The Adoption and Diffusion of Wearables

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Abstract. Although the sales of wearables are increasing in the last few years, it is still unknown how wearables are actually adopted and being used in everyday life by consumers. In this study, we try to identify the adoption and diffusion patterns of wearables by performing a sentiment analysis on 97 semi-structured interviews with wearables owners/users focused on relevance and requirements of and resources and resistance related to wearables. Based on this analysis we conclude that developers and manufacturers of wearables should make their devices more relevant, more reliable and easier to use. They should also address privacy issues and foster habit (using it all and every day) in order to speed up the adoption and diffusion of wearables. The theoretical contribution of this paper is that habit should be studied as a potential dependent variable for intention to use.

Keywords: Wearables · Adoption of IT · Diffusion

1 Introduction

In recent years, commercial technologies have been developed for automatically collecting data that can assist in self-regulation. The usage of wearable self-tracking technology has recently emerged as a new trend in lifestyle and personal optimization in terms of health, fitness and well-being. The proliferation of wearable technologies calls for the development of conceptual lenses to understand the drivers of their success (Benbusan 2018). We define wearables as *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 are rising. In the last quarter of 2016, 23 million wearables were sold worldwide and it is expected that this number will 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

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wrist-worn wearables. 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. Our related research question is defined as follows: *How to improve the diffusion, in personal use, of wrist-worn wearables?*

2 Background

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 and 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 and 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 and 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 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).

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 (Ismagilova et al. 2019). 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).

3 Research Method

Myers and Newman (2007) mention that "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 and Newman 2007). This was also the case in this research.

97 semi-structured interviews with wearable users/owners are used. These interviews are based on the USE IT method (Landeweerd et al. 2013). 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. There has been a drilldown process to make the group more homogenous. Eventually 20 interviews are analysed, where some characteristics pop up such as the majority being high educated, experience with technology and ICT and voluntarily adopted.

The qualitative data is 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.

For the structured literature study Wolfswinkel et al. (2015) was used and the main papers and key terms used can be found in Table 1. The content is shown in the section adoption of wearables.

Table 1. Results structured literature review

Wearables AND adoption	Rauschnabel, Brem and Ivens (2015) Chuah, Rauschnabel, Krey, Nguyen, Ramayah and Lade (2016) Spil, Sunyaev, Thiebes and Van Baalen (2017)
Continued use AND wearables	Canhoto and Arp (2017) Buchwald, Letner, Urbach and von Entress-Fuersteneck (2015) Nascimento, Oliveira and Tam (2018)
Sustained use AND health and fitness wearables	Kalantari (2017) Coorevits and Coenen (2016) Lupton (2018)
Health information AND privacy	Smith, Dinev and Xu (2011) Motti and Caine (2015) Lee, Lee, Egelman and Wagner (2016)

4 Adoption of Wearables, Privacy and Habit

First we present adoption literature to create a foundation for the interview model based on classic adoption literature followed by specific wearable adoption issues from literature and new notions on adoption.

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 (Landeweerd et al. 2013). 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 and Bala 2008) and "comparative advantage" (relative advantage) of the diffusion of innovations (Kapoor et al. 2014a, b; Rogers 1995). 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.

Requirements is defined as the degree to which the quality of the product fulfils the requirements of the user (Dwivedi et al. 2017). 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 and McLean, 2003; Dwivedi et al. 2011) and usability (ease of use) from the Technology Acceptance Model (Davis 1989; Venkatesh and Bala 2008). 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 and Arp 2017; Coorevits and Coenen 2016; Epstein 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.

Resources (resources) is defined as the degree to which immaterial and material resources are accessible for the design, operation and maintenance of the system. 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 (Kapoor et al. 2017a, b; 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.

Finally resistance questions are asked related to the attitude (Dwivedi et al. 2017a, b; Rana et al. 2016; 2017) of the interviewees toward IT in general and wearables specifically. 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 (Tamilmani et al. 2018) 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 (Fig. 1).

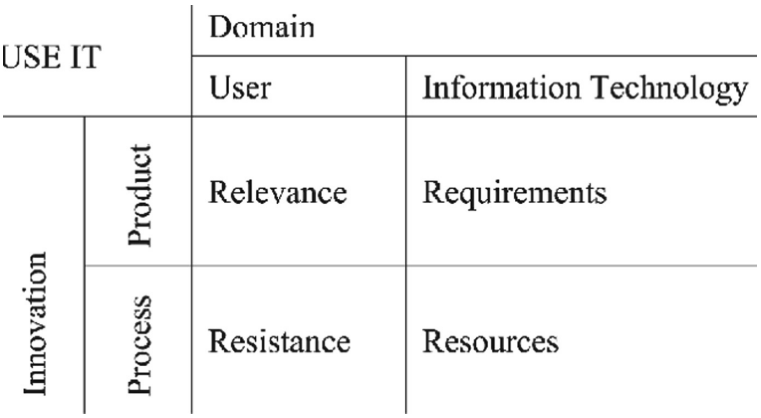

Fig. 1. USE IT model for technology innovations (interview model)

Coorevits and Coenen (2016) 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, saying: "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. 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 wearable's dashboard. They mention it might be possible that consumers "have inflated expectations about the ability of wearables to change nutritional habits.

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. Kalantari (2017) mention in a literature review of wearables that "experience with technology is a key parameter in consumers' adoption" (p. 301). Kari et al. (2016) found in the context of self-tracking technology in critical experiences that either promote or hinder the adoption or lead to rejection during the implementation that previous experience on self-tracking technologies influenced the performance expectancy toward new technologies. On the other, more 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 (Venkatesh et al. 2012).

Limayem et al. (2007) refers habit as "the extent to which people tend to perform behaviors (use IS) automatically because of learning" (p. 705). 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. 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. Wearables have specific characteristics; due to novelty of a technology habit could be an important factor in technology acceptance (Polites and 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 it habitual integrating OFC use into their everyday workout routines. However, this often fails for a longer period of time. Stragier 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.

Nascimento (2018) finds that habit was the most important feature to explain the continuance intention. Coorevits and Coenen (2016) finds, 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 mentions, within another constructs, 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.

Kari et al. (2016) in a research the critical experiences that either promote or hinder the adoption or lead to rejection during the implementation phase in the context of self-tracking technologies, with thematic analysis of ten semi-structured interviews, mention "Effort expectancy, facilitating conditions, and habit were all based on same expectations: easy to use, easy to learn, effortless, simple, and clear functions. These were seen as essential, so that the use is easy enough (effort expectancy) and the functions support the use (facilitating conditions), and should these expectations realize, they advance the formation of habit".

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 in the context of cycling people find 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.

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 become so 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 to estimate their steps or calories for the day themselves and made the wearables obsolete.

5 Results

This section describes the objective data as given by the interviewees, in the next section we give a sentimental analysis and compare to literature.

5.1 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

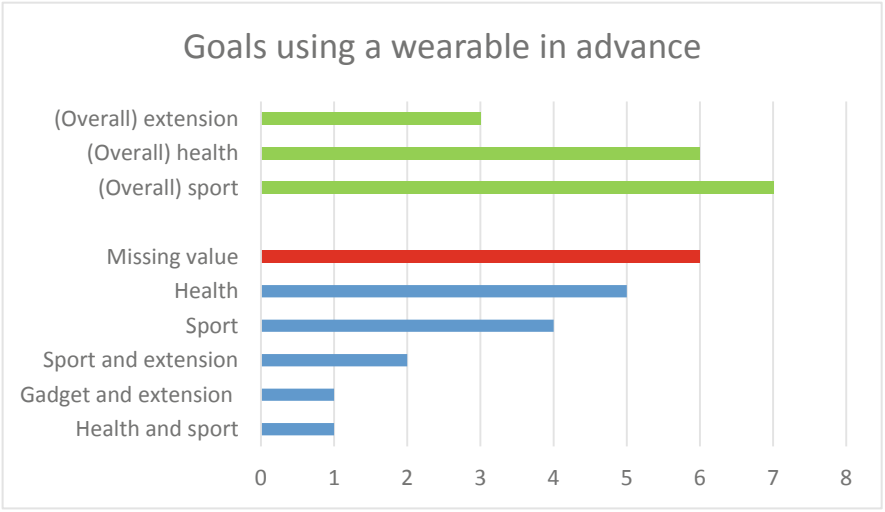

Fig. 2. Goals using a wearable in advance

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 (Fig. 2).

5.2 Type of Wearable

Half of the interviewees got a smartwatch of which the brand 'Apple' the most mentioned. Twenty five percent got some sort of bracelet. Other wearables that are mentioned are pedometers, sportwatch, pebble and fitbit.

5.3 The Use of Wearables

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 (Fig. 3).

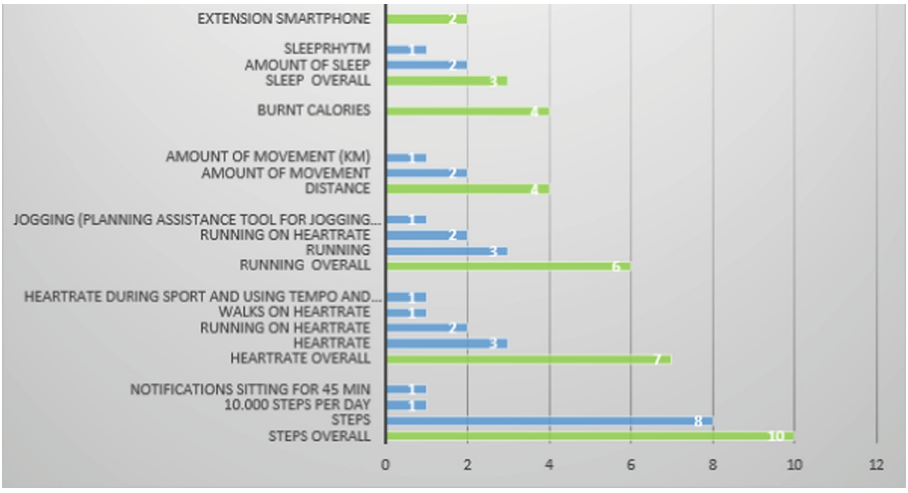

Fig. 3. The use of the wearable

5.4 Which Functions Beyond Current Possibilities

Twenty five percent of the interviewees 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.

5.5 Crucial Factors for Whether or not to Use a Wearable

When asked what the crucial factors are to use a wearable twenty five percent of the interviewees answer the additional value and ease of use (or user friendly). Twenty percent of the interviewees mentions personal interest and reliable data. Fifteen percent mentions battery lifespan and ten percent mention health, communication, behaviour change and stand-alone device (Fig. 4).

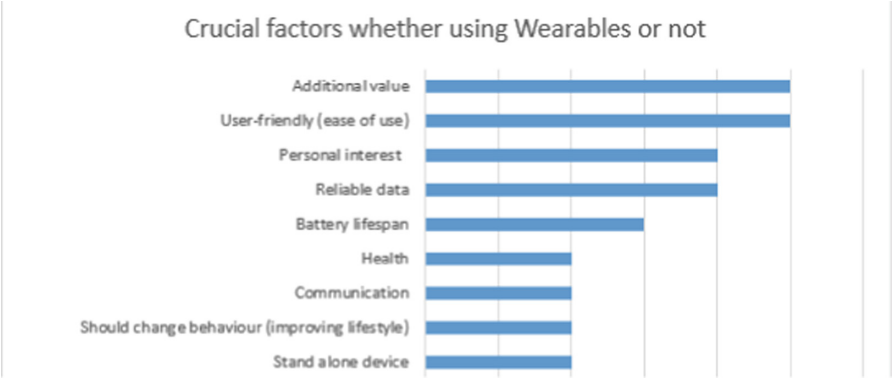

Fig. 4. Crucial factors whether using wearables or not

6 Analysis

An adoption analysis (Huberman and Miles 1994) was conducted as elaborated in the method section. We use the perspective from Kalantari (2017) because they generated a recent and relevant literature study.

6.1 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 and Arp 2017; 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.

6.2 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. 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 and Arp, 2017; Kari et al. 2016; Nascimento et al. 2018).

6.3 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 and 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.

6.4 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.

6.5 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.

6.6 Habit

Due to novelty of a technology, habit could be an important factor in technology acceptance (Polites and Karahanna 2012; Tamilmani et al. 2018). 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; Stragier 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.

7 Conclusions

Wearables diffusion is hindered by lack of relevance or relative advantage to the users. Different options such as blood pressure and body temperature measurements could be added in the future to have more relevance, although this could have a negative influence on privacy mentioned later on.

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

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 reliably and accurate since users do often not have the knowledge, time, or will for troubleshooting.

Overall people are neutral to positive (sentiment) to sharing information for diagnosis 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.

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 important. What stands out is the users of more simple models do not develop a habit of using it all day and every day.

References

Barcena, M.B., Wueest, C., Lau, H.: How safe is your quantified self. Symantech, Mountain View, CA, USA (2014)

Benbunan-Fich, R.: An affordance lens for wearable information systems. Eur. J. Inf. Syst. 1–16 (2018)

Buchwald, A., Urbach, N., von Entreß-Fürsteneck, M.: Insights into personal ICT use: understanding continuance and discontinuance of wearable self-tracking devices (2018)

Canhoto, A.I., Arp, S.: Exploring the factors that support adoption and sustained use of health and fitness wearables. J. Mark. Manag. **33**(1–2), 32–60 (2017). https://doi.org/10.1080/0267257X.2016.1234505

Chuah, S.H.W., Rauschnabel, P.A., Krey, N., Nguyen, B., Ramayah, T., Lade, S.: Wearable technologies: the role of usefulness and visibility in smartwatch adoption. Comput. Hum. Behav. **65**, 276–284 (2016)

Coorevits, L., Coenen, T.: The rise and fall of wearable fitness trackers. In: Academy of Management (2016)

Davis, F.D., Bagozzi, R.P., Warshaw, P.R.: User acceptance of computer technology: a comparison of two theoretical models. Manag. Sci. **35**(8), 982–1003 (1989)

Delone, W.H., McLean, E.R.: The DeLone and McLean model of information systems success: a ten-year update. J. Manag. Inf. Syst. **19**(4), 9–30 (2003)

Dwivedi, Y.K., Wade, M.R., Schneberger, S.L. (eds.): Information Systems Theory: Explaining and Predicting Our Digital Society, vol. 1. Springer, Heidelberg (2011). https://doi.org/10.1007/978-1-4419-6108-2

Dwivedi, Y.K., et al.: Research on information systems failures and successes: status update and future directions. Inf. Syst. Front. **17**(1), 143–157 (2015)

Dwivedi, Y.K., Rana, N.P., Janssen, M., Lal, B., Williams, M.D., Clement, M.: An empirical validation of a unified model of electronic government adoption (UMEGA). Govern. Inf. Q. **34**(2), 211–230 (2017a)

Dwivedi, Y.K., Rana, N.P., Jeyaraj, A., Clement, M., Williams, M.D.: Re-examining the unified theory of acceptance and use of technology (UTAUT): towards a revised theoretical model. Inf. Syst. Front. 1–16 (2017b). https://doi.org/10.1007/s10796-017-9774-y

Endeavour Partners: Inside wearables - part 2, July 2014. https://digitalwellbeing.org/wp-content/uploads/2015/11/2014-Inside-Wearables-Part-2-July-2014.pdf. Accessed 5 July 2018

Epstein, D.A., Caraway, M., Johnston, C., Ping, A., Fogarty, J., Munson, S.A.: Beyond abandonment to next steps: understanding and designing for life after personal informatics tool use. In: Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems, pp. 1109–1113. ACM, May 2016

Fors, V., Pink, S.: Pedagogy as possibility: health interventions as digital openness (2017). http://www.mdpi.com/2076-0760/6/2/59/htm. Accessed 25 June 2018

Fritz, T., Huang, E.M., Murphy, G.C., Zimmermann, T.: Persuasive technology in the real world: a study of long-term use of activity sensing devices for fitness. In: Proceedings of the SIGCHI Conference on Human Factors in Computing Systems, pp. 487–496. ACM, April 2014

Huberman, A.M., Miles, M.B.: Data management and analysis methods (1994)

Hutchison, E.D.: Essentials of Human Behavior: Integrating Person, Environment, and the Life Course. Sage Publications, London (2016)

Ismagilova, E., Hughes, L., Dwivedi, Y.K., Raman, K.R.: Smart cities: advances in research—an information systems perspective. Int. J. Inf. Manag. **47**, 88–100 (2019)

Kalantari, M.: Consumers' adoption of wearable technologies: literature review, synthesis, and future research agenda. Int. J. Technol. Mark. **12**(3), 274–307 (2017)

Kapoor, K.K., Dwivedi, Y.K., Williams, M.D.: Rogers' innovation adoption attributes: a systematic review and synthesis of existing research. Inf. Syst. Manag. **31**(1), 74–91 (2014a)

Kapoor, K.K., Dwivedi, Y.K., Williams, M.D.: Innovation adoption attributes: a review and synthesis of research findings. Eur. J. Innov. Manag. **17**(3), 327–348 (2014b)

Kari, T., Koivunen, S., Frank, L., Makkonen, M., Moilanen, P.: Critical experiences during the implementation of a self-tracking technology. In: PACIS 2016: Proceedings of the 20th Pacific Asia Conference on Information Systems, ISBN 9789860491029. Association for Information Systems (2016)

Kenny, G., Connolly, R.: Drivers of health information privacy concern: a comparison study (2016)

Kovach, S.: Wearables are dead, 11 December 2016. https://www.businessinsider.nl/wearables-are-dead-2016-12/?international=true&r=US. Accessed 4 Feb 2018

Landeweerd, M., Spil, T., Klein, R.: The success of Google search, the failure of Google health and the future of Google plus. In: Dwivedi, Y.K., Henriksen, H.Z., Wastell, D., De', R. (eds.) TDIT 2013. IAICT, vol. 402, pp. 221–239. Springer, Heidelberg (2013). https://doi.org/10.1007/978-3-642-38862-0_14

Ledger, D.: Inside wearables - Part 2, July 2014. https://digitalwellbeing.org/wp-content/uploads/2015/11/2014-Inside-Wearables-Part-2-July-2014.pdf. Accessed 4 Feb 2018

Lee, L., Lee, J., Egelman, S., Wagner, D.: Information disclosure concerns in the age of wearable computing. In: NDSS Workshop on Usable Security (USEC), vol. 1 (2016)

Limayem, M., Hirt, S.G., Cheung, C.M.: How habit limits the predictive power of intention: the case of information systems continuance. MIS Q. **31**, 705–737 (2007)

Lupton, D., Pink, S., Heyes LaBond, C., Sumartojo, S.: Personal data contexts, data sense, and self-tracking cycling. Int. J. Commun. **12**, 647–666 (2018)

Maher, C., Ryan, J., Ambrosi, C., Edney, S.: Users' experiences of wearable activity trackers: a cross-sectional study. BMC Public Health **17**(1), 880 (2017)

Motti, V.G., Caine, K.: Users' privacy concerns about wearables. In: Brenner, M., Christin, N., Johnson, B., Rohloff, K. (eds.) FC 2015. LNCS, vol. 8976, pp. 231–244. Springer, Heidelberg (2015). https://doi.org/10.1007/978-3-662-48051-9_17

Myers, M.D., Newman, M.: The qualitative interview in IS research: examining the craft. Inf. Organ. **17**(1), 2–26 (2007)

Nascimento, B., Oliveira, T., Tam, C.: Wearable technology: what explains continuance intention in smartwatches? J. Retail. Consum. Serv. **43**, 157–169 (2018)

Prasopoulou, E.: A half-moon on my skin: a memoir on life with an activity tracker. Eur. J. Inf. Syst. **26**(3), 287–297 (2017)

Pfeiffer, J., von Entress-Fuersteneck, M., Urbach, N., Buchwald, A.: Quantify-me: consumer acceptance of wearable self-tracking devices. In: ECIS, p. ResearchPaper99, June 2016

Polites, G.L., Karahanna, E.: Shackled to the status quo: the inhibiting effects of incumbent system habit, switching costs, and inertia on new system acceptance. MIS Q. **36**, 21–42 (2012)

Porter, E., Heppelmann, E.: How smart, connected products are transforming competition, 17 March 2017. https://hbr.org/2014/11/how-smart-connected-products-are-transforming-competition. Accessed 5 Feb 2018

Rana, N.P., Dwivedi, Y.K., Lal, B., Williams, M.D., Clement, M.: Citizens' adoption of an electronic government system: towards a unified view. Inf. Syst. Front. **19**(3), 549–568 (2017)

Rana, N.P., Dwivedi, Y.K., Williams, M.D., Weerakkody, V.: Adoption of online public grievance redressal system in India: toward developing a unified view. Comput. Hum. Behav. **59**, 265–282 (2016)

Rauschnabel, P.A., Brem, A., Ivens, B.S.: 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. Comput. Hum. Behav. **49**, 635–647 (2015)

Rogers, E.M.: Lessons for guidelines from the diffusion of innovations. Joint Comm. J. Qual. Patient Saf. **21**(7), 324–328 (1995)

Salah, H., MacIntosh, E., Rajakulendran, N.: Wearable tech: leveraging Canadian innovation to improve health. MaRS Discovery District, March 2014. https://www.marsdd.com/wp-content/uploads/2015/02/MaRSReport-WearableTech.pdf. Accessed 5 Feb 2018

Shih, P.C., Han, K., Poole, E.S., Rosson, M.B., Carroll, J.M.: Use and adoption challenges of wearable activity trackers. In: IConference 2015 Proceedings (2015)

Smith, H.J., Dinev, T., Xu, H.: Information privacy research: an interdisciplinary review. MIS Q. **35**(4), 989–1016 (2011)

Spil, T., Sunyaev, A., Thiebes, S., Van Baalen, R.: The adoption of wearables for a healthy lifestyle: can gamification help? (2017)

Stragier, J.: Physical activity in the digital age: an empirical investigation into the motivational affordances of online fitness communities. Doctoral dissertation, Ghent University (2017). https://doi.org/10.13140/rg.2.2.25036.21124/1

Tamilmani, K., Rana, N.P., Dwivedi, Y.K.: Use of 'Habit' is not a habit in understanding individual technology adoption: a review of UTAUT2 based empirical studies. In: Elbanna, A., Dwivedi, Y.K., Bunker, D., Wastell, D. (eds.) TDIT 2018. IAICT, vol. 533, pp. 277–294. Springer, Cham (2019). https://doi.org/10.1007/978-3-030-04315-5_19

Venkatesh, V., Bala, H.: Technology acceptance model 3 and a research agenda on interventions. Decis. Sci. **39**(2), 273–315 (2008)

Venkatesh, V., Thong, J.Y., Xu, X.: Consumer acceptance and use of information technology: extending the unified theory of acceptance and use of technology. MIS Q. **36**, 157–178 (2012)

Vliet, M.: Bezit wearables gestegen, maar nog verre van mainstream, 11 January 2017. https://www.telecompaper.com/achtergrond/bezit-wearables-gestegen-maar-nog-verre-van-mainstream–1179136. Accessed 17 Feb 2017

Wolfswinkel, J.F., Furtmueller, E., Wilderom, C.P.: Using grounded theory as a method for rigorously reviewing literature. Eur. J. Inf. Syst. **22**(1), 45–55 (2013)

Jang Yul, K.: Determinants of users intention to adopt mobile fitness applications: an extended technology acceptance model approach (2014)