, and normally goes even further by interpreting various aspects of the research topic (Braun & Clarke, 2006). In addition to identifying, analysing, and reporting the patterns in the data, there is also aimed to interpret various specific aspects and exceptions related to the topic of the research. In doing the analysis, the guidelines by Braun and Clarke (2006) are applied. As suggested these guidelines are applied flexibly to fit the research question and data, and the analysis process was not linear phase-to-phase process, but moved back and forth between the different phases of the analysis. There was a process of going back and ford between literature, other chapters and the interviews.

Braun and Clarke (2006) mention ''A theme captures something important about the data in relation to the research question, and represents some level of patterned response or meaning within the data set. An important question to address in terms of coding is what counts as a pattern/theme, or what „size‟ does a theme need to be? More instances do not necessarily mean the theme itself is more crucial. As this is qualitative analysis, there is no hard-and-fast answer to the question of what proportion of your data set needs to display evidence of the theme for it to be considered a theme. So researcher judgement is necessary to determine what a theme is. Furthermore, the „keyness‟ of a theme is not necessarily dependent on quantifiable measures – but in terms of whether it captures something important in relation to the overall research question'' (p. 10).

For the entire research there will be a technological and consumer market lens. A detailed literature review will be conducted in order to define the term wearable technology, determine current and future features, as well as to examine theoretical frameworks/models, such as the Diffusion of Innovations (Rogers, 1995), Acceptance Model (Davis et al., 1989) and post-adoption theories (e.g. Bhattacherjee, 2001). Furthermore literature will be used to check for important factors for pre-adoption and post-adoption of wearables. Some of these factors are the fundamental constructs of the technology acceptance theories or post-adoption theories, others are external variables that were incorporated in these models with an attempt to improve their predictive power. Many of the variables are context-specific. However caution will be taken while using existing constructs, as such constructs may bring with them commonly held beliefs and biases. Also no uniform definition of wearable technology has been established yet, neither by academia nor practice, this will be taken into account.

As well pre-adoption as post-adoption factors will be analysed since to understand sustained use, one must first understand the expectations that are present at the time of adoption. Furthermore, by understanding the sentiment around pre-adoption factors by the actual users of these wearables, they can play an important role in the growth of this market, because they increase the observability of the new technology and educate others in their networks (Rogers, 1983). Potential adopters have (false image) of certain aspects of wearables, actual users can give information about what could be improved. The users can be a source of information to potential users and make them buy it. It also important when these users ever have to repurchase a new wearable. Trying to convince the mass of a new idea is useless. Convince innovators and early adopters first (Rogers, 1983).

The current options, and related items, of wearables present at the moment of taking the interviews will be determined in order to better place it in context. This to make it able for this report and future studies and/or companies to put the results in the context of wearables available or used the most at that time. Future options of wearables might influence the adoption process (certain aspects, such as relevance), this will be determined with the help of literature. Afterwards a synthesis between the results of the literature review as well the field research will be executed. Lastly, there will be an overall conclusion which will be answering the main question.

1.5 Searching and themes

Due to the back and forth process between analysis of the semi-structured interviews and the literature review, it resulted in a continually search for literature, within literature and within the results of the semi-structured interviews.

The databases and search engines 'Scopus' 'Web of science' and 'Google Scholar' are used. It has to be mentioned wearables are very heterogeneous and there is only a small amount of articles, which being able to enter, and published in well-known magazines/journals. This was especially for articles related to the context of this research. When having only a few citations it has been checked what kind of person who published it and the amount of publications with corresponding citations. The results of the literature search were filtered by relevance and were checked at least until page 10 (in the case of enough hits).

Below an example of the searching process, for a comprehensive search figure and additional keywords see appendix B).

Source	Keywords	Filtered	Hits	Example of literature
Google Scholar	Continued use information systems	Relevance	5.140.000	Delone, W. H., & McLean, E. R. (2003). The DeLone and McLean model of information systems success: a ten-year update. *Journal of management information systems*, *19*(4), 9-30. Bhattacherjee, A. (2001). Understanding information systems continuance: an expectation-confirmation model. *MIS quarterly*, 351-370. Venkatesh, V., Thong, J. Y., & Xu, X. (2012). Consumer acceptance and use of information technology: extending the unified theory of acceptance and use of technology. *MIS quarterly*, 157-178. Venkatesh, V., Morris, M. G., Davis, G. B., & Davis, F. D. (2003). User acceptance of information technology: Toward a unified view. *MIS quarterly*, 425-478.
Scopus	Continued use information systems	Relevance	8.062	
Web of science	Continued use information systems	Relevance	9.388	
Google Scholar	Continued use information systems	Relevance since 2005	52.500	Limayem, M., Hirt, S. G., & Cheung, C. M. (2007). How habit limits the predictive power of intention: The case of information systems continuance. *MIS quarterly*, 705-737.
Scopus	Continued use information systems	Relevance since 2005	5.451	
Web of science	Continued use information systems	Relevance since 2005	7.268	
Google scholar	Wearables adoption	Relevance since 2010	7700	Canhoto, A. I., & Arp, S. (2017). Exploring the factors that support adoption and sustained use of health and fitness wearables. *Journal of Marketing Management*, *33*(1-2), 32-60. Rauschnabel, P. A., Brem, A., & Ivens, B. S. (2015). Who will buy smart glasses? Empirical results of two pre-market-entry studies on the role of personality in individual awareness and intended adoption of Google Glass wearables. *Computers in Human Behavior*, *49*, 635-647. Chuah, S. H. W., Rauschnabel, P. A., Krey, N., Nguyen, B., Ramayah, T., & Lade, S. (2016). Wearable technologies: The role of usefulness and visibility in smartwatch adoption. *Computers in Human Behavior*, *65*, 276-284.
Scopus	wearables adoption	Relevance since 2010	441	
Web of science	wearables adoption	Relevance since 2010	46	

				Spil, T., Sunyaev, A., Thiebes, S., & Van Baalen, R. (2017). The adoption of wearables for a healthy lifestyle: can gamification help?.`
Google scholar	Continued use wearables	Relevance since 2010	5.360	Canhoto, A. I., & Arp, S. (2017). Exploring the factors that support adoption and sustained use of health and fitness wearables. *Journal of Marketing Management*, *33*(1-2), 32-60. Buchwald, A., Letner, A., Urbach, N., & von Entress-Fuersteneck, M. (2015). Towards explaining the use of self-tracking devices: conceptual development of a continuance and discontinuance model. Nascimento, B., Oliveira, T., & Tam, C. (2018). Wearable technology: What explains continuance intention in smartwatches?. *Journal of Retailing and Consumer Services*, *43*, 157-169.
Scopus	Continued use wearables	Relevance since 2010	100	
Web of science	Continued use wearables	Relevance since 2010	25	
Google scholar	Sustained use health and fitness wearables	Relevance since 2010	6780	Kalantari, M. (2017). Consumers' adoption of wearable technologies: literature review, synthesis, and future research agenda. *International Journal of Technology Marketing*, *12*(3), 274-307. Coorevits, L., & Coenen, T. (2016). The rise and fall of wearable fitness trackers. In *Academy of Management*. Lupton, D. (2017). Wearable devices: Sociotechnical imaginaries and agential capacities.
Scopus	Sustained use health and fitness wearables	Relevance since 2010	4	
Web of science	Sustained use health and fitness wearables	Relevance since 2010	3	
Google Scholar	Health information privacy	Relevance	1.370.000	Smith, H. J., Dinev, T., & Xu, H. (2011). Information privacy research: an interdisciplinary review. *MIS quarterly*, *35*(4), 989-1016.
Scopus	Health information privacy	Relevance	10.458	
Web of science	Health information privacy	Relevance	4.037	
Google scholar	Wearables privacy concerns	Relevance since 2010	19.800	Motti, V. G., & Caine, K. (2015, January). Users' privacy concerns about wearables. In *International Conference on Financial Cryptography and Data Security* (pp. 231-244). Springer, Berlin, Heidelberg. Lee, L., Lee, J., Egelman, S., & Wagner, D. (2016). Information disclosure concerns in the age of wearable computing. In *NDSS Workshop on Usable Security (USEC)* (Vol. 1).
Scopus	Wearables privacy concerns	Relevance since 2010	250	
Web of science	Wearables privacy concerns	Relevance since 2010	24	

Table 1: searching process and results

The search was carried out while navigating through the different databases, where doubles were filtered. By reading through abstracts, conclusions and parts of the texts, papers that were not applicable were filtered and removed. The process of searching was repeated multiple times until no new relevant articles appeared. The selected reports were analysed by first re-reading the abstract and conclusions and highlighting the most interesting aspects. In the context of wearables for example there have been looked to contexts almost similar to the one of this report. Lastly, while preparing the analysis of the literature review, relations between the categories were found, which lead to organizing the structure of the literature review chapter. The literature review was a back and forth process between reading literature and the results of the interviews so it was really dependent on the outcomes and the set-up of the semi-structured interviews.

Also within the different articles of diffusion of wearables or within a literature review of health information privacy, most used theories-models are examined.

Furthermore, regarding the thematic analysis emerging themes or aspects from the literature has been used as search words, side long the general analysis of the semi-structured interviews, to search through the semi-structured interviews to check for emerging themes or certain aspects within these results. Examples of the search words used: fun – useful – habit – wearing – forgetting - goal and synonyms.

Also emerging themes of aspects from the results of the semi-structured interviews themselves or aspects from the structure of the interviews themselves have been a base to search through the different literature articles to check whether it is spoken about. Example of these search words are: worry – accuracy – relevance – information – doctor – knowledge and synonyms.

1.6 USE-IT model

First a comprehensive explanation of the USE-IT model, with related literature, of which the interviews are based on could be found next. Next additional literature in brief form can be found based on the results and conclusions of this report. Due to the set-up of this research, the process of back and forth, the literature in here is adjusted to the most important outcomes of the interviews and conclusions, the comprehensive literature review can be found in Appendix C

The PRIMA method focusses on both the technological as social domain. The end user of the innovation is centralized. The PRIMA method is a semi-structured interview method based on the USE-IT model. The USE IT model has four determinants: Relevance (relevance), Requirements (information requirements and quality), Resources (resources) and Resistance (resistance or attitude), see figure 2. The method is designed to discover the success of ICT innovations and the adoption process of consumers. The objective of the PRIMA method is to discover those aspects that are decisive for the success or failure of an innovation (T. Spil & Michel-Verkerke, 2012). The focus is on the end-user of ICT innovation, which is according to Rogers (1995) crucial in the theory of acceptance and adoption of innovations. Two axes are distinguished in the model: the innovation and the domain axis. The axis of the innovation has two dimensions: the innovation product (innovation itself) and the innovation process (development or implementation process). The axis of the domain has two domains: the social domain of the user and the technological domain (IT). Four determinants that describe the success of ICT innovations are derived from the domain and innovation dimensions where a distinction is present between the macro and micro level. The micro level is related to the here-and-now situation of individual users whereas the macro level is about the group and/or longer period. The resources determinant differentiates, instead of the macro and micro level, between the material and immaterial level. It is not only clear whether ICT innovation is accepted, but also what aspects of the ICT innovation contributes to this and what aspects does not. Relevance (relevance) is defined as the extent to which the user thinks that the innovation will solve his problems and achieve its goals. Relevance at the micro level has much in common with "expected or experienced utility '(perceived usefulness) in the Technology Acceptance Model (Davis, 1989; Venkatesh & Bala, 2008) and "comparative advantage" (relative advantage) of the diffusion of innovations (Rogers, 1995). Requirements is defined as the degree to which the quality of the product fulfils the requirements of the user. Regarding ICT innovations this mainly involves information needs and quality. The requirements determinant is related to information quality and system quality in the Information Systems Success Model (Delone & McLean, 2003) and usability (ease of use) from the Technology Acceptance Model (Davis, 1989; Venkatesh & Bala, 2008). Resources (resources) is defined as the degree to which immaterial and material resources are accessible for the design, operation and maintenance of the system. For an example of the set-up of the semi-structured interview, see appendix A.

USE IT		Domain	
		User	Information Technology
Innovation	Product	Relevance	Requirements
	Process	Resistance	Resources

Figure 2: USE-IT model for technology innovations

1.7 Literature

This study is built upon established theories as well as context related literature in order to elicit factors and support it with theory. To not overlook any factors within the semi-structured interviews several theoretical models and related literature are examined to elicit factors and emerging themes. This paragraph globally examines most used theories for information systems (IS) and wearables, whereas the next subsection zooms in more into different factors and themes elicited from the semi-structured interviews backed up with more context specific literature.

The next section zooms in more in the theories used in the USE-IT model and additional ones which are common used in the wearables scene or information systems. Previous research often use the technology acceptance model (TAM) of Davis (1989). The TAM is an IS theory that models how users come to accept/reject and use a technology. Initially it was developed to apply in work environments (Davis, 1989), but has proven its relevance in wearable contexts as well (Kalantari, 2017). Perceived usefulness and ease of use are jointly effecting determinants of peoples intentions to use IS. These intentions, on their turn, are determinants for using an IS. The Unified Theory of Technology Acceptance (UTAUT) originally developed in 2003 (Venkatesh et al., 2003) and in 2012 extended (Venkatesh et al., 2012) is an extension of the TAM model with additional decision-making theories such as social cognitive theory, theory of planned behaviour, theory or reasoned action and the diffusion of innovation. The original model was tested in an organizational context whereas the extension was tested in a consumer context (Venkatesh et al., 2003; Venkatesh et al., 2012). In the original model four constructs, 1) performance expectancy 2) effort expectancy 3) social influence and 4) facilitating conditions, are determents of user acceptance and usage behaviour on technology with the moderators gender, age, voluntariness, and experience (Venkatesh et al., 2003). The extension, which is tailored to the context of consumer acceptance and use of technology, added hedonic motivation, price value, and habit into the model (Venkatesh et al., 2012).

The diffusion of innovation theory was originally proposed in 1962 by Rogers (1962). Rogers (1983) says ‘’Diffusion is the process by which an innovation is communicated through certain channels over time among the members of a social system’’ (p.35). The theory tries to explain how, why, and at what pace new ideas and technology spread. It explains how inventions are almost always perceived as uncertain or even risky. It provides three valuable insights: 1) What qualities make an innovation spread successfully 2)The importance of peer-peer conversations and peer networks and 3) understanding the needs of different user segments (Rogers, 1983). Rogers (1983) speaks about diffusion occurs through a five–step decision-making process: 1) knowledge, 2) persuasion, 3) decision, 4) implementation and 5) confirmation. Central to the theory is the description of the life cycle of an innovation. The theory distinguishes five stages, in which five different groups are distinguished, with their own characteristics, that accept the product or new idea. The groups are classified as respectively innovators, early adopters, early majority, late majority and laggards.

The attitude of users' pre-acceptance is only based on cognitive beliefs (e.g. ease of use and relevance) formed potentially via second-hand information from referent others, (popular) media or other sources. These might be biased, hence users attitude has the potential to be inaccurate, unrealistic and uncertain. While post-acceptance satisfaction is based on users' experience with the IS, therefore, more realistic, unbiased, and less susceptible to change (Fazio & Zanna, 1978).

These acceptance models have proved their value for the understanding of the initial adoption of technology, but do not provide enough insights into the phase of post-acceptance. The initial adoption is essential, but for the success of a system the long-term use is important (DeLone & McLean, 2003).

The post-adoption theories of IS are opened by Bhattacherjee (2001) within a consumer context. This theory is based on the expectation confirmation theory that mentions that satisfied consumers will continue using IS where dissatisfied consumers will discontinue. According to Bhattacherjee (2001), ''Continuance intention is determined by their satisfaction with IS use and perceived usefulness of continued IS use. User satisfaction, in turn, is influenced by their confirmation of expectation from prior IS use and perceived usefulness. Post acceptance perceived usefulness is influenced by users' confirmation level'' (p. 351). Not to be mistaken that usefulness refers to post-usage usefulness instead of pre-usage usefulness. Bhattacherjee (2001) speaks about continued use rather than first-time use being vital for long-term viability of an IS. Limayem et al. (2007) built on this previous work, in a consumer context, saying continued IS usage is not only a consequence of intention and added the factor 'Habit', where habit moderates the influence of intention. Venkatesh (2012) reported, in a consumer context, facilitating conditions and habit as factors impacting directly on use behaviour. With facilitating conditions being moderated by experience, age and gender. Where for forming an habit, experience is a necessary but not sufficient condition.

The information systems success model is an information systems(IS) theory which seeks to provide a comprehensive understanding of IS success by identifying, describing, and explaining the relationships among six of the most critical dimensions of success along which information systems are commonly evaluated. The IS success model identifies and describes the relationships among six critical dimensions of IS success: information quality, system quality, service quality, system use/usage intentions, user satisfaction and net system benefits (Delone & McLean, 2003).

All previous mentioned theories and models are common used for IS systems, but does not always take into account specific wearable characteristics and contexts. It is important and necessary to understand what is relevant for wearables, what really matters and whether existing theories of IS adoption and diffusion can explain this phenomenon well. In wearable literature therefor authors sometimes extend the models for a more complete explanation about users' pre- and post-adoption behaviour in certain contexts (e.g. Buchwald et al., 2018; Canhoto & Arp, 2017; Ernst & Ernst, 2016; Pfeiffer et al.,2016; Nascimento et al., 2018). Kalantari (2017) performed a literature study and found that some authors extended some common used models to have a more complete explanation about users' pre-adoption behaviour in certain contexts. It is noteworthy that the effect of these factors vary based on the type of wearable and context.

Next some factors are more clarified, due to their relevance for this research (read: outcomes). A more comprehensive literature review can be found in appendix C.

1.7.1 Relevance

Bhattacherjee (2001) speaks about perceived usefulness as factor for post-adoption. He suggests continuance intention is positively influenced by perceived usefulness (PU). More context specific, related literature of Pfeiffer et al. (2016) reports usefulness to be a strong pre-adoption driver to use wearable self-tracking technologies. Whereas literature on self-tracking devices (Buchwald et al., 2018) and smartwatches (Nascimento et al., 2018) found relevance/usefulness to be a factor for continuance intention and literature on health and fitness wearables (Canhoto & Arp, 2017) on sustained use. Where Kai et al. (2016) mention continued adoption of technology was influenced by the possibility of improving oneself with the help of technology.

Consumers might form perceptions about the performance of a product or service. However, if the information about the product or service is misleading, expectations will not be realistic (Boulding et al., 1994; Oliver, 1980). Expectations provide the baseline level against which confirmation is assessed by users to determine their evaluative response or satisfaction (Bhattacherjee, 2001). Post-acceptance satisfaction is grounded in users' first-hand experience with the IS. It is, therefore, more realistic, unbiased, and less susceptible to change (Fazio & Zanna, 1978).

The perceived performance is influenced by these expectations and impacts the post-usage disconfirmation of beliefs. To put relevance in the context of this report, it is refined to the degree a person believes using a wrist-worn wearable would enhance her or his personal living condition, contributing to one’s health, fitness and/or well-being.

1.7.2 Reliability (requirements)

Delone and Mclean (2003) with the IS success model within as well organizational as individual context, identifies and describes the relationships among six critical dimensions of IS success: information quality, system quality, service quality, system use/usage intentions, user satisfaction, and net system benefits. Venkatesh and bala (2008), with a research in an organizational context, state that ‘’information-related characteristics of a system will influence the determinants of perceived usefulness, while the system-related characteristics will influence the determinants of perceived ease of use’’ (p. 249). And further Venkatesh and bala (2008) mention ‘’If a system can provide users relevant information in a timely manner, accurately, and in an understandable format and help them make better decisions (Speier, Valacich, & Vessey, 2003), it is more likely that users will perceive greater job relevance of the system, high output quality, and greater result demonstrability—the important determinants of perceived usefulness’’ (p.249).

More context related research mention unreliability and/or inaccurate or inconsistent data affects discontinuance intention/sustained use/continuance intention or stopped using it (Buchwald et al.,2018; Canhoto & Arp,2017; Coorevits & Coenen, 2016; Eptstein et al., 2016; Kari et al., 2016; Maher et al., 2017; Nascimento et al.,2018). Shih et al. (2015) reframe data inaccuracy as a by-product of mismanagement of expectations of the device’s capabilities and its expected usage.

1.7.3 Ease-of-use

The slope for an individual to accept innovation relatively earlier than others, is positively related to perceived ease of use. Highly innovative individuals are (mostly) active information seekers, which help them to better coop with uncertainty of innovations and hence a higher adoption intention (Rogers, 1995). For example for certain wearables (health and wellness wearables), adopted mainly by older groups, perceived ease of use is more impactful. This due to the lower levels of technology experience and innovativeness of these older individuals. Jang Yul (2014) found, on adopting mobile fitness applications, personal innovativeness in IT as significant effect on PU and PEOU.

Regarding IS continuance, Bhattarcherjee (2001) and Venkatesh et al. (2003) do not include PEOU into their model due to the fact that users gain experience with a system and resolve their PEOU concerns. More context specific: Buchwald (2018) follows this line with self-tracking devices and do not include PEUO in his research. On the contrary Nascimento et al. (2018) included it in their model and found perceived usability to have an impact on satisfaction, in turn have a significant effect on continuance intention for smartwatches.

Coorevits and Coenen (2106) refer ease of use as use experience resulting in ''But the majority of users forgot to change their settings, making the data irrelevant. Additionally, overall health tracking requires too much effort from the user. If they want to track how healthy they are by counting calories combined with their activity level, the applications require too much effort because they have to input their activity manually through the application'' (p.14).

According to Venkatesh et al. (2012), a research of IS (mobile internet) in a consumer context, facilitating conditions influence as well behavioural intention as use behaviour. Facilitating conditions in this case is measured with items such as 1) having the resources necessary to use mobile internet 2) having the knowledge necessary to use mobile Internet. 3) mobile Internet is compatible with other technologies I use and 4) being able to get help from others when I have difficulties using mobile Internet. The moderators age, gender and experience with technology moderate facilitating conditions 'influence on behavioural intention whereas gender and experience moderate in the case of use behaviour.

Experience is also of influence on PEOU, PEOU diminishes over time in the post-acceptance stage due to people gain experience with a system and resolve their PEOU concerns. However caution must be taken since this is researched in an organizational context regarding the computer program Windows (Karahanna et al., 1999).

1.7.4 Privacy

Privacy is not a common factor in traditional adoption models, but has been added to this research due to its relevance.

The understanding of information privacy remains fragmented particularly in the under examined health context. Till now, a limited number of studies have explored a few antecedents of health information privacy concern.

Smith et al. (2011) reported in a literature review on information privacy, that a subset of empirical studies addresses the concept of privacy calculus by assuming that a consequentialist trade-off of costs and benefits is salient in determining an individual's behavioural reactions. Overarching APCO Macro Models (antecedents -> privacy concerns -> outcomes) should eventually include an expanded set of antecedents as well as an exhaustive set of outcomes. Emerging technological applications and other contextual factors should be taken into account and so should be aware of the exhaustive set of antecedents, as there is the need for each discipline or sector to investigate its own set of antecedents.

More wearable specific, for example the technology acceptance model (TAM), diffusion of innovations (DOI) and unified theory of acceptance and use of technology (UTAUT) for IS do not incorporate privacy issues. The literature review of Kalantari (2017) reported, in the context of wearables, different authors extended the UTAUT2 model with for example the earlier mentioned privacy calculus theory and one author using the protection motivation theory. Whereas Kenny and Connolly (2016), in the case of health information privacy concerns, also uses the protection motivation theory to back up that individuals do appraise threats by considering media coverage, and risks associated with disclosure either to health professionals or health technology vendors. Trust can partially negate these threats. Kenny and Connolly (2016), with regards to health information privacy concerns, used the six constructs collection, unauthorized secondary use, improper access, errors, control and awareness. Overall different authors use a widespread of antecedents adjusted to the context.

In an organizational context Mayer and Davis (1995) raises a number of issues for the study of trust in organizations. The authors proposed a model with the dimensions ability, benevolence and integrity of the trustee. Mayer and Davis (1999) posit that the relevance of these dimensions differ per situation. In a commercial report of PWC (2017) 88% of consumers report the extent of their willingness to share personal information is related on how much they trust a company. Where 87% mention to take their business elsewhere if they don't trust a company handling their data responsibly. It also reported consumers trusting companies less today than in the past, respectively 12 and 17%. Kenny and Connolly (2016), with regards to health information privacy concerns, say individuals may trust the intentions of health professionals, but may not trust their ability to protect their health data. In a commercial report of PWC (2017) people trust respectively hospitals, healthcare, non-profit organizations and government more than commercial companies. More context specific PWC (2016) reports that overall consumers are more willing to trust health providers than consumer-product providers. More tailored to wearables, Motti and Caine (2015) mention people worry about a lack of control and awareness regarding who has access to the data collected. Pfeiffer et al. (2016) found, in the context of self-tracking devices, trust to be a pre-adoption factor. Whereas Buchwald et al. (2018) found, in the context of self-tracking devices, trust also being a post-adoption factor, being negatively related to the discontinuance intention.

Kenny and Connolly (2016), with regards to health information privacy concerns, the more sensitive individuals perceive health data to be, the greater their concerns are regarding the privacy of this data. Miltgen et al. (2013) extended regular adoption models with trust and privacy to investigate end-user acceptance of biometrics, showing that heightened risk perceptions are associated with lower consumer intentions to adopt. Epstein et al. (2016) found people to stop tracking location due to concerns for data sharing. Motti and Caine (2015) show that users have different levels and types of privacy concerns depending on the type of wearable they use, related to the sensors embedded in the device and the respective data collected.

The privacy loss that might be perceived as unacceptable to some kind of users might seem acceptable to others (Spagnolli et al., 2014). Lee et al. (2016) found in 2014, users are willing to tolerate risks if there is enough benefit associated with that risk.

(Lupton, 2017; Lupton et al., 2018) reported, in the context of self-tracking data, people see their personal data as having little value to others due to its ordinary nature. Motti and Caine (2015) mention this could be due to their ignorance how this information could have value and misused by third parties. Also Lee et al. (2016), among users and non-users in the context of Fitbit fitness trackers, confirms this.

Lee et al. (2016) reported that consumers may not have clear understandings of new technologies with respect to familiar ones, they may have a higher likelihood of being influenced by reports of recent events regarding to wearables. They reported respondents being concerned due to stories from the news. Kenny and Connolly (2016) related media coverage of individual experiences to health information privacy concerns.

1.7.5 Habit

Habit is not a common factor in traditional adoption models, but has been added to this research due to its relevance.

A person form many habits during his lifetime, which integrate in persons' regular behaviours, by repeatedly proceeding from intentions to actions. In the end, this kind of behaviour results in an automatic habit and is being done unconsciously (Hutchison 2013). This can be applied to self-tracking devices, due the frequent, and often daily usage of these devices it supports the transition process into an habit. The self-tracking devices value is based upon the continuously collected data, by using this collected information users can benefit from improvements. Besides this, wearable developers can use the data for segmentation, to improve next generation devices, and to provide new services (Porter & Heppelmann 2014). Limayem et al. (2007) speaks about four conditions likely to form IS habits: 1) frequent repetition of the behaviour in question 2) the extent of satisfaction with the outcomes of the behaviour 3) relatively stable contexts 4) comprehensiveness of usage, which refers to the extent to which an individual uses the various features of the IS system in question. According to Venkatesh (2012), tailored to post-adoption and sustained use, hand experience with the target technology itself is of influence on habit and use behaviour. Where habit on its turn influence behavioural intention and use behaviour.

More context related to wearables, different authors include habit in their models for continuance use of wearables (Buchwald et al.,2018; Coorevits & Coenen, 2016; Nascimento et al., 2018). Other researchers found habit to have influence as well, without including it in their model (Fritz et al.,2014; Lupton, 2017; Shih et al.,2015).

Sub conclusion

Some of the factors researched are the fundamental constructs of the technology acceptance theories or post-adoption theories such as the UTAUT, others are external variables (privacy and habit) that were incorporated in these models with an attempt to improve their predictive power. The following subjects are the main subjects which will be used for further analysis.

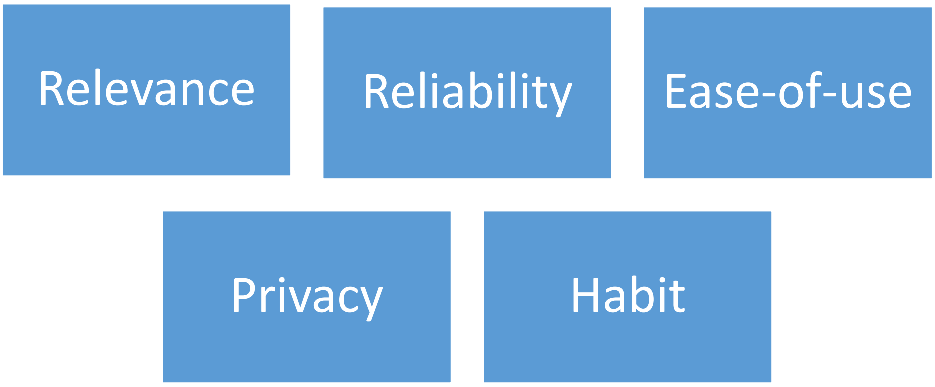

Figure 3: Main subjects of this report

2 Market

2.1 Current state

2.1.1 Introduction wearables

By keeping track of data about every aspect of one's life, people can gain exact knowledge of and insight into their daily lives. The collected data makes it possible to understand certain activities, habits and triggers for actions and behaviour taken. Quantifying oneself makes it able to improve a person's lifestyle and achievements with the help of measuring, analysing and comparing performances about different activities (Barcena, Wueest & Lau, 2014). Due to the increase of power of processors and the miniaturization of sensors and processors, longer battery lifespan, and the opportunity of communication and data collection, one embrace the idea the possibility of using always-on devices with small effort and accurately record data with the help of smartphone apps and wearables. Next to the technological aspects, people are increasingly looking after their health (Salah, MacIntosh & Rajakulendran, 2014). There are different type of wearable users; those with chronic medical conditions, sports enthusiasts who are keen to collect data about their activity performances in order to help them set goals and track their progress, persons who are interested in keeping track of certain lifestyle patterns or achieving behaviour changes, such as losing weight, having more sleep or living a healthier life (Barcena, Wueest, & Lau, 2014). The process of self-tracking typically involves the tracking and collection of data from an activity, followed by the comparison and analysis of the performance to the goal being desired. Based on the results, adjustments can be made and the process of quantifying one's performance aiming to reach a certain goal can be repeated.

The concept of wearable is not entirely new; a wrist-worn calculator watch and pedometers are present for some time now. However, due to some technological developments regarding smartphones, miniaturized networking and cheap and widely available at scale sensors, wearables have improved (PWC, 2015). Wearables can perform many of the computing tasks of laptops and smartphones, but also outperform these devices (Andrew, 2016). Wearables are more sophisticated, such as biofeedback and tracking of physiological function. The uses of wearables can have influence on different fields, for example health and medicine, fitness, aging and transportation. However, most wearables are marketed for voluntary use by persons for self-monitoring for health, wellbeing, sport and fitness purposes. Via bodily contact with traces of the wearers' flesh and fluids – their sweat, skin flakes, blood or bodily oils wearables have the potency to be personalised (Lupton, 2017).

There is no profound definition of wearables within the academic literature. It is important for this research to clarify what is meant by wrist-worn wearable for health and fitness purposes. Wearables are in some form part of the internet of things (IoT) and are embedded with internet connectivity, either with sensors in the device or indirectly via a smartphone (Ledger, 2014). The wearables have the ability for data collections, storage and transmission capabilities (Weber, 2015). However, unlike other forms of IoT, wearables are more towards machine to human interfaces. Hence these should be studies by a consumers perspective (Groopman, 2015). These wearables monitor biometrics such as steps taken, energy expended, route travelled, sleep patterns, and heart rate. This research is narrowed down to wrist-worn wearables such as bracelets, wristband, fitness trackers, activity trackers and smartwatches.

The first generation of wearables can be seen as products that only generates revenue at the point of sale and solely run tracking and analysing software within an enclosed ecosystem provided by the wearable developers. Due to the closed ecosystem, there is no possibility of service enhancements for users by third-party providers. Where the second generation of wearables, such as the Apple Watch, has an open ecosystem for applications and services of new and traditional third-party providers, which makes it possible to create additional value beyond the pure tracking and analysis of data for the user and revenue for themselves (e.g. personalized sport and fitness support and digital health-care support) (Buchwald, 2018). For example, steps and heart rate data collected by a wearable, can be accessed by a smartphone app, and integrated with food intake data collected via an app to calculate net calorie intake and hence make people able to make decisions regarding their diet (Ledger, 2014). The continuous supply with data recorded by the wearable are of major importance for these associated business and service models.

Wearable defined as 'smart wristband,' 'smart bracelets,' or 'fitness tracker' are devices that track a user's physical functions and provide relatively very limited information on small interfaces. The primary goal of these devices is collection of data that a user can analyse on another device such as a pc or smartphone. The presentation of information is relatively very limited and often do not have the possibility to install apps (e.g. Fitbit Surge). On the other side, smartwatches are larger than these more 'simple' models and often have a touchscreen. These smartwatches allow users to install different kind of apps. Smartwatches, in contrast to the more 'simple models', provide the most benefits in case they are connected to internet. Also smartwatches present other relevant information (e.g. email notifications) (Chuah et al., 2016).

Fitness trackers and smart watches are the largest device segments for wearables, accounting for more than 80% of shipments in 2016 (Tractica, 2017). Millennials are far more likely to own wearables than older adults. Adoption of wearables declines with age (PWC,2016). More fitness trackers will be sold as replacement devices rather than first-time purchases until the middle of 2017.

The abandonment rate of smartwatches is 29 percent and 30 percent for fitness trackers (Gartner, 2017).

Regarding the data being collected by the wearable, this is uploaded and stored on a server. In general, the personal health information that is collected at large scale makes it possible for knowledge development and everyday health support. The possibilities from leveraging tracking data are diverse such as feedback notification, motivations, learning, entertainment and social support (Klasnja & Pratt, 2012). Some wearables also make use of the cloud and this is increasing (Page, 2015).

The collection of data from the sensors also face some challenges, since humans do not always operate within the narrow confines of a programming language. Deviations in for example blood, sweat, and environments can all skew the data being collected (Andrew, 2016).

The continued use of wearables is also important when looking at the related apps being sold. In 2016, developers selling apps on the App Store earned over $20B (Apple, 2017). It is assumed the longer one keeps using a device, the more apps will be bought and the more profit a company can generate. Also the loyalty perspective is important for continued use; satisfied customers have a higher probability of returning to the same brand they purchased (Oliver, 1999). Also the continued use serves people to find out how it fits into their life, which is not always clear from the beginning. People might have bought it due to the novelty factor, good marketing, someone in one’s environment having it or just because being an early adopter. When people stop using the wearables, the developers cannot harvest the data on which the valuation of the IoT industry is premised, hence cannot earn back their development and marketing costs (Ledger, 2014). Next to that, people might not reap the benefits of the promised health and fitness improvements, meanwhile society being unable to coop with the increasing health problems such as obesity.

A sustainable future success heavily relies on user engagement. To date, most wearable do not pass the so called ‘’’turnaround test’’. This test tells whether a person, in case he/she forgets to take the wearable with him/her from home, turns around to retrieve it. Like for example your wallet (PWC, 2016).

2.1.2 Options (relevance and ease-of use)

The most popular wrist-worn health devices, at the time of this study (half 2016) and mentioned wearables in the semi-structured interviews are analysed. This analysis can help in further stages of analysis of the report and to the readers to put it more in context and make it more valuable. In total seven brands and 20 types of wearables are analysed of which Fitbit, Xiaomi, Apple, Garmin, Fossil, Pebble and Polar. The different types of wearables are a wristband, bracelet, sport watch and smartwatch.

Next a brief summary of the analysis with the most important results for this report, you can see appendix D for a comprehensive summary with all the items analysed, the graphs with the exact outcomes of the analysis and the visual aspects of the wearables.

All wearables have the following options: steps, distance, where most of them got activity, sleep analysis and burned calories options. They all got an open ecosystem, except for Fitbit. The more simple models do not have the broad range options of the extension of the smartphone as the more sophisticated models, such as callers id, notifications smartphone and music control. Half of the wearables have Pulse HR, Smart alarm (sleeping), floors climbed and a reminder to move. Only one wearable has own GPS, food log, NFC chip and smart coach.

The majority of the wearables have a battery lifespan of five to seven days. Where the Apple smartwatch S1 and Fossil Qfounder smartwatch only have a maximum of respectively 18 and 24 hours. Two out of the four Garmin bracelet models have a battery lifespan of up to- or more than one year. Limitations to the battery life is that these are the values mentioned by the developers themselves, which could be biased.

When talking about medical equipment at home, only Fitbit has it in its portfolio. Fitbit released a scale for at home in 2012. This scale can measure weight, body fat and BMI and is connected via WI-FI (Bennet, 2012).

More tailored to the two most popular wearables: Fitbit and Apple most used wearables: both have steps, distance, activity, burned calories sleep analysis, smart alarm and workouts as options. Where caller id, notifications and music control and pulse HR is only present in Fitbit latest models (basically the smartwatches) and Apple's S1 smartwatch. A reminder to move is only present at the latest Fitbit and Apple model. Floors climbed is available in Apples s1 and randomly available throughout Fitbits wearables. GPS is available in Apple but only in one wearable (smartwatch) of Fitbit. A smart coach is only available in Apples' smartwatch.

Figure 4: Apple Watch

Figure 5: Fitbit Charge HR

2.1.3 Usage rate

It is hard to determine the exact usage rate due to the fragmented measurement of wearables and since smartwatches are also being sold only for the extension of the smartphone. In 2016, at the time of this research, the usage rate of wearables in the Netherlands was 16 percent (Spil et al., 2017). This definition is broader than this report hence it is assumed the current usage rate in the Netherlands is slightly less than 16 percent at the moment the interviews have been conducted (half 2016). This is confirmed in a rapport at the beginning of 2017, a half year after the conduction of the interviews, that the penetration rate of smart bands and smartwatches in the Netherlands is near the 10 percent (Vliet, 2017). As regards to the stage of diffusion of Rogers, this can be classified as the stage of early adopters. It will be assumed the respondents of the interviews are innovators or early adopters.

2.1.4 Market

Major players in the consumer electronic market, such as Apple, Google and Microsoft, as well as specialized producers, such as Fitbit or Jawbone, launched their own wearable self-tracking devices (e.g., Apple Watch, Android Wear, Microsoft Band, Fitbit Charge and Jawbone UP) and start to build up software and hardware ecosystems around them. It is expected that the shipment of self-tracking devices will grow from 102 million units in 2016 to more than 224 million units in 2020 (IDC, 2016).

The biggest part of wearables shipped are wrist-worn wearables for general health and fitness purposes. Fitness devices are the most prevalent wearables where smart watches are catching up. IDC (2017) found that at half 2016 the worldwide market share of wearables was respectively: Fitbit (24.1%), Xiaomi (13%), Apple (9.6%), Garmin (6.4%), Fossil(1.4%) and others (45.5%). This with the side note that Xiaomi achieved its market share for the mast majority in its own home market China, which relatively have much residents (IDC, 2016).

Top 5 Worldwide Wearable Device Companies, Shipments, Market Share, and Year-Over-Year Growth, Q2 2017 (shipments in millions)					
Company	2Q17 Shipment Volumes	2Q17 Market Share	2Q16 Shipment Volumes	2Q16 Market Share	Year Over Year Change
1. Xiaomi	3.5	13.4%	3.1	13.0%	13.7%
2. Apple	3.4	13.0%	2.3	9.6%	49.7%
3. Fitbit	3.4	12.9%	5.7	24.1%	-40.9%
4. Garmin	1.4	5.4%	1.5	6.4%	-6.6%
5. Fossil	1.0	4.0%	0.3	1.4%	217.9%
Others	13.5	51.3%	10.8	45.5%	24.3%
Total	26.3	100.0%	23.8	100.0%	10.3%

Figure 6: Worldwide Wearable Device Companies, Shipments, Market Share, and year-over-year Growth, Q2 2017

Design is a key driver for the adoption of consumer wearables, both on the hardware and software side (PWC, 2015). As a platform, a smartwatch is only as good as the quality of the apps it has at its disposal (O'Reilly, 2015). Apple is slightly ahead of other major players in the market when considering the number (Curry, 2015) and quality (Mitroff, 2012) of apps.

Where Fitbit is relatively cheap and tailored to the low and middle segment, Apple is tailored to the high-segment and as fashion product at the time of research (PWC, 2015). Xiaomi is known for its low-cost devices (IDC, 2017).

According to Statista (2018) the Netherlands are lagging behind in comparison to other countries, in the context of wearables specifically for fitness (smartwatches excluded). Vliet (2017) mention that Fitbit is market leader in the segment of activity wearables due to its high-quality, affordable activity bands (Euromonitor, 2017) where Apple is in the segment of smartwatches (Vliet, 2017).

2.1.5. Promotion from developers

According to Lupton (2017) wearable developers in promotional material often draw on and reproduce concepts of the ideal-type user to target their markets. Futurist narratives with wearables offering new possibilities are used. They claim aspects such as users to learn more about themselves and their bodies, being better able to make major behavioural changes, obtain insights that otherwise would be invisible or hidden. Pedagogical elements are incorporated in the promotion: it mentions things like people being able to make changes in their habits, improve their health and fitness levels. Also the more playful aspects of wearables are mentioned, being portrayed as fun and intriguing. The playful capacities of some wearables are also often emphasised. These devices are frequently promoted as being fun and intriguing, escaping daily struggles which would otherwise be experienced as hard or annoying. Overall these wearables suggest they are able to enhance human life itself.

These claims are supported by the promises of mobility and ease of use, the 'always on' affordances and opportunities to optimise and improve the user's life that wearables offer. They suggest that wearables are able to seduce users into long-term relationships, working with users to generate capacities to make sustained changes in their behaviour and on top of it experience life with greater confidence and more fully.

2.1.6. Privacy

In the race to be first to the market, security on wearables is not as seriously taken in the development by the firms as it should be, the people who wear them, or by the firms who adopt them into their existing work processes and legacy systems. Typically the legal regulatory environments lag behind several years to adapt to technological advancements. Due to the push of wearable developers to newer and more powerful technological devices, the gap between laws to govern wearables and the technology itself increases (Mills et al., 2016). Patterson (2013) mention ''The dominant reaction is simply to opt out, to take self-protective measures to shield themselves from future harm, thus leaving them less able to experiment with and enjoy innovative new technologies on the horizon'' (p.48).

Wearables are more personal and unique devices, more than laptops and tablets and even smartphones so far. This uniqueness also encounters more risk and security issues than previously seen in information systems (Mills et al., 2016).

A big part of the wearables are connected to cloud databases. Third parties can often openly use this information. When data are being transmitted from wearables to cloud databases, and stored in digital archives, they are vulnerable to different kind of leakages, breaches or hacking (Langley, 2014). Combining different datasets about consumers can lead to generating data profiles that can reveal many aspects of consumers' lives and activities to a range of third parties, as well legally and illicitly (Pasquale, 2014).

The data is not only about the person and for example workout routines and sleeping patterns. But, also the wearer's date of birth and social security number can be obtained. These type of data and information are far more valuable than a stolen credit card for example (Overfelt, 2015). More context specific; Ching and Singh (2016) mention Fitbit Devices and Samsung smartwatches being easily breached with a data injection attack, denial of service (Dos), battery drain hacks, easily being tracked, phishing and brute force attack.

In the last few years wearables are popping up negatively in the Dutch news due to privacy issues, such as due to a leak in popular smartwatches, for years it was possible to track thousands of Dutch children's living place for example. Parents bought a smart watch to keep an eye on their child, but hackers could easily get involved. The vulnerability was found in the Dutch smartwatches Helloo and Belio, which are sold at large web shops. These smart watches did not store the child's data securely, making it possible to retrieve all their location data from one year to the next and the parents' telephone number (Verlaan, 2018). Another case was of secret agents: the names of these are state secret. Soldiers on mission call each other only by their first name. But, with the fitness app Polar anyone with common sense (and Google) could find their identity and home address (De Correspondent & Bellingcat, 2018).

With regards to privacy statements of wearable developers: a commercial research at the end of 2017 regarding privacy statements of seven big wearable developers resulted often in incomprehensible language, unclear purposes and a lack of transparency regarding information sharing (Consumentenbond, 2018). For more information about privacy and risk see appendix C)

2.2 Developments

In the meantime, since the taking of the interviews half 2016, there have been multiple developments in the landscape of wearables

2.2.1 Relevance

New options in wearables are integrating in wrist-worn wearables: menstruation cycle tracking on smartwatch app of Fitbit (Heater, 2018); a new battery saving mode on the wearable software WearOs from Google (Heater, 2018); blood pressure and oxygen uptake in a activity tracker of Bandeefit (1dagdeal.nl, n.d.); possibility to support connection with other devices such as glucometers and insulin pumps. Also health-app extended with new diabetes management features by Apple (ICThealth, 2017). Both Apple as Fitbit have NFC (wireless paying), a wireless headphone and saving offline music on their new smartwatch (Jacobs, 2017).

Collaborations of wearable developers with known sport brands have been set-up, such as Fitbit with Adidas and Apple with Nike. For example, Adidas Train: a new app exclusive to the Adidas edition Ionic. It houses six run-focused workouts designed to improve cardio, strength and flexibility. The workouts, which are designed by Adidas' performance experts. "Leverage Adidas' robust performance program expertise". And there's also a custom Adidas watch face that comes in four colours (Sumra, 2018).

Apple and Fitbit have the potential to maintain their lead by their investment in algorithms for tracking workouts and providing health insight. It could be a differentiator from low-cost rivals to be able to diagnose diseases (IDC, 2017).

Although you can install multiple diverse third-party coaching apps on the Apple Watch, Fitbit has its own paid coaching program for the Ionic smartwatch launched at the end of 2017. Together with partner Fitstar, Fitbit developed three programs: Fitbit Coach (guidance during work-outs) audio coaching (guidance focused on running and walking) and a guided health program (personalized programs to work towards a specific goal in a few weeks, for example eating less sugar) (Jacobs, 2017).

2.2.2 Reliability

Fitbit is focusing more on smartwatches and fashion and bought troubled smartwatch maker Pebbles for its software at the end of 2016 (Sumra, 2016). Fitbit's purchase had little to do with hardware, instead focusing on Pebble's software development kit (Heater, 2018).

More and more e-health projects are being rolled out in which wearables play a prominent role, which the possibilities within the Internet of Things and Big Data are explored. Big data is seen as the new gold. Fitbit is one of the companies being in this transition phase. The pioneer in wearables has a sizeable user base of more than 60 million, but is in heavy financial weather and the number of wearables sold is also falling. By betting on software and services, Fitbit hopes to be able to transform into a full-fledged digital health company that can successfully compete with the smartwatch segment (ICThealth, 2017). Apple build on its expertise, witnessing the acquisition of the smart sleep monitor Beddit in May of 2017 (ICThealth, 2017).

2.2.3 Ease of use

Options more regarding the ease-of-use of wearables are also more integrated; own internet on a smartwatch of Huawai (High-end) (Dudley-Nicholson, 2017), 4G on the smartwatch of Apple (Alto, 2017) and multiple standalone devices (Simkin, 2017).

Fitbit wants to compete with Apple's products. In the first place, Fitbit is making the shift to making more smartwatches and less simple models, hence bigger screens for example. Secondly, the Ionic smartwatch of Fitbit has a battery that lasts longer than of the Apple Watch. The Apple Watch series 3 has a battery lifespan of approximately 18 hours, the Fitbit Ionic easily lasts four days on a full battery. This significantly increases the ease of use of the Ionic. Also in the meantime a new battery saving mode on the wearable software WearOs from Google is added (Heater, 2018).

2.2.4 Privacy

With the arrival of the new European privacy legislation, the conditions have now been adjusted somewhat. The General Data Protection Regulation (AVG) - which entered into force on May 25, 2018 - sets stricter requirements for the collection of personal data.

The AVG ensures:

• strengthening and extending privacy rights;

• more responsibilities for organizations;
• the same powers for all European privacy regulators, such as the authority to impose fines of up to €20 million (Autoriteitpersoonsgegevens, 2018).

2.2.5 Market

In 2017 the smartwatches and fitness trackers are the most important segment in the market, but facing less growth than earlier, with their share projected to drop from 80% to 50% in 2022. There is a market consolidation with Pebble having their product discontinued and being acquired by Fitbit, where Jawbone (fitness tracker company) is undergoing liquidation. 2017 also showed a decline of wearables those without being able to run third party apps (IDC, 2017). The market is getting more and more crowded by Android devices and the Apple Watch, Fitbit is trying to make aggressive moves to keep up. The smartwatches are catching up, in terms of volumes, in comparison to the more simple fitness trackers. Especially the Apple Watch has to momentum, where Fitbit is having a hard time with a revenue drop of 40% in 2017.

Fitbit is increasingly making moves in the healthcare space, but still hasn't seemed to nail things down quite yet as it posted weaker-than-expected financial results with decreasing turnover and sales for its fourth quarter in 2017 (ANP, 2018). Fitbit is still a generic name for every pedometer for many people: a desirable status that also includes brand names such as Aspirin, Luxaflex and Sellotape. But, that name recognition did not ensure that the American company could continue its earlier rapid growth (Jacobs, 2018). Fitbit recently said to acquire a cloud-based health management platform of Twine Health, where Apple looks to increasingly secure the general consumer market and on the same time making movements to healthcare.

When looking at the market share of the different wearables developers in 2018, some changes are seen in comparison to 2016. Fitbit has dropped from place one to three, where Apple climbed from place three to one.

Top 5 Wearable Companies by Shipment Volume, Market Share, and Year-Over-Year Growth, Q1 2018 (shipments in millions)

Company	1Q18 Shipment Volume	1Q18 Market Share	1Q17 Shipment Volume	1Q17 Market Share	Year-Over-Year Change
1. Apple	4.0	16.1%	3.6	14.3%	13.5%
2. Xiaomi	3.7	14.8%	3.6	14.6%	2.3%
3. Fitbit	2.2	8.7%	3.0	12.2%	-28.1%
4. Huawei	1.3	5.2%	0.5	2.1%	147.0%
5. Garmin	1.3	5.0%	1.1	4.6%	9.1%
Others	12.6	50.3%	12.9	52.1%	-2.3%
Total	**25.1**	**100.0%**	**24.8**	**100.0%**	**1.2%**

Figure 7: Wearable companies by shipment volume, market share, and year-over-year growth, Q1 2018

During the 1st quarter of 2018 the worldwide shipments of wearable only grew 1.2% in comparison to the 18% one year ago. Basically due the decline of shipments of basic wearables; consumers more often buy smarter devices.

Regarding the smartwatch segment, the main brands are Fitbit and Apple. Other providers are much smaller or specialized in a certain segment. Fitbit and Apple can rely on additional sensors, years of underlying data and improved algorithms to help identify diseases and other health irregularities. The brands Polar and Garmin are examples who try to have their share on the market, from their strong position among athletes. Where brands as Huawei, Fossil and Samsung relatively remain invisible on the Dutch market. The market of wearables is an increasingly tough one. Besides the market leaders there are numerous of vendors trying to enter the wearables market. Meanwhile, the health and fitness segment is still the key value proposition of these devices, but also other wearables are entering the marketing such as hearables with coaching, audio modification and language translation. Also wearables who focusses on children for personal safety (IDC, 2018). Or some start-ups who focus on niches, for example tracking the blood alcohol value of people. Given the efforts of companies like Apple and these niches making more sense in a general device, it is not clear - without a whole suite of health application – a more general device has room for existence. (Lynley, 2018).

Sub conclusion

The literature review resulted in main subjects; fundamental constructs of the technology acceptance theories or post-adoption theories such as the UTAUT where habit and privacy were added for its predictive power. The wearable market in the Netherlands, at the time of research in 2016, is still in its early stages (early adopters) and has trouble reaching the next stages of diffusion, such as problems with privacy. Meanwhile, since the time of research there have been some developments in the market. The market is still having trouble reaching mainstream, but developers are trying to improve the wearables by adding more relevance and to some extent ease-of-use, fostering habit and reliability. Also recently a new European privacy legislation has entered which sets stricter requirements for the collection of personal data. At the same time there are increasing privacy breaches. The literature resulted in five main subjects and also the market analysis with their developments pointed out certain aspects related to these main subjects. The results of the preceding chapters will be used as focus to find out what wearable owners think about these subjects. This in order to find out how to improve the diffusion, in personal use, of wrist-worn wearables in the Netherlands and to what extent the developments contributed to this, so far.

3 Results

3.1 Sentiment analysis

Based on the preceding analysis it expected to find information about relevance, reliability, ease-of-use, privacy and habit. The questions of the interviews are not chronological, but sorted by subject. Sometimes questions are related to multiple subjects, but for the sake of the readability of this report it has been sorted. Habit does not have its own paragraph in this chapter, it will be more separated in the thematic analysis chapter. The first paragraph contains questions and results with some context and/or more general subjects, followed by paragraphs related to the main subjects of this report. Also, not all the questions and results are presented in this chapter, only the most important results regarding this research. The rest of the results can be found in the Excel document (tab 1).

The semi-structured interviews do not contain a separate question regarding the use of the wearable, what type of wearable being owned, goal of buying it, whether it is being a gift or not, which functions wanting to use (in the future). These information have being retrieved, as far as possible, by reading between the lines throughout the entire semi-structured interviews. These results should be analysed with caution, but it provides context to some extent.

In the next part all the results of the sentiment analysis can be found, as well as important information mentioned at the different questions of the interviews. The chapter after this contains the results of the thematic analysis, based on all the outcomes.

3.1.1 Context

GOALS

The goals of using a wearable in advance are retrieved out of multiple questions. The goals for using the wearable in the first place are shown below, the upper three results are separated out of the comments in order to give a clear view of the balance between the different overall goals. The half below are the original goals mentioned. As the chart shows, there is only a slight difference in the goals of using the wearable in advance: sport is at top, closely followed by health. There are no specific goals mentioned, such as losing weight, training for a marathon or quit smoking.

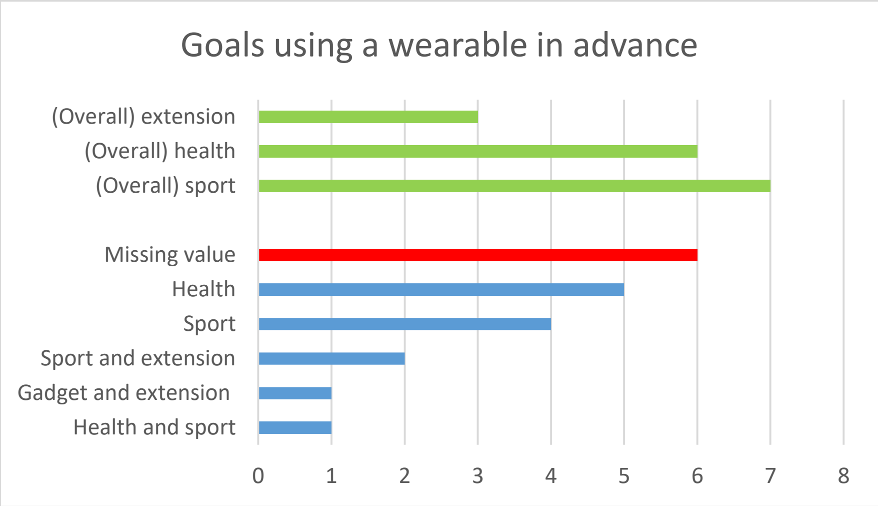

Figure 8: Goals using a wearable in advance

Type of wearable

The type of wearable of fourteen out of twenty respondents is known. Seven of these got a smartwatch of which the brand 'Apple' the most mentioned. Five got some sort of bracelet of which only 1 bracelet brand known, namely Fitbit. Noteworthy: Fitbit is being mentioned once more, but it is not clear what type of wearable.

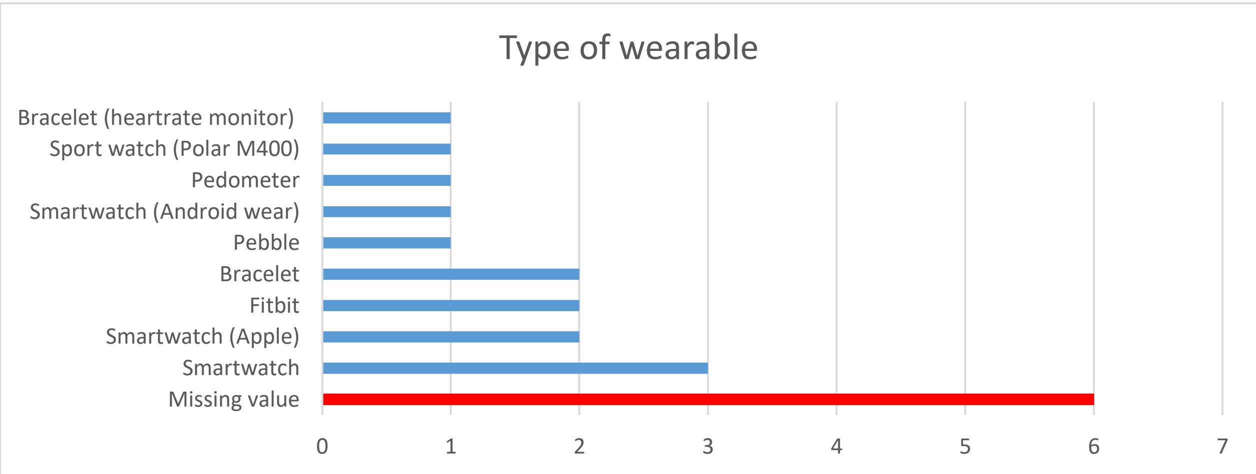

Figure 9: Type of wearable

The use

The use of the wearables are displayed in the graph below. What stands out, is the use of the step counter and heartrate function. Where the heartrate function being used by four out seven respondents for sport/movement. Whereas running being the most mentioned sport. Sleep analysis being mentioned by three respondents, of which two mentioning the amount of sleep and one the sleep rhythm. For the complete overview see appendix E.

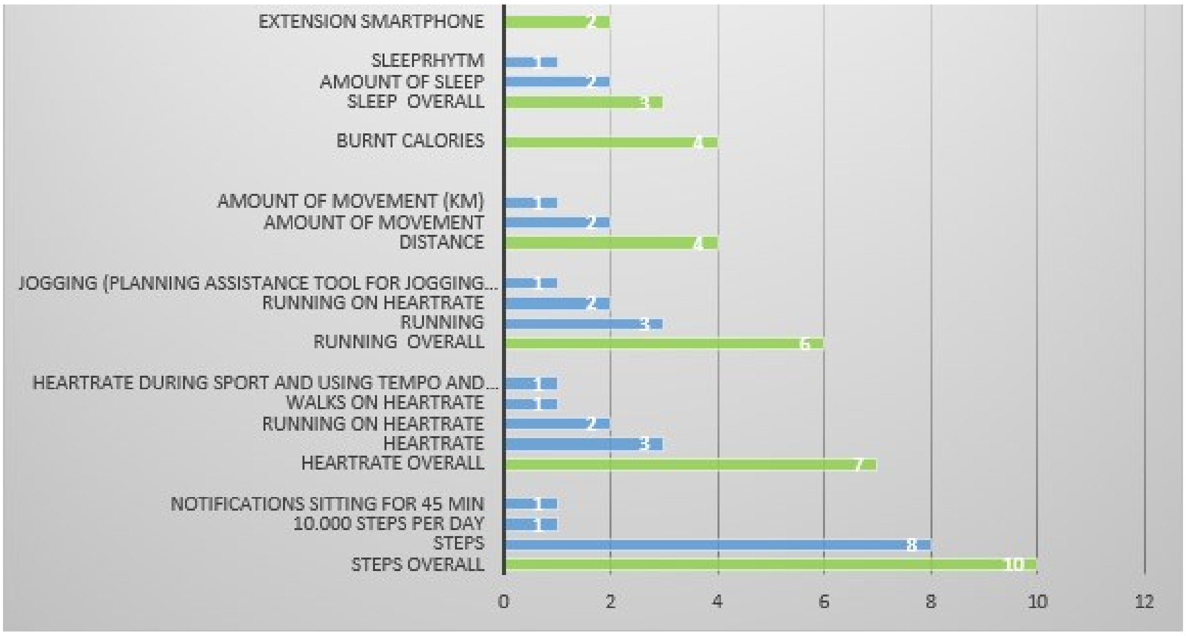

Figure 10: The use of the wearable

Which functions wanting to use (beyond current possibilities)

Basically three out of the 11 respondents mention they want to have an extension of their smartphone embedded in their wearable. Two respondents mention they want to have a stand-alone device by mentioning having own internet (2) and own GPS. Furthermore respectively with a value of two (blood pressure) and one: body temperature, BMI, weight, scanning food instead of filling it in, health app giving advice about certain disease/disorder, being able to monitoring health in order to adjust and amount of alcohol in the blood are mentioned as extra options for the wearable. A Fitbit user also mentioned wanting to have more movement functions. Basically what the respondent are saying is the need for a more comprehensive and standalone device.

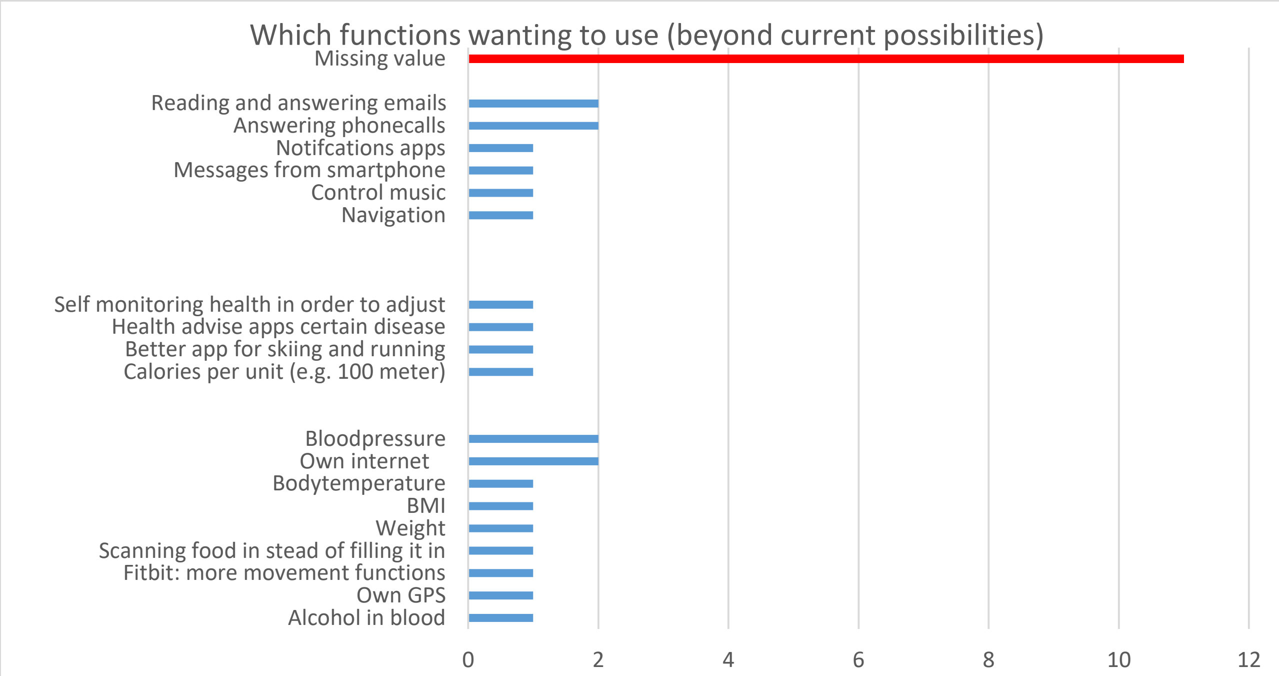

Figure 11: Which functions wanting to use (beyond current possibilities)

Crucial factors for whether or not to use a wearable

The last question of the interview is already being put here in order to have a more clear view of the situation and being helpful for further presentation of the results and analysis. For the complete figure see appendix E.

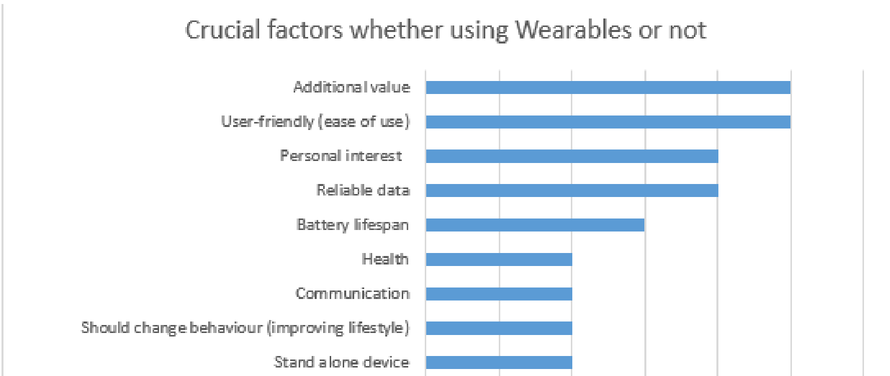

Figure 12: Crucial factors whether using wearables or not

<u>Illustrating quote</u>: R4 -- (25,M, intermediate vocational education) It must be really fun or useful. And otherwise the wearable must be a factor that encourages people to change. For example, people want to lose weight and there are a lot of programs for that, but many people do not have the motivation. If a wearable becomes the factor that makes it attractive to exercise or eat differently, then I think it can have a good future. However, the wearable must be something unique that can never be done so well on a smartphone. Because if the idea can be put in a smartphone, then I'm not going to buy an extra device.

3.1.2 Relevance

R1 Do you think that the use of a wearable can improve your personal health?

Respondents are divided about whether the wearable increases the personal health or not, with an overall positive sentiment of 0,42. Positives speak about the increase of health due to being to being able to adjust their workout, movement and/or lifestyle.

Two positives speak about the help of notifications of which one (smartwatch user) when sitting for 45 min and one respondent (Fitbit user) about lights and vibration regarding the stage and completion of the goals of that day, the Fitbit vibrated when the goal is reached, with a side note that this notification mechanism does not motivate all the time. So there is a difference in the way the notifications are set, proactive vs passive.

Whereas the negatives speak about several topics. Three respondents stated the personal health not increasing due to being able to estimate it yourself (steps and sleep). Where one respondent, with a more simple device (Fitbit), reported about not wearing the device every day or the entire day. According to two respondents another disabler is the wearable not being able to motivate in order to adjust workout or lifestyle. The following quotes are indicative of the type of data that was subsumed under this category:

Illustrating quotes: *R10 (Fitbit) -- (18, F, student university) I do not use the wearable every day but some days I do it mainly for functions regarding counting steps and I use it while running. She does not think it helps a lot, because she does not always wear the Fitbit all day. She thinks that if she does, she will become more aware of what she does in a day.*

R4 -- (25,M, Intermediate vocational education*) The wearable monitors and gives me some insight. The better the monitored is adapted to me personally, the better it can give me insight. However, this information (data) often does not motivate me sufficiently to also make such changes towards better health.*

R1.1 Do you think that the use of a wearable can improve your personal health?

Which aspects will improve and to what extent:

+ insight With the help of wearables the respondents get more insight with a positive sentiment of 1,25. The respondents are neutral to very positive. Movement (10) , sleep (3) and heart function (3) respectively are the most mentioned aspects. Comments are about the more personally focused (personalization) the better it would be able to get insight, more options for a Pedometer needed for displaying calories (e.g. per 100 meter), insight being limited due to not measuring and showing certain health aspects (e.g. blood values) and a Fitbit user mentioning the helpful notifications with light and vibration regarding targets (not always working to motivate though).

+ monitoring The respondents are positive about monitoring with a value of 1 (missing value of five). The distribution is between negative to very positive with a skew and peak at positive. Respectively steps (6), heartrate (6) , burnt calories (3) and amount of movement (2) are the most mentioned aspects. Two ‘negatives’ speak about only limited bodily functions and not being accurate enough.

i1.1 Do you think that the quantity of medical information you receive increases when you use a WEARABLE?

The quantity of medical information increases with a positive sentiment of 1,5. The value is on the edge (1,51) of being very positive. The distribution is evenly distributed between positive and very positive with a missing value of six.

+ 1.4 Do you think that a WEARABLE has enough information to get a good insight into your personal health?

The sentiment is negative with a value of -0,74. The distribution is widespread between positive and very negative with a skew to negative to very negative, with a missing value of one. By far the most heard comment is health being about more factors, namely mentioned by seven respondents. Respondents respectively speak about the lack of blood pressure, diet, liver, body temperature, heartrate and mental functions. Blood pressure and diet are mentioned the most, respectively three and two times. Two positive respondents think it depends on the kind of wearable whether it provides sufficient insight. One respondent with a Pedometer speaks about the wearable not being individually focused, side note: nothing was set about length and weight. One respondent speaks about getting more insight in case wearing day and night:

Illustrating quote: *R9 -- (28, F, University of applied science) I think that you get more and better information from a wearable that you carry with you day and night because that is not just a snapshot, it gives more insight into personal health.*

A1 To what extent are you convinced that ICT applications are needed to improve the quality of life

The respondents are divided with a neutral sentiment of 0,08. Especially the respondents with more simple devices such as Fitbit, heartrate monitor, bracelet and Pebble users think ICT is not needed to improve quality of life. The distribution is between very negative to very positive with a missing value of seven.

M6 Do you want to be able to use medical measuring equipment at home?

The sentiment of using medical measuring equipment at home is neutral to positive with a value of 0,45. The distribution is between very negative to very positive with small a peak at very negative and a greater peak at very positive. There is no missing value. Negatives speak about: respectively two respondents about better letting doctors do it, one about when it is more than about heartrate rather going to see a doctor and one respondent about worrying too much with the smallest complaint. Positives speak about diverse subjects: respectively two about if it has a certain goal at least, one about the medical equipment should not be too big, one about it has to be easy, fast and not too medical, one about when it is being reliable, one about having the need for blood pressure and another for the need for the height of glucose.

3.1.3 Reliabliity

+ 1.3 Does the combination of information that you provide and that of doctors lead to synergy?

With a value of -1,85 the sentiment is very negative. The information does not lead to synergy with the doctors. There is a missing value of seven. There is not any case mentioning it leading to a synergy. Three respondents mention doctors do not ask about the information. Two respondents themselves think the information of the wearable is not good enough to be able to lead to synergy with doctors.

Illustrating quote: *R6 (Polar M400) (Sport watch) -- (30, M, University of applied science) At the moment I do not share this information yet with, for example, my doctor, but I would not have any trouble doing that. That I do not do that yet is because it is not being asked by medical professionals*

i2.1 Do you think that the quality of medical information you receive increases when you use a WEARABLE?

The sentiment is neutral to positive with a value of 0,375. Noted that the distribution is widespread between very negative to very positive with a peak at positive, with a missing value of four. A neutral respondent speaks about an increase in quality as long as the wearable is specifically developed for certain aspects. A negative respondent speaks about the technology not being good enough and consumers might worry about their health due to misjudgement of the wearable. One respondent speaks about the importance of the way of dealing of a medic with this information in order to lift the quality. A Pedometer user mentions the application is not providing enough information.

+ i2.2 Will the information contain (more) errors?

The sentiment is negative with a value of -0,875, which in this case means the information will contain errors. The comments are distributed between positive and very negative, with a skew to the negative side. There is a missing value of four. Two respondents mention it depends on the type of wearable. An example of an error occurred was due to malfunction in the GPS. Another respondents mentions having hard- and software errors which resulted in registration errors, resulting in misjudgement of the amount of running during a certain period. Two respondents put a side note by saying all measuring systems are flawed and one speaks about it being unavoidable.

+ i2.3 Will the information be consistent?

The sentiment is neutral to slightly positive with a value of 0,1. The distribution is between very negative and very positive with a slightly skew to the positive side. It has to be noted that there is a missing value of ten. One respondents seems to mention that at the moment the information was not being constant he was able to clarify it himself, for example having sport after a busy day at work. One respondent seems to view wearables not as medical equipment:

Illustrating quote: R53 -- (21, M, University of applied science) Probably not. It is not medical equipment.

3.1.4 Ease-of-use

R2 Do you think that using a WEARABLE is going to be easy? Why, why not?

The respondents are positive with a value of 1,25. With a distribution between neutral and very positive with a skew and peak at positive/very positive. There is no missing value. Respondents speak about carrying it always with you (3), easy to wear (3), having an easy or fast interface (2) and being a watch (1). Negative comments are about not having an universal charger, apps on the smartwatch not working as smoothly as on the smartphone, updating being easy but doing more on the Pebble is not and needing enough discipline to see it as a daily routine. A more neutral comment saying it is easy to use, but having the need to read in on forehand.

+ i1.2 Do you have easy access to it (information)?

The respondents have easy access to information of the wearable with a positive sentiment of 1,13. The distribution is basically around positive to very positive, with one respondent being very negative. There is a missing value of five. A small screen/display for a wearable can be negative when a person wants to retrieve information.

I3.1 Do you think you have sufficient medical knowledge to be able to interpret the data presented by a WEARABLE yourself?

The sentiment is neutral to positive with a value of 0,35. There is a wide distribution between very negative to very positive with a slight skew to positive/very positive, with no missing value. One respondent is speaking about the interpretation of the information could lead to misjudgement by the user. People could come to the wrong conclusion and wrong adjustment of their lifestyle. For example by thinking doing more steps per day, while it might not be good for a specific person.

+ i3.2 Do you need other media for this? (Internet, telephone contact with doctor (assistant)?

The respondents are neutral to positive about needing media to interpret the information with a value of approximately 0,12. The distribution is wide distributed between very positive to very negative with a slight skew to positive with a missing value of three. This means overall respondents have the need for additional media. Seven respondents mention internet as media source in order to gather information. A side note is internet is not always clear and people could get scared. Seven respondents mention a doctor as source, of which one stating ‘perhaps’. One of the respondents mentions internet as first source and in case something is really not ok, would go see a doctor. Two respondents who do consider a doctor as source mention it would take a lot in order to visit though. One respondent mentions it consulted books and blogs in advance, where as another respondent consulted fitness instructors.

Do you think that the supplier of a WEARABLE system can offer you the following in combination with your own ICT facilities? Why, why not?

M3.1 + Reliability The respondents are positive about the reliability in combination with their own ICT-facilities. The overall sentiment has a value of 1 and has a missing value of seven. The sentiment is distributed over negative, positive and very positive with skew to the positive side. A highlight in the comment are two respondents being very positive about the brand Apple. One respondent being negative speaks about only seeing little progress in the processing of different media and the combination of associated data.

Illustrating quote: *R48 (smartwatch, Apple) -- (19, F, student University of applied science) I have been in possession of an IPhone for years and would not switch to a Samsung or any other brand. The advantage is that I have an IPad and a Mac book, which are also all 2 of Apple and the Apple Watch of course fits nicely.*

M3.2 + availability Respondents are positive and on the edge of very positive about the availability with a value of 1,45. The distribution is between positive and very positive with a peak at positive. Side note: there is a missing value of nine. As in previous section again, the brand Apple is having a good availability.

M3.3 + Security / privacy The question is not always answered well. The respondents are neutral to positive with a value of 0,21 The distribution is widespread between very negative to very positive with a peak at positive with a missing value of six. Negatives do not always mention a clear reason but one of the comments is about that everything can be hacked if needed. One respondent speaks about safety in combination with their own ICT-facilities only being partly covered. One respondent being neutral speaks about not having read the conditions in advance. Three respondents speak about the connection between smartphone and wearable being safe due to the safety of the smartphone. Also Apple is explicitly mentioned again (once), with the Iphone being safe.

3.1.5 Privacy

Regarding most privacy related questions: although the sentiment is sometimes positive, some factors are important to be addressed (boundaries), hence the results are somewhat skewed to the positive side.

R3 Do you think it is good that the information you provide about your health can be used for large statistical research (your medical data are therefore no longer linked to you as a person)? Why, why not?

Providing information about health for statistical research is being viewed positive with a value of 1. The distribution is around positive to very positive with three out of twenty being negative to very negative. Although already being mentioned in the question, eight respondents mention it has to be anonymous in order to provide it. Four respondents mention it could be helpful to health of society. One respondent speak about willing to provide information, but not being bothered with it when collectors get something useful from it. A boundary condition according to one respondent is the subject being offered as a choice. One of the negatives speak about not feeling ok providing information to research the respondent does not know anything about. Another negative speaks about viewing the wearable as a sports tool and nothing more.

Illustrating quotes: *R10 (Fitbit) -- (18, F, student University) As long as it is anonymous it would not be very bad.*

R66 (smartwatch) (for sport) -- (20, F, Student University of applied science) Well, I do not think about my health, I think it's a handy tool during exercise, but nothing more.

R4 Do you think it is ok medical professionals use data that you have entered when making diagnoses and treatments? Why, why not?

The overall sentiment is positive with a value of 0,75**.** The distribution is centred around respectively very positive to positive with four respondents being very negative and one negative. There is a missing value of zero. Three respondents mention they are willing to provide the information, at least when it improves the diagnose and being reliable enough. Five positives mention it will improve the diagnose (two), fasten the diagnose (one) or medic professionals could benefit (two). Two respondents want the medic professionals ask for permission first, and one wants to indicate each unique case whether to provide information or not. Two negatives speak about not wanting to share personal habits/privacy issues where another two respondents speak about the wearables not being good and/or reliable enough.

i4.1 What information are you prepared to share with the WEARABLE?

+ i4.2 Body data (Heart rate, blood pressure 16 out 20 respondents are willing to share body data with the wearable, one willing to share it partly (heartrate) and three are not willing. A negative respondent speak about perhaps sharing in case the respondent is being more serious with the health applications. There are no outspoken comments among the positive respondents, positives speak about (with a value of one each): data being anonymous, due to data nog being able to manipulate, provided that it is for own health improvement and might having a good influence on own movement. One respondent speaks about sharing the information in case it improves its own health.

<u>Illustrating quote:</u> *R72-- (23,M, University) All that is mentioned here is Anatoliy willing to share with a wearable, if this can serve to improve his health.*

+ 4.3 Habits (Drinking, smoking, other addictions) 12 out of 20 respondents are willing to share information about habits with the wearable. One is willing to share it partly as where six are not willing to share these data. There is a missing value of one. The negative comments are basically the same for this section as previous, with two comments in addition regarding not willing to justify for a wearable-cloud and the another other comment is about depending on how the information is being used. The comments of the positives are basically the same as previous section as well, with two new comments in addition regarding willing to share the information due not having weird habits and in case it is not being a big effort to input the information.

+ i4.4 Environment (health of working and living environment) 13 out of 20 respondents are willing to share information about their surroundings, where four do not, with a missing value of three. The comments are basically the same as for the body data section. There is one comment in addition regarding that the amount of information being shared depends on how the information is being used. An overall additional comment of a respondent is about being prepared to share his general practitioner data with the wearable, but no bank data.

A3.1 To what extent do you think your privacy is at stake when using a WEARABLE?

Respondents are neutral to negative with a value of -0,23. This means in general the respondents are divided and overall neutral. The distribution is between very negative to very positive with a peaks at neutral and negative with a missing value of seven. One respondent talks about good faith in the supplier in case maintaining privacy is being mentioned in the conditions. Three respondents speak about due to the limited amount of information not worrying about privacy, where one respondents do mention it might be an issue in case a wearable gets more medical and being able to measure a broad range of aspects.

A3.2 Do you think the system can be hacked?

The overall sentiment is positive with a value of 1,25 and has a distribution between negative to very positive, with a skew to the very positive side. Overall respondents think the system can be hacked. Seven respondents speak about that every system can be hacked. One respondent speak about wearable supplier giants are safe. Positives speak about it being able for the system to be hacked, but having faith in the supplier. The hack issue is according a respondent not the problem of the wearable itself, but the smartphone.

A3.3 Do you think that the wrong people (other doctors, nurses) can consult your information?

The sentiment is neutral to positive with a value of 0,31. A side note is that the distribution is widespread between very negative to very positive, with a peak at positive. There is a missing value of four. Of the respondents speaking about the possibility of the information falling in the wrong hands, three respondents speak about insurance companies of which two speak about them might misusing it. The third respondent mentions it for medic professionals to be ok having the information, but no commercial purposes such as insurance companies, especially if not asked in advance. A side note to the outcomes is that multiple respondents speak about not seeing the harm and relevancy in it. Four respondents speak about the information probably not being relevant, two about not caring for the information being spread. Less common comments, with a value of one, are: there is no harm due to no medical data and not seeing the reason for using the information. Two respondents speak about always wanting to provide permission. One respondent speaks about not caring much about the information, but it should not be adjusted.

R1 (bracelet)-- (24, M, University of applied science) Although I do not think anyone would like to hack such a system, because the information is personal and therefore it has very little value to another.

3.2 Thematic analysis

Next a thematic analysis can be found. An analysis between and within questions of the interviews resulted in different subthemes which are part of a bigger theme. In the analysis there has been taken into account the amount of unique respondents talking about a certain subtheme, for more info and analysis see Excel tab 2.

Themes	Subthemes
Relevance	Relevance is relatively a big theme of which mentioned by half of the respondents in different types of forms at multiple questions. **More options** Four respondents mentioning mention about the need for more options than their current wearables can offer. **Adjustment of behaviour** Adjustment of behaviour or being motivated is a theme popping up at multiple questions by multiple respondents and sometimes by the same respondents. Two respondents speak at ‘crucial factors’ about that a wearable should change behaviour. Another respondent at the ‘ICT relevant for quality life’ question mention it is being relevant health is monitored and able to adjust lifestyle. Two respondents, of which one already mentioning something about it at crucial factors, mention at the ‘increase of personal health’ question that the information/wearable does not motivate/make it able to adjust behaviour. One respondent mention only getting motivated to a certain extent (with the help of light and vibrations). **Personalization** Three different respondents at multiple questions, of which one at multiple questions, speaks about personalization. One respondent at the ‘insight regarding health’ question speaks about the more personal the better. Another respondents (Pedometer) speaks at the question about not individually focused enough for right conclusions. This same respondent mentions at the question of being convinced ICT needed to improve quality life that it should not lead you by averages, but should be individually focused. Another respondent at the question of ‘having enough knowledge to interpret the information’ is even saying people might misjudge and having a wrong adjustment of the lifestyle due to a lack of personalization (e.g. too much steps). **Displaying information** Displaying information is a small theme of which three respondents mentioning it, of which one (Pedometer user) saying some things could be improved and two mentioning communication as crucial factor whether to use it or not. The Pedometer user respondent speaks, at the ‘insight to increase of health’ question, about using the wearable more when it displays more information such as calories per 100 steps. The same respondent mentions at the ’crucial factors’ question about wanting more fitness information (burned calories). **Improving quality of life** Two respondents, with a smartwatch of which one of Apple, saying the wearable is an addition in order to improve quality of life where two with more simple devices such as Pebble and simple heartrate monitor are saying it is not needed, to improve quality of life, but makes life easier and nice.

	Viewing wearable as health tool People do not view their wearable much of a health tool (four unique), when looking at multiple questions, like one respondent saying it being a helpful tool for sport and nothing more. Another respondent speaking about not being medical equipment. Where two respondents speaking about only increasing fitness. Side note: you could say fitness is part of health.
Reliability	Reliability is relatively a big theme of which mentioned by almost half of the respondents in different types of forms at multiple questions. **Providing information** A small theme is about people willing to provide information, for external use or to the wearable, only when the information is reliable/correct. Three respondents speak about it at two different questions. Two mention about reliability being important when providing information for diagnose where one respondent mentions only providing body data when being more serious regarding health applications.
Ease-of-Use	The ease-of-use of using the device is an average to big theme, at the crucial factors question it is one of the top mentioned, 6 times. It depends what aspects of ease-of-use you look at. Using the wearable in general is viewed positive: having it always with you, easy and fast interface and being a watch. But, the device lacks ease-of-use regarding being a stand-alone device and battery lifespan. Also the more simple devices lack screen size, where Apple is praised for its compatibility with other technologies in comparison to other brands. **Stand-alone device** Stand-alone device is five times mentioned by in total of three different respondents at two different questions with different subtopics as own internet, GPS and respectively stand-alone device. **Compatibility** Two respondents at three different questions are positive about Apple, with one being really specific: saying 'not wanting anything else than Apple, an advantage is owning more devices from Apple such as a smartphone and tablet which amplify each other and is compatible'. Furthermore saying Apple's mobile phones are not easy to hack. **Size screen** The size of the wearable is a small with a slight tendency to average theme. Due to the set-up of the interview the results might be skewed. At four different questions two different respondents speak about the size of the device. One Pebble user speaks about the subject at three different questions saying the size of the screen of the Pebble is too small for viewing information, but on the other side saying the device should be small (and so quickly fairly limited). Whereas one respondent with a Fitbit, at one question, saying having bought the wearable partly due to the small size. What stands out is the respondents both having more simple models, both saying wanting it to be small, but also seeing the downfalls of it. **Battery** The battery lifespan is a small to average theme which pops up at crucial factors (top5) by three respondents of which one respondent mentioning it at two different questions. The set-up of the interview was not exactly tailored this aspect, so it could be said it is a small theme of little to average importance. **Input certain information** The food log option is a small theme, the option is not used at all, while being available in all Fitbits (but on the other side not in Apple). This could be due to the set-up of the interviews, but on the other hand did one respondent mention it costs a lot of time and work to put in the information manually.
Privacy	Privacy is a theme due to people mentioning different boundaries for sharing information and regarding privacy questions itself. Some subthemes pop up regarding privacy when looking at multiple questions, such as 'sharing data for diagnoses and treatments by medic professionals' and 'privacy being at stake'. **Anonymity** Anonymity of data is a big theme, it is mentioned by half of the persons, whereas nine of these were mentioned at the questions of statistical research (where already anonymity was mentioned in the question itself). What stands out is that anonymity is barely mentioned at the question of sharing information with the wearable itself such as body data and habits. **Benefits in return** Sharing data in return for benefits is a theme. Six respondents mention at three different questions about benefits in return for sharing data, namely the questions 'sharing data for statistical research', 'sharing body data to the wearable' and 'crucial

	factors'. One respondents mentions it even at two different questions. The type of benefits in return differ: at statistical research it are the benefits basically for society and science. Whereas the benefits at 'sharing body data to the wearable'' and 'crucial factors' questions are of personal interest. **Sensitivity information** The type of information being of influence on the willingness to share information is a theme already seeing in the difference in sentiment between the different questions. In addition/this can be confirmed by it being a theme with four respondents at three different questions, namely the 'sharing data for diagnoses', 'sharing habits/addictions data to the wearable' and 'sharing surroundings data to the wearable' questions. People mentioning rather holding some information private such as bank information or weird habits. Whereas one respondent speaks about sharing information due to not having weird habits. Basically the more sensitive the information, the more the willingness to share it decreases. **Offered as choice** Sharing information for external use being offered as a choice is mentioned by three respondents at two different questions of which two at the 'sharing data for statistical research' question and the other at 'diagnoses and treatments by medic professionals'. **How information used (transparency)** A small theme is about people wanting to know how the information is used, which being shared. With two respondents at three different questions mentioning it, namely one at the 'sharing data for statistical research' question and one respondent at both of the questions 'sharing habits/addictions data to the wearable' and 'sharing surroundings data to the wearable'. **Reliability** A small theme is about people willing to provide information only when the information is reliable/correct, as mentioned earlier at reliability. **Relevance of the information being misused** Four respondents speak about not seeing the harm and relevancy in the information for external misuse.
Habit	Three respondents mention at three different questions, of which one respondents at multiple questions, about not wearing the wearable the entire day, basically only during exercise/sport and needing enough discipline to see it as a daily routine. What stands out is that these respondents all have more simple devices such as a sport watch, Fitbit and a Pedometer. One respondent even mentions getting more insight in personal health when she would be wearing the wearable day and night.

Figure 13: thematic analysis results

Sub conclusion

Relevance

The sentiment around different relevance questions is divided. The thematic analysis also shows certain subthemes where respondents are not satisfied with certain aspects. Overall this results in a lack of relevance to a certain extent.

Reliability

The sentiment around reliability issues is tailored to the negative side and also the thematic analysis prove reliability to be an issue.

Ease-of-use

The sentiment of the ease-of-use is divided between the questions, but overall more tailored to the neutral to positive side. A the side note is that the positive sentiment is more tailored to the interface ,comfort and easy to wear factors, where there are more factors regarding ease-of-use. With the help of the thematic analysis more subthemes popped up, such as the lack of a stand-alone device, compatibility, screen size and the difference between brands and type of wearable. So there is a lack of ease-of-use, but only to a certain extent and regarding certain factors.

Privacy

The sentiment around for example sharing information is quite positive, but differs between questions and respondents. Also of major importance is respondents mentioning factors which should be taken care of before sharing information regarding privacy issues. So the sentiment is somewhat skewed to the positive side regarding sharing information.

Habit

There is less habit for respondents with a more ‘’simple’’ device (Fitbit, pedometer, sport watch), where respondents do not use it all day and/or every day.

4 Discussion

First there will be some general information about the research, diffusion and context. Afterwards there will be a discussion of the results of this report.

4.1 Context

The respondents of the semi-structured interviews can be classified as millennials, who voluntarily adopted the wearables, instead of using it for chronic illness. This group represent a market segment with a significant growth potential (Meulen, 2015). They are commercially an interesting subject: millennials are far more likely to own wearables than older adults and are generally marked by an increased use and familiarity with communications, media, and digital technologies, where adoption of wearables declines with age (PWC, 2016). Furthermore the respondents all have a wrist-worn wearable, using the wearable for general health and/or fitness purposes, are all from the Netherlands and within a personal ICT context. Whereas the majority is high educated (or pending) and got experience (to some extent) with technology/ICT. Regarding the stage of diffusion of Rogers, the respondents and the market - at the time of research half 2016 - is classified as the stage of early adopters. The mainstream has not been reached yet for broader diffusion.

To put some more context: there is only a slight difference in the goals of using the wearable in advance, sport is at top, closely followed by health. This resembles earlier research where younger people, the appeal is to focus on fitness optimization, while older people are looking for improvement of their overall health and life extension (Canhoto & Arp, 2016; Endavour, 2014; Ledger, 2014). As mentioned, due to the set-up of the interviews, people with wearables only for smartphone extension are left out, as such these outcomes have to be analysed.

The smartwatch being the most used type of wrist-worn wearables resembles the market research report of Vliet (2017) regarding this group of age. Furthermore, Fitbit and Apple being the most mentioned brands, for respectively bracelets and smartwatches, resembles the overall market tendency in the Netherlands (Vliet, 2017) and worldwide (IDC, 2017). There is a difference in design between wearables, where smartwatches are more towards being designed for fashion as well as information.

When comparing the features of the most popular wearables and the mentioned use of it, with keeping in mind these outcomes are not completely right, a global estimation of the situation can be made which features are used while having a wearable. What stands out is the use of amount of steps (10) - Heartrate (7) and activity (Running (6) + skiing (1)) since these options can be found in all Fitbit and Apples wearables, and even in the vast majority of all popular mentioned wearables. What is noteworthy is the burnt calories and sleep analysis being mentioned relatively little, and smart alarm not once, while being present in the majority of the wearables. Where floor climbed is not mentioned once, while being present in Apples watch and the majority of the Fitbit wearables. Blood pressure and oxygen content is mentioned by one respondent while not being found as option in the analysed wearables. Also the food log is not used at all, while being available in all Fitbits. The use of the extension of the smartphone and listening to music is relatively mentioned little as well, a side note: this could be the result of the set-up of the interview. Also only people that at least are using the wearable for health and fitness purposes were included in the research. What must be noted: there is no structured question regarding the use, options available and options not using on purpose. The outcomes are retrieved by reading through the lines. It is really the use of it, and not where the respondents fell for.

4.2 Relevance

The sentiment around different relevance questions is divided. The thematic analysis also shows certain subthemes where respondents are not satisfied with certain aspects. Overall this results in a lack of relevance to a certain extent. Most respondents are being positive regarding the increase of insight and monitoring, but are divided regarding the increase of personal health with the help of their wearables. Also providing enough information for insight in personal health is being valued as well positive as negative with an overall negative sentiment mainly due to respondents people mentioning the lack of different health conditions. Especially blood pressure and diet, apart from the ones being mentioned once such as liver, body temperature and mental functions. Also wearables are not viewed as something that can give information about every aspect of health. The most mentioned comment is about some aspects that cannot be measured such as mental functions and the liver. Although the mentioned goals in advance for using a wearable are slightly more sport than health related. Positives are able to adjust their lifestyle and/or workout which in turn increases their health. Relevance/additional value is relatively a big theme of which mentioned by half of the respondents in different types of forms at multiple questions, of which multiple respondents mention it in a certain form at multiple questions which seems to amplify the importance of this theme.

More options

People would like to see more options in the wearable, which could might add some to the relevance. Basically three out of the 11 respondents mention they want to have an extension of their smartphone, beyond the current possibilities of the device, embedded in their wearable. Two respondents want own internet and one own GPS. Furthermore respectively with a value of two (blood pressure) and one: body temperature, BMI, weight, scanning food instead of filling it in, health app giving advice about certain disease/disorder, being able to monitoring health in order to adjust and amount of alcohol in the blood are mentioned as extra options for the wearable. A Fitbit user also mentioned wanting to have more movement functions. Basically what the respondent are saying is the need for a more comprehensive device which could also be factor to add relevance to the wearable.

Adjustment of behaviour

Adjustment of behaviour or being motivated is a theme popping up at multiple questions by multiple respondents and sometimes by the same respondents. Two respondents speak about that a wearable should change behaviour. Another respondent mention it is being relevant health is monitored and able to adjust the lifestyle. Two respondents mention that the information/wearable does not motivate/make it able to adjust behaviour. The continued adoption of technology is of influence by the possibility of improving oneself with the help of technology. Relevance is as well a pre- (Pfeiffer et al., 2016) as a post-adoption factor (Buchwald et al., 2018; Canhoto & Arp, 2017; Kari et al., 2016; Nascimento et al., 2018).

Viewing wearable as health tool

People do not view their wearable much of a h4ealth tool.

Personalization

Three different respondents at multiple questions of which one at multiple questions speaks about personalization. The more personal a wearable is, the better. The wearable is not individually focused enough for right conclusions. It should not lead you by averages but should be individually focused. One respondent even speaks about saying people might misjudge and make wrong adjustments in their lifestyle due the lack of personalization (too much steps e.g.).

Displaying information

Displaying information is a small theme of which three respondents mentioning it. For example a Pedometer user mentioning the need for more information such as burnt calories per 100 steps.

Medical equipment at home

Regarding people willing to use medical equipment at home, which could perhaps add relevance, people are divided but the overall value is neutral to positive. So there might be demand for its which should be further explored. What respondents furthermore mention is that it has to have a certain goal at least, should not be too big, be easy to use, fast, not too medical and reliable. Options being looked for, for example, could be blood pressure or the height of glucose.

Developments

Meanwhile, since the time of the research in 2016, developers have focussed more on adding relevance. New options are integrated in wrist-worn wearables, Apple and Fitbit invested in algorithms for tracking workouts and providing health insight, Fitbit added its own paid coaching program to its latest smartwatch and developed with another company three programs such as guidance during work-outs and a guided health program for more personalisation and motivation.

4.3 Reliability

The sentiment around reliability issues is tailored to the negative side and also the thematic analysis prove reliability to be an issue. Reliability is relatively a big theme of which mentioned by almost half of the respondents in different types of forms at multiple questions, of which multiple respondents mention it in a certain form at multiple questions which seems to amplify the importance of this theme. Reliability could potentially be a negative factor, due to reliability and errors are an important part of wearable due its relationship with usefulness. A lack of reliability or the presence of errors could be an important factor for discontinued use and respondents overall being negative about the errors, is in line with comparable research (e.g. Buchwald, 2018; Canhoto & Arp, 2017; Epstein et al., 2016; Maher et al., 2017; Nascimento et al., 2018). Where as well software as hardware errors are mentioned as problems. Regarding consistency, people are less negative, but still divided and neutral overall. It case it was not constant, one respondent mentions he was able to clarify himself. This is in line with Lupton et al. (2018) and Fors and Pink (2017) mentioning people are continually determining the accuracy of the data, whether the metrics are influenced by other conditions, making a synergy on their own between the data from the wearable and the other conditions. A quote to illustrate this reliability subject: “No, I think that a wearable cannot give information about the full status of human health in the short term, there are already some points behind in the progress. Wearables should be in the near future focus on completing certain aspects before thinking ahead to the full health mapping’’. This same respondent at multiple questions speaks about data accuracy. He believes that the sensors and software are not accurate enough, especially for increasing health. Also the lack of data accuracy is mentioned as potential disabler at the ‘crucial factors for wearables’ question.

A small theme is about people willing to provide information, regarding health data, only when the information is reliable/correct. This could be due to that users are afraid that approximate values of the generated data could lead to incorrect allocations within tariff systems or could be used for inaccurate medical diagnoses or treatments.

To put some information in context, six respondents speak about errors and systems being hacked is something common for devices and systems. Comments such as ‘all measuring systems are flawed’’ and ‘’every system can be hacked’’ are present.

Developments

In the years following after the initial research in 2016, there have been taken small steps to improve the reliability. Fitbit bought Pebble for its software development kit because Fitbit is betting more on software and services. Also Apple builds on its expertise, witnessing the acquisition of the smart sleep monitor Beddit. Also developers of wearables are focussing more on the internet of things and big data. But, whether the problems with humans not always operating within the narrow confines of a programming language (e.g. changes in human blood, sweat) is being solved, remains unclear.

4.4 Ease-of-use

The sentiment of the ease-of-use is divided between the questions and between respondents, but overall more tailored to the neutral to positive side. A side note is that the positive sentiment is more tailored to the general ease-of-use, interface and comfort factors, where there are more factors regarding ease-of-use. With the help of the thematic analysis more subthemes popped up such as the lack of a stand-alone device, compatibility, screen size and the difference between brands and type of wearables. So there is a lack of ease-of-use, but only to a certain extent and regarding certain factors.

Ease-of-use is mostly seen as a pre-adoption factor, where only one study on smartwatches found it to be a factor, by impacting satisfaction, for sustained use. The comfort is mentioned as positive aspect which is in line with e.g. Coorevits and Coenen (2016) who found, in a study with the help of netnography on wearable fitness trackers, comfort one of the factors impacting the ease of use perceptions.

The respondents of this research do have easy access to the information, with the smartphone mentioned as reinforcing aspect by retrieving and storing the information. Also easy access to information is an important pre-adoption factor in a similar research of Canhoto and Arp (2017) in the context of health and fitness wearables. Regards the ease-of-use questions, a watch is pointed out as being a positive thing. The results are somewhat skewed to the positive side due to the respondents already having experience with technology and ICT and millennials in general already being familiar with communications, media and digital technologies. Also early adopters and innovators often possess more technology innovativeness. This will help them better coop with uncertainty of new technologies and hence a higher adoption intention (Rogers, 1995). Furthermore according to IS literature users gain experience with a system and resolve their PEOU concerns.

Facilitating conditions (compatibility)

Having the medical knowledge necessary for using the wearable has much in common in the facilitating conditions of Venkatesh et al. (2012). People are divided about this aspect and neutral to positive overall, and the same goes for the need of additional media. With overall a neutral value. Internet is here the most mentioned aspect and closely followed by the doctor, but it would take more to visit the doctor. A side note to this, is that the internet is not always clear. The outcomes might be skewed to the internet side, due to the age of the respondents. Facilitating conditions impact as well pre-adoption and post-adoption.

People thinking to get enough management support or education in order to use the wearable has much in common with facilitating conditions of Venkatesh et al. (2012). Respondents sometimes do not understand the question well, but overall the respondents do not need education or management support, where an instruction manual should be enough. One respondent even mentions not hoping the need for education or management support, that a good interface should be enough. The few that go in-depth talk about expensive brands should have better support and there is enough built-in support. First of all the majority of the respondents have experience with technology and ICT which could negatively influence the reliance on external support furthermore younger consumers tend to place less importance on the availability of adequate support than older people (Venkatesh et al., 2012).

Two respondents at three different questions are positive about Apple, with one specific saying not wanting anything else than Apple. Apple offers a wide range of products (e.g. tablet, laptop, and smartphone) and ecosystem and have experience in a wide range of branches. These technologies amplify each other and are compatible. According to Venkatesh et al. (2012) facilitating conditions influence as well behavioural intention as use behaviour. Facilitating conditions in this case is the compatibility with other technologies. It has to be mentioned - regarding the questions of reliability, availability and safety in combination with own ICT- they have relatively high missing values, especially the availability with a missing value of nine.

Stand-alone device

Stand-alone devices is five times mentioned by in total of three different respondents at two different questions with different subtopics as own internet, GPS and respectively stand-alone device. In the line of the stand-alone device, but not exactly the same: three respondents mention the extension of the smartphone as function wanting to use. The respondents want to use options such as reading and answering mails, answering phone calls, having notification of apps, messages from the smartphone, control music and navigation. What has to be taken into account is that consumers do not always know what they are looking for in innovations and so it is possible they do not act upon what they are telling. The danger in adding the extension of smartphone option and making wearables a more stand-alone device could be the constant connectivity. This also a worry of a respondent saying a wearable should not control your life. This can be seen in the broad trend of continue connectivity worries regarding smartphones.

Size screen

The size of the wearable is a small theme. Due to the set-up of the interview the results might be skewed. At four different questions two different respondents speak about the size of the device. One Pebble user speak about the subject at three different questions saying the size of the screen of the Pebble is too small viewing information but on the other side saying the device should be small (and so quickly fairly limited) whereas one respondent with a Fitbit is saying having bought the wearable partly due to the small size. What stands out is the respondents both having more simple models, both saying wanting it to be small but also seeing the downfalls of it.

Battery

The battery lifespan is a small theme which pops up at crucial factors (top5) by three respondents of which one respondent mentioning it at two different questions. With most wearable 'only' having a battery lifespan of a few days, where smartwatches only one to two days. The set-up of the interview was not exactly set toward to this aspect so it could be said it is a small theme of little to average importance.

Input certain information

The food log option is not used at all, while being available in all Fitbits (but on the other side not in Apple). This could be due to the set-up of the interviews, but on the other hand did one respondent mention it costs a lot of time and work to put in the information manually.

Developments

The ease of use in the last few years has been improved to some extent; this by the development of more stand-alone devices with own 4G (internet) and GPS. Also the problems with small screens is taken care of with Fitbit for example more focussing on smartwatches. Also a small step has been taken regarding the batter lifespan, with a small improvement in the lifespan and battery saving modes. But Fitbit for example has still no open ecosystem and lack the compatibility of Apple with their own tablets, laptops and smartphones. Also the input of food may still be a problem, which is still handwork.

4.5 Privacy

In the race to be first to the market, security on wearables is not as seriously taken in the development by the firms as it should be, the people who wear them, or by the firms who adopt them into their existing work processes and legacy systems. Typically the legal regulatory environments lag behind several years to adapt to technological advancements. The Netherlands as specific geographical location is of interest due to differences in privacy concerns between countries. Canhoto and Arp (2016), in the context of health and fitness wearables, found different privacy concerns in Germany than a study conducted in China. Therefore, research should consider consumers in diverse geographical contexts.

Pfeiffer et al. (2016) found in the context of self-tracking devices trust to be a pre-adoption factor. Whereas Buchwald et al. (2018) found in the context of self-tracking devices trust also being a post-adoption factor, being negatively related to the discontinuance intention. Also Epstein et al. (2016) found people to stop tracking location due to concerns for data sharing, hence a post-adoption factor.

Providing information about health for statistical research is being viewed positive with a value of 1. The distribution is around positive to very positive with three out of twenty being negative to very negative. The sentiment for information for diagnoses and treatments by medic professionals overall sentiment is positive with a value of 0,75. The distribution is centred around respectively very positive to positive with four respondents being very negative and one negative. Regarding sharing information with the wearable there is a difference in the type of data, the majority are willing to share information of body data (17/20) such as heartrate and blood pressure, but are more divided about the sharing of bad habits/addictions (12/20, missing value 1) and the health of work- and living environment (13/20, missing value 3). Furthermore since the wearable cannot detect these habits or addictions, it should not be a big effort to input information according to a respondent.

Respondents overall think the system is being able to be hacked, but regarding whether privacy is at stake respondents are divided and overall neutral, although a relatively high missing value of 7. A side note hereby is that a vast amount of respondents think every system can be hacked. Furthermore saying Apple's mobile phones are not easy to hack. Also one respondent mentioning wearable Giants are safe, which Apple is. The sentiment around wrong people consulting information is neutral to positive with a value of 0,31. A side note is that the distribution is widespread between very negative to very positive, with a peak at positive. Especially commercial companies are viewed as not done, or at least ask for permission.

Anonymity

Anonymity of data is a big theme, it is mentioned by half of the persons whereas nine of these were mentioned at the questions of statistical research where already anonymity was mentioned in the question itself. What stands out is that anonymity is barely mentioned at the question of sharing information with the wearable itself such as body data and habits. It is only mentioned once here. It seems as other research, external use or able to manipulate the information is seen as more risky. This reflects the theory of consumers being worried about their privacy. Individuals may trust the intentions of health professionals, but may not trust their ability to protect their health data (Kenny & Connolly, 2016).

Benefits in return

Sharing data in return for benefits is a big theme. Six respondents mention at three different questions about benefits in return for sharing data. The benefits in return differ, at statistical research it are the benefits basically for society and science whereas the benefits at 'sharing body data with the wearable' and 'crucial factors for wearables' questions are of personal interest. Having benefits in return for information sharing have resemblance to the privacy calculus theory and related literature (Chang et al., 2016; Lee et al., 2016; Spagnolli et al., 2014).

Sensitivity information

The type of information being of influence on the willingness to share information is a theme already seeing in the difference in sentiment between the different questions. In addition/this can be confirmed by it being a theme within the thematic analysis. People mentioning rather holding some information private such as bank information or weird habits. For example, one respondent is talking about when the wearable gets to medical and being able measure a broad range of aspects, privacy issues might increase. So the more sensitive the information, the more the willingness to share it decreases. This is also confirmed by different authors (Kenny & Connolly, 2016; Motti & Caine, 2015)

Offered as choice

Sharing information for external use being offered as a choice is mentioned by three respondents at two different questions. This can be viewed as an average theme, but important to opt in. Especially commercial companies are viewed as not done, or at least ask for permission. Respondents are more positive towards personal health disclosure for the purpose of medical research purposes or product improvement, than for transferring information to third (commercial) parties. Also the affection to commercial use is reported by PWC (2016). PWC (2016) mentions that overall consumers are more willing to trust health providers more than consumer-product providers.

How information used (transparency)

A small theme is about people wanting to know how the information is used that is being shared. On the other side one comment was also about not wanting to be bothered with the research itself.

Reliability

Reliability is of importance in order to share information as mentioned earlier at reliability.

Relevance of the information being misused

An average theme is four respondents speaking about not seeing the harm and relevancy in people using their information. Four respondents speak about the information probably not being relevant. Kenny and Connolly (2016) found older individuals to express higher privacy concerns and these results have to be analysed as such that younger people have less concerns. Also a limitation to the results is the ignorance of people with regards to the value of this kind of information and misuse of it (Bellekens et al., 2016; Lee et al., 2016; Motti & Caine, 2015). With increasing security breaches and privacy issues in the news this could influence the values. The results of habits/addictions might be a bit skewed due to respondents might not having bad habits at the moment (could be characteristics of respondents), as one respondent mentions not having weird habits. These people might have a more healthy lifestyle than potential adopters.

Developments

The arrival of the new European privacy legislation is a welcome stepping stone; developers are tight to stricter rules regarding transparency, data protection and offering choices. But, there are still ways for developers to manipulate the process, without violating the law (Rietbroek, 2018). And it is unknown whether the law is far reaching enough. Also data protection is of importance to all chains in the process, not only for the developers. In the meantime there might still be reliability problems and not communicating the benefits in return. Last, but not least there is an increase of security breaches and privacy issues in the news, which could have a negative effect.

4.6 Habit

Due to novelty of a technology, habit could be an important factor in technology acceptance (Polites & Karahanna, 2012). Also do wearables have specific characteristics. Three respondents speak about not wearing the wearable the entire day, only during sport and needing enough discipline to see it as a daily routine. This is mentioned at questions such as enough information for insight personal health, increase of personal health and ease-of-use. What stands out these respondents all have more simple device such as a sport watch, Fitbit and a Pedometer. A respondent is for example saying getting more insight in personal health when she would wearing the wearable day and night. Of the three respondents mentioned earlier, one said at a different question it is easy to wear, so this is probably not the disabler. When be looked at comfort part, at questions such as ease of use for example, other respondents feel like it is easy to wear and it is easy to use (to some extent). Where a few respondents mention being a watch at the same time is an enabler. So it not exactly clear why there is a lack of forming a habit with the help of the interviews, but assumptions can be made with the help of literature and the difference between the type of wearables. Successful use of the wearable on the long-term is determined by long term integration in the daily routines, but is often hard for most consumers (Fritz et al.,2014; Strategier et al., 2016). Venkatesh et al. (2012) reason habit as a factor impacting directly on sustained use. More context related Nascimento et al., (2018) mention habit as factor for continuance intention, where Coorevits and Coenen (2016) speak about attrition. So this could be a possible disabler for continued use. Moreover, due the value of wearables is based on data, it is important for wearables to be carried with you all the time.

Developments

While it is not exactly known, at least with the help of the interviews, how to foster the habit, assumptions are made. In the meantime, since the time of research, more comprehensive, stand-alone and fashionable smartwatches are launched on the market.

4.7 Overall difference between wearables and brands

Analysing multiple questions, some aspects come to mind which can form, to little extent, some overall view of the wearable. Regarding peoples view on the wearable - and derived aspects - especially those with more simple devices, are more negative. When analysing different aspects throughout the interviews, it becomes clear that the more ‘’simple devices’’ lack important aspects as reliability, usefulness, ease of use and habit. Regarding the brands, for Fitbit it could be that, next to the offering of more simple models than for example Apple, lacks an open ecosystem and compatibility with other ICT like Apple has with their Ipad Iphone Imac.

When speaking about the need of wearables, the ones with more simple devices are more negative. One with a pedometer says having no need for the wearable. Where another with a smartwatch of Apple says the price was high, but worth it. Two respondents, with a smartwatch of which one of Apple, saying the wearable is an addition in order to improve quality of life where two with more simple devices, such as Pebble and a simple heartrate monitor, are saying it is not needed to improve quality of life, but makes life easier and nice. A respondent who got a Fitbit as gift is more negative towards wearables and do not think it is needed, on the same time saying other hardware such as laptops, mobile phones and WhatsApp is more needed (relevance). Also regarding ICT improving the quality of life; in general the ones with a more simple device such as Fitbit, bracelet or a Pebble are negative. This could be due to their ‘’bad’ ’experiences with these devices which influence the current view of ICT needed to improve life.

A limitation to this in some cases, is the quality perception being closely associated with consumer’s perception of the manufacturer brand image (Keller, 1993; Rauschnabel and Ro ,2016) which could have skewed the results to little extent.

The outcomes must be valued carefully due to that these might be flawed due to the set-up of the interview not specifically asking for the respondents view on the wearable and not asking the exact use and goal of buying the wearable. Also there is not specifically asked about the type and brand of the wearables. In addition, the results regarding reliability, availability and safety in combination with own ICT have relatively high missing values, especially the availability with a missing value of 9.

Developments
As mentioned before, Fitbit is focussing more on launching comprehensive smartwatches on the market. But, Fitbit still lacks an open ecosystem and the extent of compatibility of Apple for example.

5 Conclusion

This investigation tried to explain how to improve the diffusion, in personal use, of wrist-worn wearables in the Netherlands. To the best of the author's knowledge, this is not investigated yet at the time of the start of this research. To do this, a sentiment, thematic analysis, literature review and market research have been executed. Semi-structured interviews with wearable owners were the base for the sentiment and thematic analysis. Wearables is a broad term and different type of wearables have different type of pre- and post-adoption factors, which makes the need for more context specific boundary 'wrist-worn wearables' paramount. So the context is narrowed down with multiple aspects such as personal ICT context, age, wrist-worn wearables. Furthermore the market at the moment of writing has been described in detail to put the results in context, to make it able for future use as much relevant as possible.

The process of analysing and research was not a linear phase-to-phase process, but moved back and forth between the different phases of the analysis. As this is a qualitative analysis, there is no hard-and-fast answer to the question of what proportion of your data set needs to display evidence of the theme for it to be considered as a theme. The same subjectivity goes for the sentiment analysis: the quality of the researcher is of major importance and even then there is always criticism due to each person view things differently, it is no exact science. Some of the factors researched are the fundamental constructs of the technology acceptance theories or post-adoption theories, others are external variables that were incorporated in these models with an attempt to improve their predictive power. Many of the variables are context-specific. However caution must be taken with using existing constructs, as such constructs may bring with them commonly held beliefs and biases.

Furthermore, by understanding the sentiment around pre-adoption factors by the actual users of these wearables, they can play an important role in the growth of this market, because they increase the observability of the new technology and educate others in their networks (Rogers, 1983). Due to the visibility of the wearables and the relevance of observability of new technologies in the dissemination and popularization (Rogers, 2003), it is important for markets to find out what consumers like or not about wearables, and what supports sustained use of it. Potential adopters have an inaccurate image of certain facets of wearables, the actual users of it can provide information of what aspects could be improved. It is also important when these users ever have to repurchase a new wearable. But first, trying to convince the mass of a new idea is pointless, convince innovators and early adopters first (Rogers, 1983). The state of diffusion is currently classified as the early adopters stage, this has been of importance in the analysis of this report.

5.1 Relevance

Respondents do not view the wearable much of a health tool. Respondents feel like the wearables are sometimes not able to adjust behaviour, lack some functions, lack certain information display and personalization. This are potential disablers for relevance. Different options such as blood pressure, body temperature could be added in the future to have more relevance, although this could have a negative influence on privacy mentioned later on.

Regarding people willing to use medical equipment at home - which could perhaps add relevance - are divided but the overall value is neutral to positive, hence there might be demand for its which should be further explored. Adding more relevance with the help of medical equipment at home could be possible, however also here reliability comes into play and people might not like the idea of extra devices in the end. So it might be an idea for innovators and early adopters first.

Also the display of information is of importance. For wearables to be truly effective, they need to provide information that is not just descriptive but also prescriptive.

Moreover, wearable health device vendors could rely on accumulating users' health data to provide free and professional health services, and this will help users understand the importance of continued use.

5.2 Reliability

A lack of reliability or the presence of errors could be an important factor in discontinued use. Regarding reliability, while organizations often have IT-service departments and service contracts with their vendors to solve reliability issues, within the personal ICT context it is nowadays expected that a consumer technology is working reliable and accurate since users do often not have the knowledge, time, or will for troubleshooting. Hence, it is important for producers of self-tracking de-vices to update their devices regularly to prevent reliability problems and developing future wearables and related apps/ecosystem with more reliability.

Some options, find in the wearables, are barely used such as burnt calories and sleep analysis, this could be due to reliability issues.

To make sure people are willing to share information it should reliable, otherwise they might worry about the generated data leading to incorrect allocations within tariff systems or could be used for inaccurate medical diagnoses or treatments.

Also it of importance, for medic professionals to take wearables seriously and leading to synergy, the reliability increases.

5.3 Ease-of-use

The ease of use is of importance, but not all aspects of the ease-of-use are of importance. The basic issues of using a wearable are easy, this could also be due the characteristics of millennials and early adopters. Regarding external support for the use of the wearable: the majority of the respondents have experience with technology and ICT which could negatively influence the reliance on external support. Furthermore younger consumers tend to place less importance on the availability of adequate support than older people. A good instruction manual and interface should be enough. The only thing is, if they want to track how healthy they are by activity in combination with their diet, the applications require too much effort because they have to input their diet manually through the smartphone.

Furthermore, people sometimes do not always have the medical knowledge to interpret the information. Making sure there is a place for information or help.

Respondents are overall satisfied with reliability and availability of their wearables with their own ICT facilities. Safety is divided, but the smartphone is being viewed as safe since the information flows from the wearable through the smartphone. Although there is a difference between brands. It is key for manufactures to make sure the facilitating conditions (compatibility) is all right, where Apple is setting the tone already.

A stand-alone device is important for the ease-of-use, but developers should mitigate the risk of privacy issues by paying attention to these devices being safe since the smartphone is not the major component anymore.

Furthermore it is important to have a longer battery lifespan, especially when focussing more on smartwatches since these got a relatively low battery lifespan. Also the size of the wearable is also of importance where respondents saying wanting it to be small, but respondents also seeing the downfalls of it. A balance is needed. There is a trade-off of the size of the wearable. A small and easy to carry with you is in a greater extent more fragile, easy to forget and less noticeable whereas a bigger wearable is being viewed as uncomfortable and bulky to wear. Besides, different persons might have different needs regarding the size as well.

5.4 Privacy

Overall people are neutral to positive (sentiment) to sharing information for diagnoses and statistical research and sharing body data, habits/addictions and living environment with the wearable. The extent depends on several factors. Also people think wearables can be hacked, but regarding privacy being at stake people are divided. To make sure people are willing to share information it should reliable, as mentioned earlier at reliability. Also it is important to make sure people know how the information is used and to whom being shared. Making sure to communicate and/or add benefits for sharing the information makes people more willing to share information. Half of the respondents mentioning sharing the information should be anonymous which reflect the trend of people worrying about their privacy.

The type of information being shared has influence of the willing to share, the more sensitive the less likely to share. This is of importance when adding more options to wearables in the future since it can lead to more sensitive information. As one respondent says it himself; ‘’in case a wearable gets more medical and being able to measure a broad range of aspects privacy issues might change’’. Also the type of company handling the information is respondents are more positive towards personal health disclosure for the purpose of medical research purposes or product improvement, than for transferring information to third (commercial) parties.

Noteworthy is that there are respondents not seeing the harm in the current information being shared, this could be due to their ignorance regards to the value of this kind of information and misuse of it. With increasing security breaches and privacy issues in the news this could be a potential problem in the future. Privacy concerns must be addressed for people not abandoning the device and before more mainstream consumers would consider adopting.

The industry could add the following: (1. Permission (2. Assign the person concerned to his rights (3. Transparency, (4. Accessibility, (5. Work with opt-in procedures. Basically allowing users to select settings in terms of the level, the amount, and the type of data they intend to share, and with whom, and make users aware of who has the right to access and view their personal data. Also managers need to work together with the different companies, health providers and government to make sure privacy is protected at all chains. Finally, at the policy level, comprehensive privacy policies need to be in place in order to render the wearables as effective public health tools. It has to be noted millennials value privacy less important, they are also eager to put personal information on Facebook for example; relative importance vary among generations.

5.5 Habit

The exact reasons some people do not form the habit of using the wearable is not clear when looking at the outcomes of the interviews, but it is clear it is important. What stands out is the more simple models users have a lack of habit using it all day and every day. Based on the small signs in the interviews and literature some recommendations can be made. To increase the habit, and long-term use, of using a wearable daily and the entire day more simple devices should not be developed, it should be more towards a smartwatch (comprehensive/fashionable) and make it more ''critical'' (more relevance) for daily life such a smartphones and keys. This by reliability, form of smartwatch (fashion), comprehensiveness and stand-alone device. Especially the fashion aspects can come into play in the later stages of diffusion, where people have different needs. Also when the information of the wearables can be motivating this can lead to long-term behaviour changes (e.g. sitting less or more walking) which can lead these respondents to feel frustrated and disappointed when it not being monitored/measured. Satisfaction with the outcome of the behaviour of wearing is of major importance. (Bhattacherjee, 2001) says ''The findings of this study reveal that satisfaction is an important factor affecting a user's intention to continue using a smartwatch, especially for those users with a low level of habit. Therefore, in order to retain them, managers need to focus on the users' satisfaction'' (p.165). A potential problem with simple devices is that there might be a learning curve which make the respondents being able to estimate their steps or calories for the day themselves and make the wearables obsolete. Also in the future people might lose interest when the novelty phase moved into routine. On top of this, it could be of importance remembering to keep the wearable with them, by notifications, to form a habit using it.

5.6 Overall

The results of this report show producers of wearables should, regarding the time of this research, add more relevance, reliability, ease-of-use, addressing privacy issues and foster Habit (using it all and every day) in order to make wearables a success and accelerate the diffusion. .

When wearable manufactures, with more products and branches other than wearables, sell wearables they have to take in consideration that the quality perception is closely associated with consumer's perception of the manufacturer brand image. Apple might have taken advantage of this. Also the presence of an open ecosystem and multiple products who are compatible with the wearable such as the Iphone, Ipad, Imac. Furthermore Apple offered a smartwatch from the beginning, made it a more comprehensive device and perhaps fashion could have played a role as well with their design, but this should be investigated more.

FITBIT for example, who got a closed ecosystem at the moment of writing, the collected self-tracking data is of limited value since it provides insights for the self-tracking users but does not allow service enhancements for users by new and traditional third-party providers.

When speaking about the need of wearables, the ones with more simple devices are more negative. Basically what the respondent are saying is the need for a more comprehensive and standalone device. The danger in adding extension of smartphone and more stand-alone device to wearable could be constant connectivity, which is also a worry of a respondent which is saying a wearable should not control your life. The movement in society in continue connectivity might have a negative impact. This needs to be addressed by manufactures and future research.

Although it has to be mentioned, the initially promises of the market on forehand might not have been realistic and too optimistic which caused a friction between expectations and promises. A more realistic message is needed from the market to prevent friction between expectations and promises. Manufacturers can learn from this research by optimizing the innovations to match user needs better and marketers can learn to manage expectations based on the link between the optimized product and the user needs. Selling a smartwatch that delivers on its promise, or, on the other hand, under-promises and over-delivers, will result in a higher confirmation level, and likewise, satisfaction.

5.7 Diffusion

Media presence is important for creating knowledge, but interpersonal channels are more effective in forming and changing attitudes towards a new idea, especially later in the curve of the diffusion cycle. But first, trying to convince the mass of a new idea is useless, convince innovators and early adopters first. When the exact tipping point to the early majority will be, is unknown. Innovators and early adopters are more easily willing to adopt wearables in the first place; they are less demanding. But, to make sure they keep using it and educate others in their network, later in the stage of diffusion, manufactures and marketers need to address the different factors. The biggest gap between all adoption groups is between the visionaries (early adopters) and pragmatics (early majority). Penetrating to a market segment can be a tough challenge due to differences between new target customers based on psychographic profile. Therefore, in order to fill this chasm, those characteristics of visionaries that alienate pragmatists need to be observed and considered. Past research shows many important differences between earlier and later adopters of innovations: (1) socioeconomic status, (2) personality variables, and (3) communication behaviour (Rogers, 1995). Also factors, who are barely mentioned in these interviews such as fashion - which could also be due to the set-up of the interview more towards the medical side - could come more into play in the later stages of diffusion. Also the popularity of wearables may wane as wearables progress into other stages of their product life cycle, and start being used by groups less enthusiastic about having an additional device. So the exact needs of the following groups in the diffusion cycle should be investigated to make the diffusion succeed. Also the expectation to buy a product at a lower price could be a problem. The expectation for lower prices induces consumers to reject or postpone product buying (Park & Koh, 2017).

A possible solution could be a human centred design; often involving actual and potential users early in the research to improve design. In case developers can ‘wow’ their consumers by good designed wearables, they can also use this to improve their core business process such as customer services, sales and marketing.

Also a promising avenue for the adoption of wearables and adjustment of behaviour could be gamification as mentioned by Spil et al. (2017).

The wearables are created with different design goals and hence should be created with specific requirements. Every target group has its own requirements and hence a ‘one-size-fits-all’ approach does not yield the constructive results.

Regarding the development of wearables, it should be an ongoing process of fine tuning the wearables. Customer expectations are not static: what the customer first regards as luxury can be expected later as a standard attribute.

5.8 Developments

Regarding the developments, since the time of research, smartwatches have caught up the last few years in comparison to the more simple trackers. Fitbit switched more to smartwatches, but are still suffering from their image of having simple trackers. More relevance is added by more options and more prescriptive and valuable information. Also fashion, which is more focussed on, could be a good step for the later stages of diffusion. Also the ease-of-use is improved with more wearables with bigger screens and stand-alone devices (4G internet and GPS). The increasing focus on more comprehensive and stand-alone devices brings along the potential problem of continue connectivity, which could be a potential problem which should be addressed. The increasing focus of developers on smartwatches bring along the battery issue, since smartwatches have relatively little battery lifespan. The battery lifespan is improved only to little extent and whether this will be enough remains questionable. Also the lack of compatibility with other ICT, for some brands, remain a problem. With the more comprehensive, fashionable, stand-alone devices and less simple models the developers are on the right track regarding habit to some extent. But it is unknown is whether notifications to keep using the wearables are added and also whether the information of the wearables can be motivating enough to feel frustrated and disappointed when it not being monitored/measured. Reliability issues has been addressed to some extent, but the collection of data from the specific sensors will also prove challenging, since people do not always operate within the confines of the language of programmes. Changes in sweat, tears, environments, blood and emotions can all skew the data being collected(Andrew, 2016). The developers should not forget to make sure the reliability is sufficient which is of major importance. Also privacy issues should be addressed well, especially with the increasing privacy breaches in the last few years and the increasing focus on stand-alone devices (securing the wearable instead of the smartphone) and comprehensive wearables (privacy worries might increase when adding more functions to wearables due to the risk associated with this type of data collected). The new privacy law in the Netherlands, can be a stepping stone and welcome addition in managing privacy issues regarding certain aspects, but it is only applicable on certain privacy issues and the question remains if it is far reaching enough. Since news already reporting companies in general finding creative ways to ‘avoiding’ the law. Also, there might still be reliability problems regarding sharing information and not communicating the benefits in return for sharing information. Also more collaboration at all chains is needed; to address privacy issues (e.g. protection). Basically the more bigger brands are relatively on the right track by at least improving certain aspects, but more smaller and unknown brands having trouble and lacking different important factors. But, also bigger brands have issues to be addressed, like Fitbit - although Fitbit made some changes within their wearables/business – still do not have an open ecosystem and not the extent of compatibility of Apple with their laptops, smartphones and tablets. Fitbit has work to do. And for example Apple only has a battery lifespan of 18 hours, where that of Fitbit’s latest smartwatch respectively has four days. At the same time developers should make sure there is a match between marketing promises and actual delivery. On the other side, wearables are more and more integrated in society within different respects such as businesses, transportation, hospitals, workforce. This might be a promising vision of the future for people getting used to having a wearable and being more critical for life (relevance).

5.9 Limitations

The research was executed in the Netherlands and it will be hard to be generalized. This research does not lent itself for explicitly pointing out the aspects for sustained use and adoption, but many factors emerged that could be possible disablers or enablers as regards to the literature. It has to be mentioned wearables are very heterogeneous and there is only a small amount of articles, which being able to enter, published in well-known magazines/journals or with many citations. This was especially for articles related to the context of this research. The sentiment and thematic analysis is subject to subjectivity. The accuracy is, in principle, how well it agrees with human judgments.

The speedy evolution of wearables is outpacing efforts to test, evaluate, and validate them. Due to analysing existing qualitative data, caution must be taken while using existing constructs, as these may bring commonly held beliefs and biases, so the results cannot be seen as one on one. Also no uniform definition of wearable technology has been established yet, neither by academia nor practice, which makes it harder to draw conclusions and compare research.

5.10 Relevance science, companies and society

Regarding the relevance for science, companies and society: with the state of the wearables and attrition level at the time of this research (half 2016), people may not be able to reap the benefits of the wearables as promised and society may not be able to stop the rising obesity levels. Therefore, this research can be a welcome addition. Each country has its own demographic profile of users and different cultural norms and context. Yet, there is little known about how to accelerate the diffusion of wrist-worn wearables in the Netherlands. Due knowing what users of wearables expect from wearables, developers could try to improve it in order to retain them as customers, since the costs and effort for acquiring a new user is five times higher of retaining an actual user. Also the IoT industry is based on data (Ledger, 2014) and benefits of data of a big user base and of users using the wearable regularly and continuously. The value for users is built upon the explanatory power of continuously collected data. By using the gathered information, users gain profit from improvements to tracked aspects of their life. Furthermore, the data from this report can be used for segmentation by companies, to enhance the next generation wearables and providing new services to consumers. Companies may, as part of a segmentation strategy, quantify the proportion of users that value the aspects mentioned by the participants. Also sustained use could result in higher revenue and profit for app developers. Moreover, some aspects are important for pre-adoption as post-adoption, where others are mostly important for one of the two. This finding is relevant for marketers, who can use this to offer proactive customer support and adapt their messages to the customer journey stage. Research is often very superficial/quantitative, a closer look at the literature of wearable technology adoption reveals the lack of qualitative research methodologies in this area. This research add value to that.

5.11 Future research

The research is somewhat narrowed to for example age, education level, geographical location and personal ICT context, but all the aspects mentioned by the participants in the study could be used by future studies as input for a quantifying study to make it more generalizable. It could be used in a broader sense, an addition to the already scientific research regarding this topic. Research is often very superficial/quantitative, this research add value by eliciting factors as well a sentiment analysis which could be used to check whether the sentiment has changed over the years. Future research could test the efficacy of different efforts for privacy, such as offering people control over their data in wearables. Perhaps when repeating this research, habit could be added to the model, the same goes for example goals and type of wearable. Aspects as health ology, privacy, complementary goods and enabling technologies were not included in previous technology adoption models, highlighting that existing models need to be updated when it comes in the domain of wearable technologies.

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Appendix

Appendix A) Interview set-up

Date of interview:	
Name interviewer:	
Name interviewee:	
Age:	
Sex:	
Highest level of education?	

P	**To what extent does a WEARABLE fit into your daily routine?**
P1	Most WEARABLE systems contribute to different living and working processes. Can you name the most important processes / activities where you use the computer? This does not necessarily have to be via a WEARABLE
P 2	Which media do you use most to get in touch with other people? (mail, apps, social media)? Which devices do you use most to do that?
P 3	Which exceptions or disruptions make a system such as this sometimes inconvenient and that you have to contact via other ways than via the computer?

REL	**In hoeverre is een WEARABLE voor u persoonlijk relevant?**
R1	Do you think that the use of a wearable can improve your personal health? Which aspects will it improve and to what extent: + insight + monitoring
R2	Do you think that using a WEARABLE is going to be easy? Why, why not?
R3	Do you think it is good that the information you provide about your health can be used for large statistical research (your medical data are therefore no longer linked to you as a person)? Why, why not?
R4	Do you think it good medical professionals use data that you have entered when making diagnoses and treatments? Why, why not?
R 5	On which points could the use of ICT be of personal interest to you? + what kind of application do you think? + for what purpose or in which situation to use?

R6	To what extent does ICT contribute to the information you receive, such as social media and mail?

INF	**What is the quality of the information?**
I1	Do you think that the quantity of medical information you receive increases when you use a WEARABLE? + Do you have easier access to it? + Does the combination of information that you provide and that of doctors lead to synergy? + Do you think that a WEARABLE has enough information to get a good insight into your personal health? + Do you think that a WEARABLE can give you information about every aspect of your health?
I2	Do you think that the quality of medical information you receive increases when you use a WEARABLE? + Will the information contain (more) errors? + Will the information be consistent?
I3	Do you think you have sufficient medical knowledge to be able to interpret the data presented by a WEARABLE yourself? + Do you need other media for this? (Internet, telephone contact with doctor (assistant)?
I4	What information are you prepared to share with the WEARABLE? + Body data (Heart rate, blood pressure) + Habits (Drinking, smoking, other addictions) + Environment (health of work and living environment

M	**What resources do you have available / do you want to make available?**
M1	Which ICT facilities do you have? + Hardware (Smartphone, PC, laptop, tablet) + Software (operating system) + Communication (webcam, Wifi connection, 3 / 4G)
M2	Which ICT facilities do you want to use when using WEARABLE? + Hardware
M3	Do you think that the supplier of a WEARABLE system can offer you the following in combination with your own ICT facilities? Why, why not? + Reliability + availability + Security / privacy
M4	Do you think you will receive sufficient support if you want to use a WEARABLE? + training + management support
M5	How much of your own resources do you want to use for successful use of a WEARABLE? + Time + Money
M6	Do you want to be able to use medical measuring equipment at home?

A	**Attitude: what is your attitude towards WEARABLE and ICT?**
A1	To what extent are you convinced that ICT applications are needed to improve the quality of life + How much experience? + How much time is left? + Are there positive experiences from the past? + How often do you use the internet
A2	Do you feel social pressure to use a WEARABLE? + Have you ever discussed it with an acquaintance? + Have you ever heard about it in the media?
A3	To what extent do you think your privacy is at stake when using a WEARABLE? + Do you think the system can be hacked? + Do you think that the wrong people (other doctors, nurses) can consult your information?
A4	Are you encouraged by your environment to participate in the changes?

Finally, in brief statements: What do you think are the crucial factors for whether or not to use a WEARABLE?

Do you also have something you want to lose?

Finally, I would like to thank you for this interview!

Appendix B) Searching and themes

Source	Keywords	Filtered	Hits	Example of literature
Google Scholar	Diffusion information systems	Relevance	3.840.000	Bhattacherjee, A. (2001). Understanding information systems continuance: an expectation-confirmation model. *MIS quarterly*, 351-370. Limayem, M., Hirt, S. G., & Cheung, C. M. (2007). How habit limits the predictive power of intention: The case of information systems continuance. *MIS quarterly*, 705-737.
Scopus	Diffusion information systems	Relevance	18.778	
Web of science	Diffusion information systems	Relevance	10.785	
Google Scholar	Diffusion theory of technology	Relevance	2.630.000	Karahanna, E., Straub, D. W., & Chervany, N. L. (1999). Information technology adoption across time: a cross-sectional comparison of pre-adoption and post-adoption beliefs. *MIS quarterly*, 183-213.
Scopus	Diffusion theory of technology	Relevance	4.131	
Web of science	Diffusion theory of technology	Relevance	2.692	
Google Scholar	Diffusion theory of innovations	Relevance	1.380.000	Rogers, E. M. (2010). *Diffusion of innovations*. Simon and Schuster.
Scopus	Diffusion theory of innovations	Relevance	4.321	
Web of science	Diffusion theory of innovations	Relevance	2.791	
Google Scholar	Acceptance technology	Relevance	2.650.000	Davis, F. D., Bagozzi, R. P., & Warshaw, P. R. (1989). User acceptance of computer technology: a comparison of two theoretical models. *Management science*, *35*(8), 982-1003. Davis, F. D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS quarterly*, 319-340. Venkatesh, V., Morris, M. G., Davis, G. B., & Davis, F. D. (2003). User acceptance of information technology: Toward a unified view. *MIS quarterly*, 425-478. Venkatesh, V., Thong, J. Y., & Xu, X. (2012). Consumer acceptance and use of information technology: extending the unified theory of acceptance and use of technology. *MIS quarterly*, 157-178.
Scopus	Acceptance technology	Relevance	30.317	
Web of science	Acceptance technology	Relevance	22.959	
Google Scholar	Continued use information systems	Relevance	5.140.000	Delone, W. H., & McLean, E. R. (2003). The DeLone and McLean model of information systems success: a ten-year update. *Journal of management information systems*, *19*(4), 9-30. Bhattacherjee, A. (2001). Understanding information systems continuance: an expectation-confirmation model. *MIS quarterly*, 351-370. Venkatesh, V., Thong, J. Y., & Xu, X. (2012). Consumer acceptance and use of information technology: extending the unified theory of acceptance and use of technology. *MIS quarterly*, 157-178. Venkatesh, V., Morris, M. G., Davis, G. B., & Davis, F. D. (2003). User acceptance of information technology: Toward a unified view. *MIS quarterly*, 425-478.
Scopus	Continued use information systems	Relevance	8.062	
Web of science	Continued use information systems	Relevance	9.388	
Google Scholar	Continued use information systems	Relevance since 2005	52.500	Limayem, M., Hirt, S. G., & Cheung, C. M. (2007). How habit limits the predictive power of intention: The case of information systems continuance. *MIS quarterly*, 705-737.

Scopus	Continued use information systems	Relevance since 2005	5.451	
Web of science	Continued use information systems	Relevance since 2005	7.268	
Google scholar	wearables adoption	Relevance since 2010	7700	Canhoto, A. I., & Arp, S. (2017). Exploring the factors that support adoption and sustained use of health and fitness wearables. *Journal of Marketing Management*, *33*(1-2), 32-60. Rauschnabel, P. A., Brem, A., & Ivens, B. S. (2015). Who will buy smart glasses? Empirical results of two pre-market-entry studies on the role of personality in individual awareness and intended adoption of Google Glass wearables. *Computers in Human Behavior*, *49*, 635-647. Chuah, S. H. W., Rauschnabel, P. A., Krey, N., Nguyen, B., Ramayah, T., & Lade, S. (2016). Wearable technologies: The role of usefulness and visibility in smartwatch adoption. *Computers in Human Behavior*, *65*, 276-284. Spil, T., Sunyaev, A., Thiebes, S., & Van Baalen, R. (2017). The adoption of wearables for a healthy lifestyle: can gamification help?.`
Scopus	wearables adoption	Relevance since 2010	441	
Web of science	wearables adoption	Relevance since 2010	46	
Google scholar	Continued use wearables	Relevance since 2010	5.360	Canhoto, A. I., & Arp, S. (2017). Exploring the factors that support adoption and sustained use of health and fitness wearables. *Journal of Marketing Management*, *33*(1-2), 32-60. Buchwald, A., Letner, A., Urbach, N., & von Entress-Fuersteneck, M. (2015). Towards explaining the use of self-tracking devices: conceptual development of a continuance and discontinuance model. Nascimento, B., Oliveira, T., & Tam, C. (2018). Wearable technology: What explains continuance intention in smartwatches?. *Journal of Retailing and Consumer Services*, *43*, 157-169.
Scopus	Continued use wearables	Relevance since 2010	100	
Web of science	Continued use wearables	Relevance since 2010	25	
Google scholar	Sustained use health and fitness wearables	Relevance since 2010	6780	Kalantari, M. (2017). Consumers' adoption of wearable technologies: literature review, synthesis, and future research agenda. *International Journal of Technology Marketing*, *12*(3), 274-307. Coorevits, L., & Coenen, T. (2016). The rise and fall of wearable fitness trackers. In *Academy of Management*. Lupton, D. (2017). Wearable devices: Sociotechnical imaginaries and agential capacities.
Scopus	Sustained use health and fitness wearables	Relevance since 2010	4	
Web of science	Sustained use health and fitness wearables	Relevance since 2010	3	
Google Scholar	Adoption health and fitness wearables	Relevance since 2010	11.000	Canhoto, A. I., & Arp, S. (2017). Exploring the factors that support adoption and sustained use of health and fitness wearables. *Journal of Marketing Management*, *33*(1-2), 32-60. Shih, P. C., Han, K., Poole, E. S., Rosson, M. B., & Carroll, J. M. (2015). Use and adoption challenges of wearable activity trackers. *IConference 2015 Proceedings*. Dehghani, M. (2016). An assessment towards adoption and diffusion of smart wearable technologies by
Scopus	Adoption health and fitness wearables	Relevance since 2010	26	
Web of science	Adoption health and fitness wearables	Relevance since 2010	6	

				consumers: the cases of smart watch and fitness wristband products. In *HT (Extended Proceedings)*.
Google Scholar	Information privacy	Relevance	1.820.000	Smith, H. J., Dinev, T., & Xu, H. (2011). Information privacy research: an interdisciplinary review. *MIS quarterly*, *35*(4), 989-1016.
Scopus	Information privacy	Relevance	74.745	
Web of science	Information privacy	Relevance	22.863	
Google Scholar	Health information privacy	Relevance	1.370.000	Smith, H. J., Dinev, T., & Xu, H. (2011). Information privacy research: an interdisciplinary review. *MIS quarterly*, *35*(4), 989-1016.
Scopus	Health information privacy	Relevance	10.458	
Web of science	Health information privacy	Relevance	4.037	
Google scholar	Wearables privacy concerns	Relevance since 2010	19.800	Motti, V. G., & Caine, K. (2015, January). Users' privacy concerns about wearables. In *International Conference on Financial Cryptography and Data Security* (pp. 231-244). Springer, Berlin, Heidelberg. Lee, L., Lee, J., Egelman, S., & Wagner, D. (2016). Information disclosure concerns in the age of wearable computing. In *NDSS Workshop on Usable Security (USEC)* (Vol. 1).
Scopus	Wearables privacy concerns	Relevance since 2010	250	
Web of science	Wearables privacy concerns	Relevance since 2010	24	
Google scholar	Wearables trust	Relevance since 2010	20.600	Pfeiffer, J., von Entress-Fuersteneck, M., Urbach, N., & Buchwald, A. (2016, June). Quantify-me: Consumer Acceptance of Wearable Self-tracking Devices. In *ECIS* (p. ResearchPaper99).
Scopus	Wearables trust	Relevance since 2010	113	
Web of science	Wearables trust	Relevance since 2010	11	

Appendix C) Literature

Literature

This study is built upon established theories as well as context related literature in order to elicit factors and support it with theory. To not overlook any factors within the semi-structured interviews several theoretical models and related literature are examined to elicit factors and emerging themes. This paragraph globally examines most used theories in Information systems (IS) and wearables context whereas the next subsection zooms in more into different factors and themes elicited from the semi-structured interviews backed up with more context specific literature. There is a difference between pre-adoption and post-adoption factors which will be outlined next.

Previous research often use the technology acceptance model (TAM) of Davis (1989). The TAM is an IS theory that models how users come to accept/reject and use a technology. Initially it was developed to apply in work environments (Davis, 1989), but has proven its relevance in wearable contexts as well (Kalantari, 2017). Perceived usefulness and ease of use are jointly effecting determinants of peoples intentions to use IS. These intentions, on their turn, are determinants for using an IS. The Unified Theory of Technology Acceptance (UTAUT) originally developed in 2003 (Venkatesh et al., 2003) and in 2012 extended (Venkatesh et al., 2012) is an extension of the TAM model with additional decision-making theories such as social cognitive theory, theory of planned behaviour, theory or reasoned action and the diffusion of innovation. The original model was tested in an organizational context whereas the extension was tested in a consumer context (Venkatesh et al., 2003; Venkatesh et al., 2012). In the original model four constructs, 1) performance expectancy 2) effort expectancy 3) social influence and 4) facilitating conditions, are determents of user acceptance and usage behaviour on technology with the moderators gender, age, voluntariness, and experience (Venkatesh et al., 2003). The extension, which is tailored to the context of consumer acceptance and use of technology, added hedonic motivation, price value, and habit into the model (Venkatesh et al., 2012).

The diffusion of innovation theory was originally proposed in 1962 by Rogers (1962). Rogers (1983) says ‘’Diffusion is the process by which an innovation is communicated through certain channels over time among the members of a social system’’ (p.35). The theory tries to explain how, why, and at what pace new ideas and technology spread. It explains how inventions are almost always perceived as uncertain or even risky. It provides three valuable insights: 1) What qualities make an innovation spread successfully 2)The importance of peer-peer conversations and peer networks and 3) understanding the needs of different user segments (Rogers, 1983). Rogers (1983) speaks about diffusion occurs through a five–step decision-making process: 1) knowledge, 2) persuasion, 3) decision, 4) implementation and 5) confirmation. Central to the theory is the description of the life cycle of an innovation. The theory distinguishes five stages, in which five different groups are distinguished, with their own characteristics, that accept the product or new idea. The groups are classified as respectively innovators, early adopters, early majority, late majority and laggards.

Users' pre-acceptance attitude is based solely on cognitive beliefs (e.g., usefulness, ease of use) formed potentially via second-hand information from referent others (others' opinions), popular media, or other sources. These influence sources may be biased. Hence, user attitude potentially may be inaccurate, unrealistic, and uncertain. In contrast, post-acceptance satisfaction is grounded in users' first-hand experience with the IS. It is, therefore, more realistic, unbiased, and less susceptible to change (Fazio & Zanna, 1978).

While these acceptance models made important contributions to the understanding of the initial technology adoption, they only provide limited insights into the post-acceptance phase. While initial adoption is important, long-term use of a system is a key measure of ultimate success of a system (DeLone& McLean, 2003).

Karahanna et al. (1999) reported in an organization context, with WINDOWS program as subject, different factors for potential adopters and users regarding adoption and use. According to their findings, while behavioural intentions for IT adoption can be explained by subjective norm alone, behavioural intentions for continued IT usage are only influenced by attitude. They also find attitudes toward adopting and continuing to use to be influenced by different preceding factors, except perceived usefulness, underlining the case for analysing pre- and post-adoption separately. Bhattacherjee (2001) opens up the domain of post-adoption theories of IS and tested it in a consumer context. It is based on the expectation confirmation theory which states that satisfied consumers will continue with using IS where dissatisfied consumers will not continue (discontinue). According to Bhattacherjee (2001), ''Continuance intention is determined by their satisfaction with IS use and perceived usefulness of continued IS use. User satisfaction, in turn, is influenced by their confirmation of expectation from prior IS use and perceived usefulness. Post acceptance perceived usefulness is influenced by users' confirmation level'' (p. 351). Not to be mistaken that usefulness refers to post-usage usefulness instead of pre-usage usefulness. Bhattacherjee (2001) speaks about continued use rather than first-time use is vital for long-term viability of an IS. Limayem et al. (2007) build on this previous work, in a consumer context, saying continued IS usage is not only a consequence of intention and added the factor 'Habit', where Habit moderates the influence of intention. Venkatesh et al. (2012) reported, in a consumer context, facilitating conditions and habit as factors impacting directly on use behaviour. With facilitating conditions being moderated by experience, age and gender. Where for forming an habit, experience is a necessary but not sufficient condition.

The information systems success model is an information systems(IS) theory which seeks to provide a comprehensive understanding of IS success by identifying, describing, and explaining the relationships among six of the most critical dimensions of success along which information systems are commonly evaluated. The IS success model identifies and describes the relationships among six critical dimensions of IS success: information quality, system quality, service quality, system use/usage intentions, user satisfaction and net system benefits. (Delone & McLean, 2003).

Buchwald et al. (2018), in the context of self-tracking devices, add another theory by saying it is important to understand that continuance and discontinuance intentions are considered not one bipolar construct, but rather dual-factored constructs similar to the motivation-hygiene theory of Herzberg. They are formed by dividing a presumed bipolar construct into two independent parts with often different preceding influencing factors. For example, the occurrence of an error in a system increases the intention to discontinue the use of a system. However, the absence of this error does not necessarily build up the intention to continue using the system.

All previous mentioned theories and models are common used for IS systems, but does not always take into account specific wearable characteristics and contexts. It is important and necessary to understand what is relevant for wearables, what really matters, and whether existing theories of IS adoption and diffusion can explain this phenomenon well. In wearable literature therefor authors sometimes extend the models for a more complete explanation about users' pre- and post-adoption behaviour in certain contexts (e.g. Buchwald et al., 2018; Canhoto & Arp, 2017; Ernst & Ernst 2016; Nascimento et al., 2018; Pfeiffer et al.,2016).

Literature tailored to the research

This subsection zooms in more into different factors and themes elicited from the semi-structured interviews backed up with more context specific literature. Some of these factors are the fundamental constructs of the technology acceptance theories such as TAM, UTAUT, UTAUT2. Others are external variables that were incorporated in these models with an attempt to improve their predictive power. However, caution should be taken while using existing constructs, as such constructs may bring with them commonly held beliefs and biases.

Confirmation and satisfaction

Oliver (1980) tried to explain this paradox by developing the expectation disconfirmation theory, a cognitive theory which seeks to explain post-purchase or post adoption satisfaction as a function of expectations, perceived performance, and disconfirmation of beliefs (Oliver, 1980). Expectations are the elements or attributes that a person anticipates to find in the technology. Before purchase, the consumers have expectations about specific products or services (Oliver, 1980) that are based on existing knowledge and prior experience. Depending on these factors, the extent of the expectations can vary for different customers for the same product.

Users' pre-acceptance attitude is based solely on cognitive beliefs (e.g., usefulness, ease of use) formed potentially via second-hand information from referent others (others' opinions), popular media, or other sources. These influence sources may be biased. Hence, user attitude potentially may be inaccurate, unrealistic, and uncertain. Consumers might form perceptions about the performance of a product or service. However, if the information about the product or service is misleading, expectations will not be realistic (Boulding et al., 1994; Oliver, 1980). Bhattacherjee (2001) says ‘’Expectations provide the baseline level against which confirmation is assessed by users to determine their evaluative response or satisfaction’’ (p.355). Post-acceptance satisfaction is grounded in users' first-hand experience with the IS. It is, therefore, more realistic, unbiased, and less susceptible to change (Fazio & Zanna, 1978). Users' may accommodate this uncertainty in affect by underweighting more uncertain attitude in their acceptance decisions and overweighting more certain satisfaction in continuance decisions (Bhattacherjee, 2001).

Expectations influence the perception of performance and disconfirmation of beliefs. The perceived performance is influenced by these expectations and impacts the post-usage disconfirmation of beliefs. The perceived performance is the perception of the actual performance of the technology. The evaluation a person makes regarding the technology is the construct disconfirmation of beliefs. These are made when the original expectations are compared with the actual usage. Lower expectation and/or higher performance lead to greater confirmation, which in turn positively influence customer satisfaction and continuance intention. The reverse causes disconfirmation, dissatisfaction, and discontinuance intention. Satisfied consumers form a repurchase intention, while dissatisfied users discontinue its subsequent use.

Bhattacherjee (2001) indicates that satisfaction is a fundamental determinant in post-acceptance behaviour (Bhattacherjee, 2001).

More context specific Coorevits and Coenen (2016) in the context of wearable fitness trackers try to identify the key determinants from a consumer perspective leading to dissatisfaction and eventually wearable attrition. They mention that it can be assumed that considering the limited focus on user needs in wearable research development, the consumer beliefs got disconfirmed leading to avoidance. Nascimento et al. (2018) in the context of smartwatches uses confirmation and satisfaction as constructs in order to explain continuance intention. The authors also mention that selling a smartwatch that delivers on its promise or under-promises and over-delivers, will yield in a higher confirmation level, and so satisfaction (Limayem et al., 2007; Oliver, 1980). Canhoto and Arp (2017), in a research of adoption and sustained use in the context of health and fitness wearables, mention consumers may have specific dietary needs that are not sufficiently captured by the wearables' dashboard. They mention it might be possible that consumers ''have inflated expectations about the ability of wearables to change nutritional habits. Consumers blame the technology for the unsatisfactory outcome, whereas the issue may be their expectations. Indeed, it is well established in the customer satisfaction literature (e.g., Malle, Guglielmo & Monroe, 2014; Oliver, 1999), that satisfaction is a process of appraisal of the extent to which perceived performance exceeds expected performance such that if expectations are unmet they lead to a dissatisfied customer'' (p.31).

Buchwald et al. (2018), in the context of self-tracking devices in understanding continuance and discontinuance, does speak about satisfaction as well dissatisfaction. The authors mention, regarding to the hygiene theory of Herzberg, hygiene factors can cause dissatisfaction, but not necessarily satisfaction. For example, the presence of system unreliability fosters a discontinuance intention, whereas its absence does not contribute to the formation of a continuance intention.

Brand names could have a positive influence on satisfaction by enhancing social image in the context of wearables in general (Yang et al., 2016). Where Jeong et al. (2016), in the context of smartwatches, mention consumers tend to associate the quality of novel products with the existing products of a manufacturer. There is a positive effect on perceived usefulness and perceived ease-of-use due to perceived similarity between the quality of existing and expanded products.

Sauerwein et al. (1996) mention in the Kano-model, how to delight customers, consumer satisfaction is based on the presence or absence of certain attributes (properties) of a product or service. Kano distinguishes three levels of attributes in his model: basic needs, performance and bonus. He also indicates that attributes can be classified on a different level over the course of time. Shifts of characteristics from one level to another occur due to changes in consumer expectations and changes in the level of performance of competing products. What the customer first regards as luxury can be expected later as a standard attribute.

Experience (with technology)

According to Venkatesh et al. (2012), in a consumer context of mobile internet, pre-experience with technology influence facilitating conditions, social influences and effort expectancy. Social influences and effort expectancy impact behavioural intention whereas facilitating conditions on its turn impact as well behavioural intention and use behaviour. Adoption barriers can be reduced with relevant, transferable knowledge and skills from experience with technology. Also Kim and Malhotra (2005) mention experience with technology is a strong predictor of future technology use.

More context specific, Kalantari (2017) mention in a literature review of wearables, that ''experience with technology is a key parameter in consumers' adoption''(p. 301).

On the other hand, more tailored to post-adoption and sustained use, experience with the target technology itself is of influence on habit and use behaviour. Where habit on its turn influence behavioural intention and use behaviour (Venkatesh et al., 2012). Karahanna et al. (1999) in an organizational context with the program Windows, mention ''Post-adoption, however, when users through experience have concrete knowledge of the technology, only instrumentality beliefs of usefulness and perceptions of image enhancements influence attitude. These results represent an important first step toward a deeper understanding of the temporal evolution of beliefs, attitudes, norms, and behaviour across different phases of the innovation process'' (p. 203). Experience is also of influence on perceived ease of use, PEOU decreases over time in the post-acceptance stage due to people gain experience with a system and resolve their PEOU concerns. However is this researched in an organizational context. On the contrary Nascimento et al. (2018) included it in their model and found perceived usability to have an impact on satisfaction, in turn have a significant effect on continuance intention for smartwatches in a personal ICT context.

Habit

Habit is not a common factor in traditional adoption models, but has been added to this research due to its relevance.

A person form many habits during his lifetime, which integrate in persons' regular behaviours, by repeatedly proceeding from intentions to actions. In the end, this kind of behaviour results in an automatic habit and is being done unconsciously (Hutchison 2013). This can be applied to self-tracking devices, due the frequent, and often daily usage of these devices it supports the transition process into an habit. The self-tracking devices value is based upon the continuously collected data, by using this collected information users can benefit from improvements. Besides this, wearable developers can use the data for segmentation, to improve next generation devices, and to provide new services (Porter & Heppelmann 2014).

Limayem et al. (2007) refer habit as ''the extent to which people tend to perform behaviours (use IS) automatically because of learning'' (p. 705). Limayem et al. (2007) speak about four conditions likely to form IS habits: 1) frequent repetition of the behaviour in question 2) the extent of satisfaction with the outcomes of the behaviour 3) relatively stable contexts and 4) comprehensiveness of usage (which refers to the extent to which an individual uses the various features of the IS system in question). Prior behaviour's frequency is important for the strength of habit. Limayem et al. (2007) reported that habit intervenes in the relationship between intention and usage whereas Venkatesh et al. (2012) reason habit as a factor impacting directly on sustained use**.** Intention is less important with increasing habit (Limayem et al., 2007). Routines are not habits per se (Limayem et al., 2007). Also Venkatesh et al. (2012) mentions people can form different levels of habit depending on the use of a target technology (e.g. within 3 months individuals can form different levels of habit). Further mentioning experience being necessary but not sufficient condition when forming a habit. Ajzen and Fishbein (2005) also noted that feedback from previous experiences, with the target technology, will influence various beliefs and, consequently, future behavioural performance. Wearables have specific characteristics; due to novelty of a technology habit could be an important factor in technology acceptance (Polites & Karahanna, 2012).

Wearables and mobile phones make it possible to collect physiological data for health and wellness purposes. Users often access these data via Online Fitness Community (OFC) platforms, such as Fitbit, Strava or RunKeeper. To reap the benefits from these functionalities, users need to habitual integrate OFC use into their everyday workout routines. However, this often fails for a longer period of time. Strategier et al. (2016) surveyed 394 (OFC) users and reported that enjoyment and self-regulatory motives indirectly predict habitual OFC use, by driving the perceived usefulness of OFCs. Prime drivers of habitual OFC use for novice users are self-regulatory motives where social motives and enjoyment are more important for experienced users.

More context related study on smartwatches (Nascimentoet al., 2018) find that habit was the most important feature to explain the continuance intention. Coorevits and Coenen (2016) find, with the help of netnography, wearable fitness trackers being easy to forget one of the factors leading to attrition. One of the factors that affect the design considerations of wearables with regards to comfort is their intervention with daily behaviour and activities. Coorevits and Coenen (2016) puts this under the denominator lifestyle compatibility: the change that the device requires in order to simply wear it. Users mention forgetting about the wearable when taking it off for charging or hindering during workouts. This is caused by example the unobtrusiveness and not being engaged enough to remember. Buchwald et al. (2018) reports in a study of self-tracking wearables perceived routine constraints being positively related to discontinuance intention, e.g. by wearing specific clothes. Buchwald et al. (2018) also mention, within another construct, individuals can also form attachments to routines or systems by affection, strengthening the individual's status quo bias. This results from the individual being comfortable and happy with the system or even when pleasure is taken in its usage, leading to a positive emotional bond . In the case of self-tracking devices, the affective-based inertia is formed during extensive every-day usage. This can have a positive effect on the continuance intention.

Shih et al. (2015), in the context of Fitbit activity trackers, mention that the wearables are tailored to remind people of the activities, but not remembering to keep the activity tracker with them. It was reported consumers having problems to keep the activity trackers with them or needing to remove it due to engaging in certain activities such as not suitable for work environment, showering, washing dishes. Also there seems to be a trade-off of the size of the wearable. A small and easy to carry with you is in a greater extent more fragile, easy to forget and less noticeable whereas a bigger wearable is being viewed as uncomfortable and bulky to wear. On the contract the respondents barely forget to take their keys, mobile phones or wallets. Shih et al. (2015) view this as the respondents might having more experiences and longer period of adoption to incorporate these other aspects into their daily (activity) routines.

Lupton et al. (2018) mention, in the case of self-trackers, cycling people trying to integrate the devices into the everyday routines is a form of work. The people have to prepare the wearable such as charging or making sure the GPS is working properly, turning them on and remembering to bring them with them. Where some of the practice become habituated (needing little thought or attention), others on the contrary need continual vigilance.

Lupton (2017) mentions keeping wearables paired with the smartphone and review the information which has been collected were a few of the factors to participants' decisions not to continue to use them.

Fritz et al. (2014) found, in the context of long-term fitness tracking wearable users in three different continents, that most of them integrated it deeply in their routines. The information provided by the wearables was motivating and led to long-term behaviour changes (e.g. sitting less or more walking) which led these respondents to feel frustrated and disappointed when it not being monitored/measured. They became use to it; they felt strange when they took the wearables off. But, the majority of these people however lost interest when the novelty phase moved into routine. There was a learning curve which made the respondents being able to estimate their steps or calories for the day themselves and made the wearables obsolete.

Facilitating conditions

In UTAUT, facilitating conditions is hypothesized to influence technology use directly based on the idea that in an organizational environment, facilitating conditions can serve as the proxy for actual behavioural control and influence behaviour directly. This is because many aspects of facilitating conditions, such as training and support provided, will be freely available within an organization and fairly invariant across users. In contrast, the facilitation in the environment that is available to each consumer can vary significantly across application vendors, technology generations, mobile devices and so on. Specifically, a consumer who has access to a favourable set of facilitating conditions is more likely to have a higher intention to use a technology. According to Venkatesh et al. (2012), a research of IS (mobile internet) in an consumer context, facilitating conditions influence as well behavioural intention as use behaviour. Facilitating conditions in this case is measured with items such as 1) having the resources necessary to use mobile internet 2) having the knowledge necessary to use mobile Internet. 3) Mobile Internet is compatible with other technologies I use and 4) Being able to get help from others when I have difficulties using mobile Internet.

The moderators age, gender as experience with technology moderate facilitating conditions 'influence on influence behavioural intention whereas gender and experience moderate in the case of use behaviour. Greater experience can lead to greater familiarity with the technology and better knowledge structures to facilitate user learning, thus reducing user dependence on external support. Users with less experience or familiarity will depend more on facilitating conditions.

Compared to younger consumers, older consumers tend to place greater importance on the availability of adequate support. Men tend to rely less on facilitating conditions when considering use of a new technology whereas women tend to place greater emphasis on external supporting factors. As people become older, particularly from teenagers to adults, the differentiation of their gender roles will be more significant.

Impacts of age and gender on consumer learning will be less significant than when they have acquired enough knowledge or expertise about the technology (e.g. when they have more experience). The dependence on facilitating conditions is of greater importance to older women in the early stages of technology use because they place greater emphasis on reducing the learning effort required in using new technology. This particular group of consumers views availability of resources, knowledge, and support as essential to acceptance of a new technology.

Relevance

Relevance (relevance) is defined as the degree to which the user thinks that the innovation will solve his problems and will help achieve its goals. Relevance is as well a pre- as a post-adoption factor. Relevance has much in common with "expected or experienced utility '(perceived usefulness) in the Technology Acceptance Model (Davis, 1989; Venkatesh & Bala, 2008) and" comparative advantage "(relative advantage) over diffusion of innovations Rogers (Rogers, 1995). Bhattacherjee (2001) speaks about perceived usefulness as factor for post-adoption. He suggests continuance intention is positively influenced by perceived usefulness. Spil et al. (2004) mention economic improvements, social improvements, functional improvements, saving time and effort, solve here-and-now problems and compatibility with working process as sub determinants for relevance. More context specific, related literature of Pfeiffer et al. (2016) reports usefulness to be a strong pre-adoption driver to use wearable self-tracking technologies. Whereas literature on self-tracking devices (Buchwald et al., 2018) and smartwatches (Nascimento et al., 2018) found relevance/usefulness to be a factor for continuance intention and literature on health and fitness wearables (Canhoto & Arp, 2017) on sustained use. To put relevance or perceived usefulness in the context of this report, it is refined to the degree a person believes using a wrist-worn wearable would enhance her or his personal living condition, contributing to one’s health, fitness and/or well-being. Consumers are telling they have to perceive real value before they can invest in a wearable (PWC, 2016).

Requirements

Requirements (literally: requirements) is defined as the extent to which the product quality of the innovation fulfils the requirements of the user. With ICT innovations it mainly involves information needs and quality. The requirements determinant is strongly related to information quality (information quality) and system quality (system quality) in Information Systems Success Model (Delone & McLean, 2003) and usability (ease of use) from the Technology Acceptance Model (Davis et al., 1989; Venkatesh & Bala, 2008). Delone and Mclean (2003) with the IS success model ,within as well organizational as individual context, identifies and describes the relationships among six critical dimensions of IS success: information quality, system quality, service quality, system use/usage intentions, user satisfaction and net system benefits. They name adaptability, availability, reliability, response time and usability as determinants of systems quality, whereas completeness, ease of understanding , personalization, relevance and security being mentioned as determinants of information quality and Service quality with the determinants of assurance, empathy, responsiveness. Systems quality, information quality and service quality on their turn have influence on the intention to use and user satisfaction, which on their turn determine the net benefits and back around. Venkatesh and Bala (2008), with a research in an organizational context, state that ‘’information-related characteristics of a system will influence the determinants of perceived usefulness, while the system-related characteristics will influence the determinants of perceived ease of use'' (p. 249). And further Venkatesh and Bala (2008) mention ''If a system can provide users relevant information in a timely manner, accurately, and in an understandable format and help them make better decisions (Speier, Valacich, & Vessey, 2003), it is more likely that users will perceive greater job relevance of the system, high output quality, and greater result demonstrability—the important determinants of perceived usefulness'' (p.249). Whereas Davis (1989) mention in an organizational context usability (ease of use) to be of influence on perceived usefulness and attitude towards using. The four items Davis (1989) used for ease of use are 1) Learning to operate …. would be easy for me 2) I would find it easy to get …. To do what want it to do 3)It would be easy for me to become skilful at using ... and 4) I would find …easy to use.

A more context specific research of Buchwald et al. (2018), on the continuance and discontinuance of wearable self-tracking devices in a personal ICT context, found support for system unreliability (e.g., unreliable measurement of data on discontinuance intention). Buchwald et al. (2018) thereby do not put importance to whether the unreliable data measurement is caused by a hardware or software defect. What must be noted is that it is a bipolar construct into two independent parts with often different preceding influencing factors. For example, when there is an error in a system, it increases the intention to discontinue using the self-tracking device. On the other hand, the lack of this error does not necessarily mean the intention to continue using the system. Maher et al. (2017) also mention technical difficulties with the device/accompanying software to be one of the key barriers for continued use in the context of wearable activity trackers. Canhoto and Arp (2017) also found accurate and consistent data to be of influence on sustained use in the context of health and fitness wearables. On top of this, they found the ability to transfer and aggregate data to have an effect on sustained use. Nascimento et al. (2018) found, in the context of smartwatches, perceived usability to have an impact on satisfaction, in turn have a significant effect on continuance intention. Usability in this case was measured with eight different items such as 'The smartwatch provides accurate information and functions that I need', 'The amount of information displayed in the smartwatch is appropriate' and 'It is easy to find the information I need from the smartwatch'. Epstein et al. (2016) examined people, in the context of self-tracking tools, who stopped using the wearable and reported data quality concerns: ''People often desire greater accuracy than their tools provide [12]: "the calories burnt seemed so random, and didn't line up with other online sources" (p123, 19 others), or find data unreliable "the GPS would lose my location and stop tracking my run" (p139), leading to imperfect personal data. This problem in collection inhibits effective reflection and consequently action'' (p.1110).

Kari et al. (2016) confirm all aforementioned in the context of self-tracking technologies and says ''the adoption was promoted by experiences that matched the expectations of technology being easy to use, the given information being understandable and reliable, and the use being as effortless as possible. In practice, if the technology was sufficiently ubiquitous and useful part of everyday life, it promoted the adoption. The continued adoption of technology was also influenced by the possibility of improving oneself with the help of technology. The interviewees highlighted use experiences that concretely showed improvement in the measured area or the expected fulfilment of personal goals. The rejection was promoted by experiences of the technology being difficult to use, bad functionality, the given information not being valid and reliable, technology usage not matching expectations regarding use and improving oneself, and the technology ending up being a mere tracker of activities instead of a tool to improve oneself'' (p.14). Important adoption factors according to Canhoto and Arp (2017), in the context of health and fitness wearables, were features that signalled the ability to capture health and fitness data: counts, monitors and easy access to the data. Where for sustained use, the key was that data were accurate and useful; device portability and resilience. Portability suggests, able to use wearables anytime and anywhere and capture data consistently. And further it was important to transfer and aggregate data with inputs from other devices or applications. While some factors impact both on adoption and sustained use, the effect results from different attributes – for instance, utilitarian features related to monitoring activity vs. features related to data accuracy. Downfalls of the health and fitness wearables were in terms of the use of wearables for nutrition purposes, clumsy data inputs, limited visualisation and analysis capabilities. Challenging effectively store, retrieve and analyse the vast amount of data collected by wearables in a meaningful way. Also limited immediate feedback, cues, nudges and rewards. Specific dietary needs that are not sufficiently captured by the wearable's dashboard (e.g. marathon vs short run).

Coorevits and Coenen (2016) reported, in the context of wearable fitness trackers with the help of netnography of ex-users, different key determinants for dissatisfaction and eventually wearable attrition. They mention by simply providing data to the user is not sufficient: wearables should also provide users with feedback based on their activity level in the form of information and/or notifications. Consumers feel that the fitness trackers often inhibit their current performance, that the added value of the metrics is being too limited and the data-accuracy is too small to improve the consumers' behaviour.

Consumers bought the device for the initially marketed promise people allowing to track their progress but then realized that the functionalities are too limited. It will not provide them with sufficient insights in their workout such as lifting weights and cycling and due to these limited insights, they stopped wearing their device. Heart rate measurements and accelerometers are not optimized for workouts. The accuracy and reliability of the data was not right due to confounding factors, e.g. sleeping in a different bed, steps while standing etc. There was a discrepancy between the behaviour and the registered data, which resulted in losing faith in the overall data-value. There was also a limited user experience between the device and the application supporting the device. Coorevits and Coenen (2016), like other authors, also mentioned that there is a mismanagement of expectations of the device's capabilities and its expected usage.

A research with Dutch and German respondents with the vast majority non users of wearables in 2016, mention they have lack of confidence in the information quality health gamification can deliver. The respondents think that gamification provides additional data, which might be valuable for activity tracking. On the other side strongly doubt the quality of this information. Although people have strong doubts about the information quality of gamified health apps and the features of wearables that add value to them, respondents still think that wearables are useful and easy to use (Spil et al., 2017).

Also Shih et al. (2015), in an experiment of providing respondents a FITBIT activity tracker for 6 weeks, mention that respondents were frustrated that FitBit did not automatically record calories burned from other activities such as weightlifting. Shih et al. (2015) also mentioned respondents found that inputting their diet was difficult and time-consuming and finding comparable food on the food list was not always possible.

Shih et al (2015) reframe data inaccuracy as a by-product of mismanagement of expectations of the device's capabilities and its expected usage and mention in the context of wearable activity trackers ''participants did not discern data inaccuracy such as the miscounting number of steps, but rather, they were surprised by having to constantly learn and readjust of their expectations on what the device is actually capable of doing. In essence, the perception of inaccuracy is directly related to the mismatch of expectation due to the lack of knowledge on the device's technical capabilities'' (p. 8).

Where Lupton et al. (2018) mention people are continually determining the accuracy of the data, whether the metrics are influenced by other conditions. In the case of cyclists wondering about for example the weather conditions, their state of health, type of bicycle. Then making an synergy on their own between the data from the wearable and the other conditions. Also Fors and Pink (2017) in the context of self-tracking wearables and apps found The connections respondents were able to make between their bodily knowledge and the data to how meaningful these data were.

Ease-of-use (EOU)

Ease of use is a straightforward concept –it's a measurement of how easy the finished product is to use by its intended users. Design is often a battle between trying to deliver functionality, visuality and trying to deliver ease of use. Wearables could face aspects such as small screens/controls that hinder usability, body contact that some will find uncomfortable, short battery life, immature technology/applications and more. Davis et al. (1989) mention ''Perceived ease of use (PEOU) refers to the degree to which the prospective user expects the target system to be free of effort'' (p. 985). In literature multiple names are used for ease-of-use, namely ease of use (Davis et al., 1989; Karahanna et al., 1999; Venkatesh et al., 2003), effort expectancy (Venkatesh et al., 2012), usability (Buchwald et al., 2018; Nascimento et al., 2018; Venkatesh & Bala, 2008) and user experience (Coorevits & Coenen, 2016). Regarding general IS literature, Venkatesh et al. (2012) mention effort expectancy being moderated by age, gender and experience. In the information systems success model of Delone and Mclean (2003), system quality was measured in terms of ease-of-use. The TAM of Davis et al.(1989) suggests that perceived usefulness increases as consumers perceive the technology as easy to use; therefore, perceived usefulness partially mediates the relationship between PEOU and behavioural intention to use a new technology.

According to Spil et al. (2017) respondents are willing to adopt wearables mainly due to the usefulness and ease of use a wearable can offer, which must be noted this is for wearables which can be used as a stand-alone device.

The effect of PEOU on behavioural intention to use (adopt) wearable technologies has been widely studied and confirmed in the literature in various contexts such as mobile fitness applications (Jang Yul, 2014) and smartwatches (Chuah et al., 2016; Krey et al., 2016). On the contrary, a study more context specific regarding self-tracking devices, Pfeiffer et al. (2016) did not find support for perceived ease of use. A potential explanation according to the Pfeiffer et al. (2016) is that ''might be that the survey group cannot yet evaluate the importance of the ease of use for wearable self-tracking devices due to the novelty of the technology and the inexperience of the potential users'' (p.11).

Perceived comfort is one of the factors impacting the ease of use perceptions according to Coorevits and Coenen (2016) with the help of netnography on wearable fitness trackers. One of the factors that affect the design considerations of wearables with regards to comfort is their intervention with daily behaviour and activities (Coorevits and Coenen, 2016).

Technology innovativeness, the slope an individual to accept innovation relatively earlier than others, is positively related to perceived ease of use. Highly innovative individuals can be referred as active information seekers. This will help them better coop with uncertainty of new technologies and hence a higher adoption intention (Rogers, 1995). Some of the factors like perceived ease-of-use are more impactful for certain devices because they are mainly adopted by older groups. For example, the influence of perceived ease-of-use in health and wellness medical devices is higher than smart glasses because they are more likely to be adopted by older individuals who have lower levels of technology experience and innovativeness. Jang Yul (2014) found, on adopting mobile fitness applications, personal innovativeness in IT as significant effect on PU and PEOU.

Regarding IS continuance, Bhattarcherjee (2001) and Venkatesh et al. (2003) do not include PEOU into their model to the fact that users gain experience with a system and resolve their PEOU concerns. More context specific; Buchwald (2018) follows this line with self-tracking devices and do not include PEUO. On the contrary Nascimento et al. (2018) included it in their model and found perceived usability to have an impact on satisfaction, in turn have a significant effect on continuance intention for smartwatches.

Coorevits and Coenen (2016) refer ease of use as use experience resulting in ''But the majority of users forgot to change their settings, making the data irrelevant. Additionally, overall health tracking requires too much effort from the user. If they want to track how healthy they are by counting calories combined with their activity level, the applications require too much effort because they have to input their activity manually through the application'' (p.14).

Privacy and risk

In the race to be first to the market, security on wearables is not as seriously taken in the development by the firms as it should be, the people who wear them, or by the firms who adopt them into their existing work processes and legacy systems. Typically the legal regulatory environments lag behind several years to adapt to technological advancements. Due to the push of wearable developers to newer and more powerful technological devices, the gap between laws to govern wearables and the technology itself increases (Mills et al., 2016). Patterson (2013) mention ‘’The dominant reaction is simply to opt out, to take self-protective measures to shield themselves from future harm, thus leaving them less able to experiment with and enjoy innovative new technologies on the horizon’’ (p.48).

Wearables are more personal and unique devices, more than laptops and tablets and even smartphones so far. This uniqueness also encounters more risk and security issues than previously seen in information systems (Mills et al., 2016).

A big part of the wearables are connected to cloud databases. Third parties can often openly use this information. When data are being transmitted from wearables to cloud databases, and stored in digital archives, they are vulnerable to different kind of leakages, breaches or hacking (Langley, 2014). Combining different datasets about consumers can lead to generating data profiles that can reveal many aspects of consumers’ lives and activities to a range of third parties, as well legally and illicitly (Pasquale, 2014).

The data is not only about the person and for example workout routines and sleeping patterns. But, also the wearer’s date of birth and social security number can be obtained. These type of data and information are far more valuable than a stolen credit card for example (Overfelt, 2015). More context specific; Ching and Singh (2016) mention Fitbit Devices and Samsung smartwatches being easily breached with a data injection attack, denial of service (Dos), battery drain hacks, easily being tracked, phishing and brute force attack.

In the last few years wearables are popping up negatively in the Dutch news due to privacy issues, such as due to a leak in popular smartwatches, for years it was possible to track thousands of Dutch children’s living place for example. Parents bought a smart watch to keep an eye on their child, but hackers could easily get involved. The vulnerability was found in the Dutch smartwatches Helloo and Belio, which are sold at large web shops. These smart watches did not store the child's data securely, making it possible to retrieve all their location data from one year to the next and the parents’ telephone number (Verlaan, 2018). Another case was of secret agents: the names of these are state secret. Soldiers on mission call each other only by their first name. But, with the fitness app Polar anyone with common sense (and Google) could find their identity and home address (De Correspondent & Bellingcat, 2018).

The understanding of information privacy remains fragmented particularly in the under examined health context. Till now, a limited number of studies have explored a few antecedents of health information privacy concern.

In an organizational context Mayer and Davis (1995) raises a number of issues for the study of trust in organizations. The authors proposed a model with the dimensions ability, benevolence and integrity of the trustee. Mayer and Davis (1999) posit that the relevance of these dimensions differ per situation. Smith et al. (2011) reported in a literature review on information privacy, that a subset of empirical studies addresses the concept of privacy calculus by assuming that a consequentialist trade-off of costs and benefits is salient in determining an individual’s behavioural reactions. Overarching APCO Macro Models (antecedents -> privacy concerns -> outcomes) should eventually include an expanded set of antecedents as well as an exhaustive set of outcomes. Emerging technological applications and other contextual factors should be taken into account and so should be aware of the exhaustive set of antecedents, as there is little need for each discipline or sector to investigate its own set of antecedents. Similarly, context parameterization could be used to highlight outcomes that would be more or less salient for different contexts

More context specific with regards to health information privacy concerns Kenny and Connolly (2016) developed the Health Information Privacy Concerns Model (HIPC) to address privacy concerns with health information technologies. The model is composed of the six constructs Collection, Unauthorized Secondary Use, Improper Access, Errors, Control and Awareness, which are based on the Information Privacy-Model (CFIP) and Internet Users Information Privacy Concerns-Model (IUIPC). This model is also used by Becker (2018) in semi-structured focus groups for understanding users' health information privacy concerns for health wearables. Kenny and Connolly (2016) also uses the information boundary theory to explain that the more sensitive individuals perceive health to be, the greater the concerns regarding the privacy. This theory provides the motivational elements that illuminate when and why individuals withhold or release valuable information. Miltgen et al. (2013) extended the models technology acceptance model (TAM), diffusion of innovations (DOI) and unified theory of acceptance and use of technology (UTAUT) along with the trust-privacy research field to investigate end-user acceptance of biometrics. Showing that heightened risk perceptions are associated with lower consumer intentions to adopt. Whereas Pavlou (2003) added trust and perceived risk to the adoption theory of reasoned action (TRA) and technology acceptance model (TAM) model to determine consumer acceptance of electronic commerce. According to Ferrin and Rao (2008) trust, reputation, privacy concerns, security concerns, the information quality of the website and the company's reputation, have strong effects on internet consumers' trust a website.

More wearable specific the technology acceptance model (TAM), diffusion of innovations (DOI) and unified theory of acceptance and use of technology (UTAUT) for IS do not incorporate privacy issues. The literature review of Kalantari (2017) reported, in the context of wearables, different authors extended the UTAUT2 model with for example the earlier mentioned privacy calculus theory and one author using the protection motivation theory. Whereas Kenny and Connolly (2016), in the case of Health Information Privacy Concerns, also uses the protection motivation theory to back up that individuals do appraise threats by considering media coverage, and risks associated with disclosure either to health professionals or health technology vendors. Trust can partially negate these threats. Overall different authors use a widespread of antecedents adjusted to the context.

Kenny and Connolly (2016), with regards to Health Information Privacy Concerns (HIPC), used the six constructs Collection, Unauthorized Secondary Use, Improper Access, Errors, Control and Awareness. They found older people expressing higher HIPC and are less likely to adopt due to trust and privacy issues. Furthermore individuals with sensitive conditions showing higher HIPC; the more sensitive individuals perceive health data to be, the greater their concerns are regarding the privacy. In case of trusting health technology vendors, they will express lower HIPC. People may trust the intentions of health professionals, but perhaps not trust their ability to protect the health data. When people believe disclosing health data is risky, they show higher HIPC. Privacy related media coverage of experiences of individuals positively influenced HIPC in U.S. data, but not in the other (Irish) sample. A possible explanation was the individuals may be aware of privacy news stories but perhaps not think they are (personally) at risk to this kind of outcomes.

To delve deeper into the wearables, Motti and Caine (2015) show that users have different levels and types of privacy concerns depending on the type of wearable they use, related to the sensors embedded in the device and the respective data collected. They found several factors affecting the privacy concerns among users, including: The nature of the data collected, the respective levels of confidentiality and sensitiveness, ability to share and disclose the information, and also potential implications (social, criminal, etc.). They found wearables including cameras and microphones extreme privacy concerns, followed by wearables with displays and GPS. Activity trackers (e.g. rate, steps and pulse) are less seen inoffensive to the user's privacy, this could be due to their ignorance how this information could be of value and misused by third parties.

Lee et al. (2016) found in 2014, among users and non-users in the context of Fitbit fitness trackers, Pebble smartwatch and Google glass the most concerning type of data is video (78.0%), photos (76.2%), (66.8%), demographic data (65.4%), behavioural (53.1%) and biometric (46.3%) data. These authors were also surprised of the biometric information seen as benign, explaining it might be due to their ignorance. Users are willing to tolerate risks if there is enough benefit associated with that risk.

Pfeiffer et al. (2016) found in the context of self-tracking devices trust to be a pre-adoption factor. Whereas Buchwald et al. (2018) found in the context of self-tracking devices trust also being a post-adoption factor being negatively related to the discontinuance intention saying ′′ trust comprises the ability of the self-tracking service provider to continuously protect the individual's data, continuous take actions in the individual's best interest and integrative behaviour. We suggest that trust is an important factor because the service provider continuously gathers and analyses data from the individual that is highly sensitive. If trust diminishes as judged by the individual user, we argue that this perception contributes to a discontinuance intention′′ (p.8). And also Buchwald et al. (2018) mentions ′′ Finally, trust has a negative impact on the discontinuance intention, suggesting that users value a trustworthy vendor of a self-tracking device, when their highly sensitive data is gathered and analysed′′ (p.12). Epstein et al. (2016) found people to stop tracking location due to concerns for data sharing. People were concerned about what friends could see, knowing where they are all the time, as well as companies using information about them.

Canhoto and Arp (2017) reported that their respondents from Germany, regarding the adoption and sustained use of health and fitness wearables, had concerns regarding the use of data by third-parties.

In another research, within the context of self-tracking whether people were worried or concerned about who might be viewing their data, most of them had only spent little time thinking about these issues, how well their data were protected, reviewing terms and conditions or privacy policies for the devices/apps. They tended to see their personal data as having little value to others due to its ordinary nature (Lupton, 2017; Lupton et al., 2018).

Chang et al. (2016) reported perceived privacy positively influenced behavioural intention in the context of wearable adoption in a research among users and non-users.

In a research between experts (experts in dangerous work, heavy work, sport, homecare, research) and non-experts of wearables, experts seemed to have less privacy concerns than no experts. Probably because they are more used to releasing some personal information for the sake of their activity. When the dependence and intimacy with the technology is higher, there are less concerns. The bottom line is that the kind of privacy loss that might be perceived as unacceptable to some kind of users might seem acceptable to others (Spagnolli et al., 2014).

Lee et al. (2016) reported that consumers may not have clear understandings of new technologies with respect to familiar ones, they may have a higher likelihood of being influenced by reports of recent events regarding to wearables. They reported respondents being concerned due to stories from the news.

Regarding incorporating biometrics (e.g. geolocation, heart rate, breathing, body temperature, brain activity, muscle tension and blood chemistry) professionals at the Biometrics Institute Asia Pacific Conference, at the end of 2017, mention privacy concerns regarding access to biometric information stored on the cloud as the most significant struggle to incorporate biometrics into wearables (79%) (Kendall, 2017).

In a commercial report of PWC (2017) regarding what consumers want, what worries them, and how companies can earn their trust—and their business regarding cybersecurity and privacy in general context, only 25% of respondents believe most companies handle their sensitive personal data responsibly. 88% of consumers report the extent of their willingness to share personal information is related on how much they trust a company, where 87% mention to take their business elsewhere if they don't trust a company handling their data responsibly. It also reported consumers trust companies less today than in the past, respectively 12 and 17%. People trust respectively hospitals, healthcare, non-profit organizations and government more than commercial companies.

More context specific PWC (2016) reports that overall consumers are more willing to trust health providers than consumer-product providers. Consumers are excited about the prospect of their doctor, hospital, and/or health insurance provider releasing their own wearables, more than any other industry.

A commercial research at the end of 2017 regarding privacy statements of seven big wearable developers resulted in developers often stating incomprehensible language, unclear purposes and unclear what data is being shared with other companies (Consumentenbond, 2018).

Appendix D) Market

Options/products

The most popular wrist-worn health devices, at the time of this study (half 2016), and mentioned wearables in the semi-structured interviews are analysed. This analysis can help in further stages of analysis of the report and to the readers to put it more in context and make it more valuable.
In total seven brands and 20 types of wearables are analysed of which Fitbit, Xiaomi, Apple, Garmin, Fossil, Pebble and Polar. The different types of wearables are a wristband, bracelet, sport watch and smartwatch.

As displayed in the figures below all, popular or mentioned wearables in the Netherlands, have the following options: steps, distance, syncing wireless via Bluetooth and data viewing on iOS. Furthermore all wearables has data viewing on Android except for Apples smartwatch S1. All wearables contain the options activity and sleep analysis except for the brand Fossil (smartwatches). The same goes for burned calories, but the only exception here is the brand Pebble (smartwatches).

All wearables have an open ecosystem (third party apps) except for Fitbit.

The majority of the wearables have the option of showing the callers id, the exceptions are basically the bracelets. The same goes for notifications from the smartphone, but not for the especially the more older and cheaper versions of Fitbit and Garmin.

Approximately half of the wearables have Pulse HR , smart alarm (sleeping) of which Fossil and Garmin excluded, music control of which the wristband/bracelets excluded, workouts.

Slightly more than half of the wearables is water resistant and slightly less than the half waterproof.

More than half of wearables, of which only the brands Fitbit, Garmin and Polar have the ability to data viewing on web/desktop.

Only half of the Fitbit wearables, the smartwatch of Apple and Garmin VIvosmart HR bracelet have the option ‘floors climbed’ embedded. Furthermore half of wearables got a reminder to move.

Barely any wearable has own GPS except for the Apple smartwatch s1, Fitbit Surge (smartwatch) and Polar m400 (sport watch).

Syncing wireless via WIFI is only included in the Apple smartwatch s1 and Fossil Qfounder Smartwatch. Whereas Data viewing via Windows only being possible for Fitbit and Polar.

Fitbit is the only brand which the wearables have the ability of logging food. Whereas Pebble being the only Brand having the ability to wireless call via Bluetooth. Apple is the only brand having a NFC chip (e.g. making it possible to pay wirelessly) and a smart coach. An additional HR monitor is possible for the POLAR m400 only.

The majority of the wearables have a battery lifespan of five to seven days. Where the Apple smartwatch S1 and Fossil Qfounder smartwatch have only a maximum of respectively 18 and 24 hours. Two out of the four Garmin bracelet models have a battery lifespan of up to- or more than one year.

None of the wearables have the ability to correct posture, automatic calorie intake, automatic hydration level, energy balance, nutrients intake (fat, carbs, protein), involuntary behaviour, stress level, sync manually, data viewing via blackberry, oxygen content and blood pressure.

More tailored to the two most popular wearables: Fitbit and Apple most used wearables: both have steps, distance, activity, burned calories sleep analysis, smart alarm and workouts as features. Where caller id, notifications and music control, pulse HR is only present in Fitbit latest models (basically the smartwatches) and Apple’s S1 smartwatch. Reminder to move: only latest Fitbit and Apple. Floors climbed is available in Apples s1 and randomly available throughout Fitbits wearables. GPS available in Apple but only in one wearable (smartwatch) of Fitbit. Smart coach is only available in Apples smartwatch.

When talking about medical equipment at home: Fitbit released a scale for at home in 2012 measuring weight, body fat and BMI connected via WI-FI (Bennet, 2012).

In addition, functions such as skin temperature and perspiration level, as mentioned by Shih et al. (2015) being available in wearables, have not been found in the most popular or used wearables by the respondents. This could be due to not specifically available (yet) in wrist-worn wearables at the time of research. Wearables more tailored to the medical side/purpose are having this opportunity already.

Limitations to the battery life is that these are the values mentioned by the developers themselves, which could be biased.

Side note: The semi-structured interviews resulted in two separate respondents mentioning using the option of oxygen content and blood pressure, but none of the wearables mentioned in the following graphs has one of these options.

Graphs with the analysis of the wearables

Brand	Model	Type	Released	Price at time of release ($)	Steps	Distance	Activity	Burned calories	Sleep analysis	Pulse HR	Swim	Floors climbed	Smart alarm	Foodlog	Caller ID	GPS tracking	Posture correction	Notifications	Music control	inKinsupport (social fitness app)
Fitbit	Flex	Wristband	2013	$100	✓	✓	✓	✓	✓	✗	✗	✗	✓	✓	✗	✗	✗	✗	✗	✓
Fitbit	Force	Wristband	2013	$129.99	✓	✓	✓	✓	✓	✗	✗	✓	✓	✓	✗	✗	✗	✗	✗	Unknown
Fitbit	Charge	Wristband	2014	$130	✓	✓	✓	✓	✓	✗	✗	✓	✓	✓	✓	✗	✗	✗	✗	✓
Fitbit	Charge HR	Wristband	2015	$150,	✓	✓	✓	✓	✓	✓	✗	✓	✓	✓	✓	✗	✗	✓	✗	Unknown
Fitbit	Surge	Smart watch	2015	$250.	✓	✓	✓	✓	✓	✓	✗	✓	✓	✓	✓	✓	✗	✓	✓	✓
Fitbit	Blaze	Smart watch	jan-16	$199	✓	✓	✓	✓	✓	✓	✗	✗	✓	✓	✓	✗	✗	✓	✓	✓
Fitbit	Alta	Wristband	feb-16	$149.95	✓	✓	✓	✓	✓	✗	✗	✗	✓	✗	✓	✗	✗	✓	✗	✓
Xiaomi	Miband	Bracelet	jul-14	$15	✓	✓	✓	✓	✓	✗	✗	✗	✓	✗	✗	✗	✗	✓	✗	✓
Apple	s1	Smartwatch	apr-15	$349 to $1,099 (different types)	✓	✓	✓	✓	✓	✓	✗	✓	✓	✗	✓	✓	✗	✓	✓	✓
Garmin	Vivofit1	Bracelet	2014	$99	✓	✓	✓	✓	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓
Garmin	Vivofit 2	Bracelet	2015	$130	✓	✓	✓	✓	✓	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✓
Garmin	Vivosmart	Bracelet	2014	$219	✓	✓	✓	✓	✓	✓	✓	✗	✗	✗	✓	✗	✗	✓	✓	✓
Garmin	Vivosmart HR	Bracelet	2015	$219.99	✓	✓	✓	✓	✓	✓	✗	✓	✗	✗	✓	✗	✗	✓	✓	✓
Fossil	Qfounder	Smartwatch	2015	$275	✓	✓	✗	✓	✗	✗	✗	✗	✓	✗	✓	✗	✗	✓	✓	✗
Fossil	Qreveler	Smartwatch	2015	$125	✓	✓	✗	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓	✗	✗
Fossil	Qdreamer	Smartwatch	2015	$125	✓	✓	✗	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓	✗	✗
Pebble	Pebble steel	Smartwatch	2014	$249	✓	✓	✓	✗	✓	✗	✗	✗	✓	✗	✓	✗	✗	✓	✓	✗
Pebble	Pebble time	Smartwatch	2015	$149	✓	✓	✓	✗	✓	✗	✗	✗	✓	✗	✓	✗	✗	✓	✓	✗
Pebble	Time steel	Smartwatch	2015	$249	✓	✓	✓	✗	✓	✗	✗	✗	✓	✗	✓	✗	✗	✓	✓	✗
Polar	Polar m400	Sportwatch	2014	$179	✓	✓	✓	✓	✓	✓	✗	✗	✓	✗	✓	✓	✗	✓	✗	✓

Figure 15: Table 1 features wearables

Brand	Model	Type	Released	Idle alert (reminder to move)	Workouts	Bluetooth wireless call	NFC	Waterproof	Water resistant	Smart coach	Additional HR monitor	Automatic calorie intake	Automatic hydration level	Energy balance	Nutrients intake (fat, carbs, protein)	Involuntary behavior	Stress level	Sync wireless wifi
Fitbit	Flex	Wristband	2013	✗	✓	✗	✗	✗	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗
Fitbit	Force	Wristband	2013	Unknown	✓	✗	✗	✗	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗
Fitbit	Charge	Wristband	2014	✗	✓	✗	✗	✗	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗
Fitbit	Charge HR	Wristband	2015	Unknown	✓	✗	✗	✗	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗
Fitbit	Surge	Smart watch	2015	✗	✓	✗	✗	✗	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗
Fitbit	Blaze	Smart watch	jan-16	✗	✓	✗	✗	✗	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗
Fitbit	Alta	Wristband	feb-16	✓	✓	✗	✗	✗	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗
Xiaomi	Miband	Bracelet	jul-14	✓	✗	✗	✗	✗	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗
Apple	s1	Smartwatch	apr-15	✓	✓	✗	✓	✗	✓	✓	✗	✗	✗	✗	✗	✗	✗	✓
Garmin	Vivofit1	Bracelet	2014	✓	✗	✗	✗	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗
Garmin	Vivofit 2	Bracelet	2015	✓	✗	✗	✗	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗
Garmin	Vivosmart	Bracelet	2014	✓	✓	✗	✗	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗
Garmin	Vivosmart HR	Bracelet	2015	✓	✗	✗	✗	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗
Fossil	Qfounder	Smartwatch	2015	✗	✗	✗	✗	✗	✓	✗	✗	✗	✗	✗	✗	✗	✗	✓
Fossil	Qreveler	Smartwatch	2015	✗	✗	✗	✗	✗	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗
Fossil	Qdreamer	Smartwatch	2015	✗	✗	✗	✗	✗	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗
Pebble	Pebble steel	Smartwatch	2014	✗	✗	✓	✗	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗
Pebble	Pebble time	Smartwatch	2015	✗	✗	✓	✗	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗
[illegible]	Time steel	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Figure 14: Table 2 features wearables

Brand	Model	Type	Released	Sync manual	Dataviewing: web/desktop	Dataviewing: iOs	Dataviewing: Android	Dataviewing: blackberry	Dataviewing: Windows	Battery life	Ecosystem	Oxygen content	Bloodpressure	Body temperature	Perspiration
Fitbit	Flex	Wristband	2013	×	✓	✓	✓	×	✓	5 days	Closed	×	×	×	×
Fitbit	Force	Wristband	2013	×	✓	✓	✓	×	✓	7-10 days	Closed	×	×	×	×
Fitbit	Charge	Wristband	2014	×	✓	✓	✓	×	✓	7-10 days	Closed	×	×	×	×
Fitbit	Charge HR	Wristband	2015	×	✓	✓	✓	×	✓	5 days	Closed	×	×	×	×
Fitbit	Surge	Smart watch	2015	×	✓	✓	✓	×	✓	7 days	Closed	×	×	×	×
Fitbit	Blaze	Smart watch	jan-16	×	✓	✓	✓	×	✓	5 days	Closed	×	×	×	×
Fitbit	Alta	Wristband	feb-16	×	✓	✓	✓	×	✓	5 days	Closed	×	×	×	×
Xiaomi	Miband	Bracelet	jul-14	×	×	✓	✓	×	×	30 days	Open	×	×	×	×
Apple	s1	Smartwatch	apr-15	×	×	✓	×	×	×	18 hours	Open	×	×	×	×
Garmin	Vivofit1	Bracelet	2014	×	✓	✓	✓	×	×	Up to 1 year	Open	×	×	×	×
Garmin	Vivofit 2	Bracelet	2015	×	✓	✓	✓	×	×	More than 1 year	Open	×	×	×	×
Garmin	Vivosmart	Bracelet	2014	×	✓	✓	✓	×	×	Up to 7 days	Open	×	×	×	×
Garmin	Vivosmart HR	Bracelet	2015	×	✓	✓	✓	×	×	Up to 5 days	Open	×	×	×	×
Fossil	Qfounder	Smartwatch	2015	×	×	✓	✓	×	×	Up to 24 hours	Open	×	×	×	×
Fossil	Qreveler	Smartwatch	2015	×	×	✓	✓	×	×	7 days	Open	×	×	×	×
Fossil	Qdreamer	Smartwatch	2015	×	×	✓	✓	×	×	7 days	Open	×	×	×	×
Pebble	Pebble steel	Smartwatch	2014	×	×	✓	✓	×	×	Up to 7 days	Open	×	×	×	×
Pebble	Pebble time	Smartwatch	2015	×	×	✓	✓	×	×	Up to 7 days	Open	×	×	×	×
Pebble	Time steel	Smartwatch	2015	×	×	✓	✓	×	×	Up to 10 days	Open	×	×	×	×
Polar	Polar m400	Sportwatch	2014	×	✓	✓	✓	×	✓	up to 30 days	Open	×	×	×	×

Figure 16: Table 3 features wearables

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Figure 17: Apple watch

Figure 18: Fitbit charge HR

Figure 19: Fitbit surge

Figure 20: Miband (Xiaomi

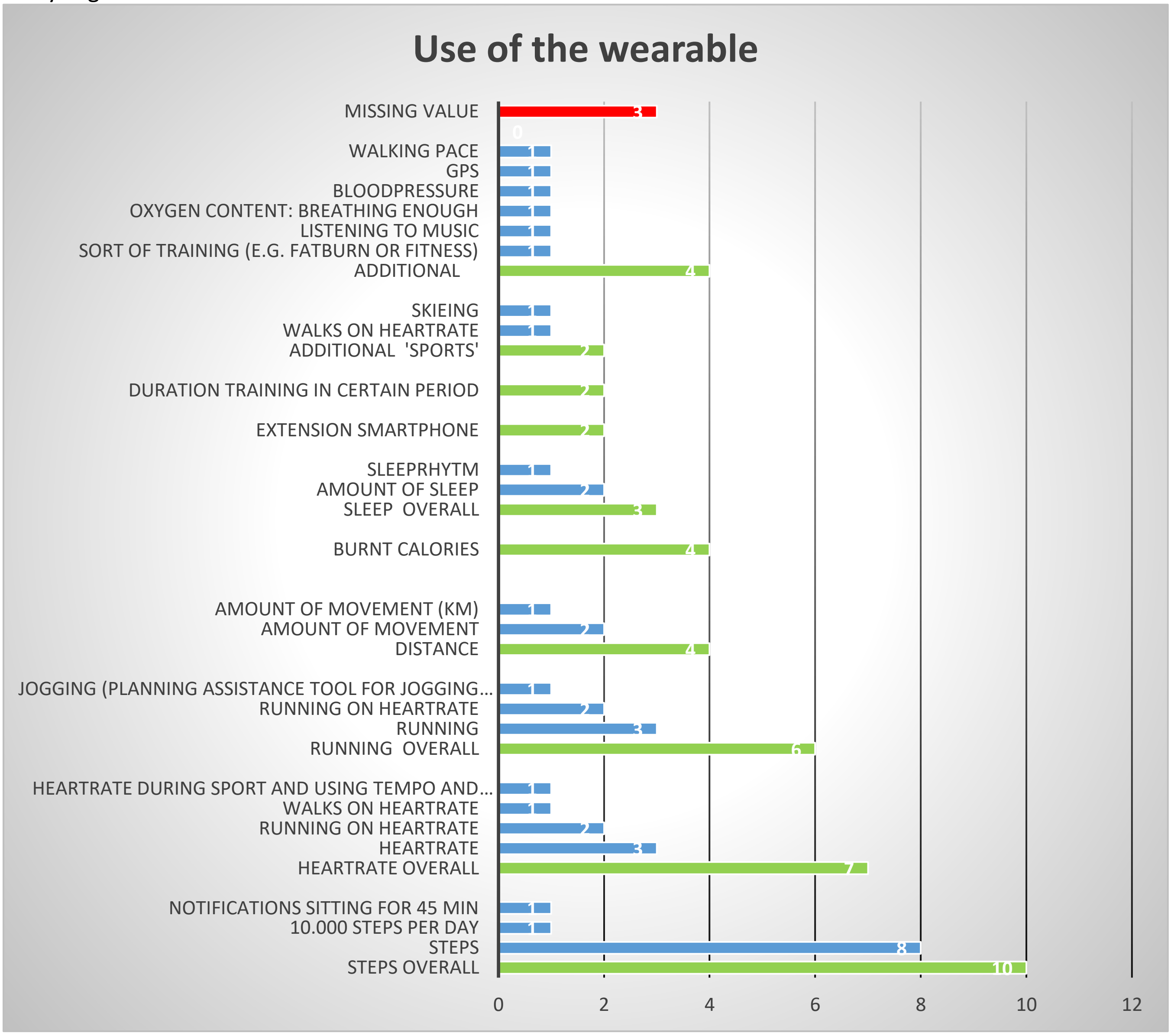
Figure 21: Garmin Vivofit

Figure 22: Garmin Vivofit

Appendix E) Results semi-structured interviews

The use

The use of the wearables are displayed in the graph below. What stands out is the use of the step counter and heartrate function. Where the heartrate function being used by 4 out 7 respondents for sport/movement. Whereas running as being the most mentioned sport. Sleep analysis being mentioned by 3 respondents, of which 2 the amount of sleep and 1 the rhythm. As mentioned earlier the results should be analysed with caution, for example the use as extension of the smartphone/notifications could be higher than displayed due to the set-up of the semi-structured interviews. One respond mentions using oxygen content (breaking enough) as function where another respondent mentions using blood pressure. These two functions are not found when analysing the wearables.



Crucial factors

Finally, in short terms: What do you think the crucial factors are to use a WEARABLE or not?