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**USER EXPERIENCES OF
WEARABLE SELF-MEASUREMENT
DEVICES IN SOCIAL MEDIA**

MASTER OF WELFARE TECHNOLOGY

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<p>User Experiences of Wearable Self-Measurement Devices in Social Media</p>		
<p>Master of Welfare Technology</p>		
<p>Purpose of this study was to find out reasons, experiences and development ideas regarding wearable devices from social media.</p> <p>Data was collected entirely from social media platforms; Facebook, YouTube, Instagram, Reddit, Twitter, public blog postings and online marketplaces such as Amazon.com and Ebay.com.</p> <p>Data was analyzed by qualitative methods and presented as citations in result chapter.</p> <p>While purchasing devices people tend to value functions over usability, users wanted device often for specific purpose, such as fitness tracking, goal-oriented training, sleep tracking or as regular watch. Health related reasons such as improving physical condition were key reasons to purchase devices. Users valued functions like pedometer, sleep tracking abilities, touchscreen, battery longevity, GPS, HRM and daily analytics important factors depending reason to purchase.</p> <p>Users experienced working devices, social features and success stories, such as weight loss or possibility to improve one's sleep as positive experiences.</p> <p>As users purchase devices based on commercials and information from various sources as social media, people are expecting devices to fulfill their marketing speeches. Therefore, people had negative experiences when device lacked battery life, durability or caused allergic reaction for example.</p> <p>For development ideas users wanted more automation with smart homes, smart speakers and ability to record data without accessing applications. Also, ability to use device regardless of phone operating system and universal application were both wished development ideas.</p>		
<p>Keywords: social-media, self-measurement device, wearable devices, self-tracking</p>		

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REFERENCE

1 INTRODUCTION

Global trend has proven that physical inactivity has been identified as the fourth leading risk factor for global mortality. Physical inactivity has many side-effects, including high blood pressure, tobacco use, high blood glucose, but it also increases risk for overweight and obesity (WHO 2010, 10-14). Physical inactivity also increases risk of chronic diseases, the body rapidly maladapt to insufficient physical activity, and if continued, results in substantial decreases in both total and quality years of life. There is also fact that physical activity primarily prevents, or delays, chronic diseases, implying that chronic disease need not be an inevitable outcome during life (Booth, Roberts & Laye, 2012). Nowadays self-measuring devices are also capable to track multiple functions in addition to physical activity, pulse. In addition, they can follow your daily routines, sleep quality, how many steps you have been taken daily or weekly and recommend amount of rest required after workout (Polar Vantage V [www-pages](#), 2019).

Poor sleep quality and insufficient sleep quantity have also been linked to obesity due to link of neuroendocrine dysfunction, which increases risk of obesity, stress, cardiovascular diseases and mood disorders. According to the WHO there are over 1.9 billion obese adults worldwide nowadays. There are estimates that nearly 2.8 million people die yearly in consequence of obesity (Piegel, Tasali, Leproult & Van Caeter, 2009).

Meanwhile Nielsen statistics shows that nearly one-third of U.S. smartphone owners, about 46 million unique users—accessed apps in the fitness and health category in January 2014, an 18 percent increase in users compared with the same month a year earlier. Women are biggest growing user group in fitness and health apps, as 60% of women ages 30-39 use smartphone apps, compared to overall usage of fitness and health apps (44%). Wearable devices are equally likely owned in both genders, yet women used smartphone apps nearly twice as often as men per month – accessing the app nearly every day (Nielsen Connected Life Report, [www-pages](#), 2014).

As the ultimate objective this study tends to find out previously mentioned motivations for purchasing new devices, and how people have experienced their use. Using social media as source is natural, because technology is becoming natural part of general population's daily culture and everyday life (Saldana, 2011). There are over 16 000 self-tracking apps available for downloading to smartphones. Smartphones and smartwatches themselves have built-in sensors such as GPS, gyroscopes, accelerometers and hearth rate monitors that can be employed for self-tracking. Some high-end smartphones and smartwatches do include also even more sophisticated biometric monitoring sensors (Lupton, 2016). In addition to traditional smartphones and smartwatches there are other self-measuring devices such as rings that includes various sensors such as body temperature, measuring blood volume trough palmar arteries, accelerometer and gyroscope (ÖURA www-pages, 2020).

Outcomes of this research could be applied to future research of new innovations applied to trackers, but also to see why people are using these devices – this could prove useful to companies manufacturing such devices.

2 PURPOSE OF STUDY AND CONCEPTUAL FRAMEWORK

2.1 Purpose of the study

In Finland UKK national guidelines for activity suggest that each adult (18-65) should do 2,5 hours moderate aerobic physical activity and 75 minutes vigorous aerobic physical activity per week. In addition, muscle-strengthening and balance trainings are supposed to be trained at least twice per week. (UKK-instituutti, 2009) The latest addition to guidelines states fact, that physical activity does not need to last at least 10 minutes, but instead it is more important to do light physical activity as often as possible. (UKK-instituutti, 2019)

WHO also states that levels of physical inactivity are increasing in many countries with major implications for the general health of people worldwide. Both men and

women who reported increased levels of physical activity and fitness were found to have reductions in relative risk (by about 20%–35%) of death, and even greater reduction in case of cardiovascular diseases (Warburton, Nicol & Bredin, 2006). WHO estimate states that physical inactivity is being principal cause for various types of health issues, such as breast and colon cancer burden (~21-25%), diabetes (27%) and approximately 30% of ischemic heart disease burden. Also, non-communicable diseases account nowadays for nearly half of the overall global burden of disease. WHO also estimates that of every 10 deaths, 6 are attributable to noncommunicable conditions. (WHO, 2010).

Godino, Watkinson, Gorder, Sutton, Griffin & Sluijs (2014) studied how aware people are about their personal physical activity. Results showed that 57% of the participants were physically inactive, but 50,4% of inactive participants incorrectly perceived that they were achieving recommended levels of physical activity. Because of that fact there is clearly a need to develop new cost-effective health behavior interventions to increase physical activity at the population level, because physical inactivity does have many health-related consequences. For example, pedometer- and/or web-based interventions have shown that providing participants with feedback on physical activity performance and asking them to record their steps can increase motivation and physical activity levels (Wang, Cataldo, Ayala, Natarajan, Cadmus-Bertram, White, Madanat, Nichols & Pierce, 2016). In addition, there have been research conducted by Advancements in technology provide also more opportunities to facilitate users to build self-regulatory skills including self-monitoring of physical activity (Wang, et al. 2016)

Using possible mobile health information and wearable technologies have potential to reduce the cost of health care and reduce risk of chronic diseases. These technologies and innovations can support continuous health monitoring and encourage healthy behaviors to prevent or reduce health problems (Kumar, Nilsen, Abernethy, Patrick, Pavel, Riley, Shar, Spring, Spruijt-Metz & Hedeker, 2013). Both aerobic and muscular exercise have been shown to be associated with decreased risk of type 2 diabetes. In large prospective study, each increase of 500 kCal in energy expenditure per week was associated with decreased risk of type 2 diabetes (Warburton, Nicol & Bredin, 2006).

In this study, wearable devices are limited to different activity trackers, also called as fitness trackers and heart rate monitors / sport watches targeted to end consumers. The Internet's social capabilities and possibility to share a picture or opinion for example and it becomes quickly popular, have created a completely new forum for consumers. Internet communities, blogs and social networks have become a part of life for most Americans, but also in other countries (Internet World Stats, 2019). This proliferation and increasing usage of social media websites provides a platform for nurturing brands and impacting people's purchase decisions (DEI Worldwide, 2008). Because of fast growth of social media and internet usage as Internet World Stats statistics shows, and because the growth is not limited only to Western Countries. There has been significant growth also in sub-Saharan Africa, South America and Asia too; this reason does validate this study (Internet World Stats, 2019).

This study seeks answers to the following research questions:

1. What motivates people to use wearable devices based on social media data?
2. What sort of experiences have end users shared in social media regarding self-measurement devices?
3. What possible development ideas emerge from user experiences?

2.2 Conceptual framework

2.2.1 Social Media

Study by DEI Worldwide (2008) provides the following statistics regarding social media: 70% of consumers have visited social media sites to get information; 49% of these consumers have made a purchase decision based on the information they found through the social media sites; 60% said they were likely to use social media sites to pass along information to others online; and 45% of those who searched for information via social media sites engaged in word-of-mouth. The report states that companies not engaging in social media as part of their online marketing strategy are missing an opportunity to reach consumers. With a significant percentage of people passing along information to others through social media, the value of one customer is worth

far more than what he or she initially spends. Thus, firms and brands now need to factor in the value of customers and the influence of social media on them (DEI Worldbook, 2008).

In addition, easy accessibility to ICT and its advances has given rise to a variety of social networking sites. Social networking sites were solely accessed by PC or laptops and allowed individuals to create public profiles to get in touch with online community and have online interactions with other individuals. Over time, accessibility has improved in mobile devices, but also amount of services provided, enabling users to send messages and share information with online community. Most social networking sites are free to join and have gained widespread usage (Sage Handbook of Online research methods, 4, 2018).

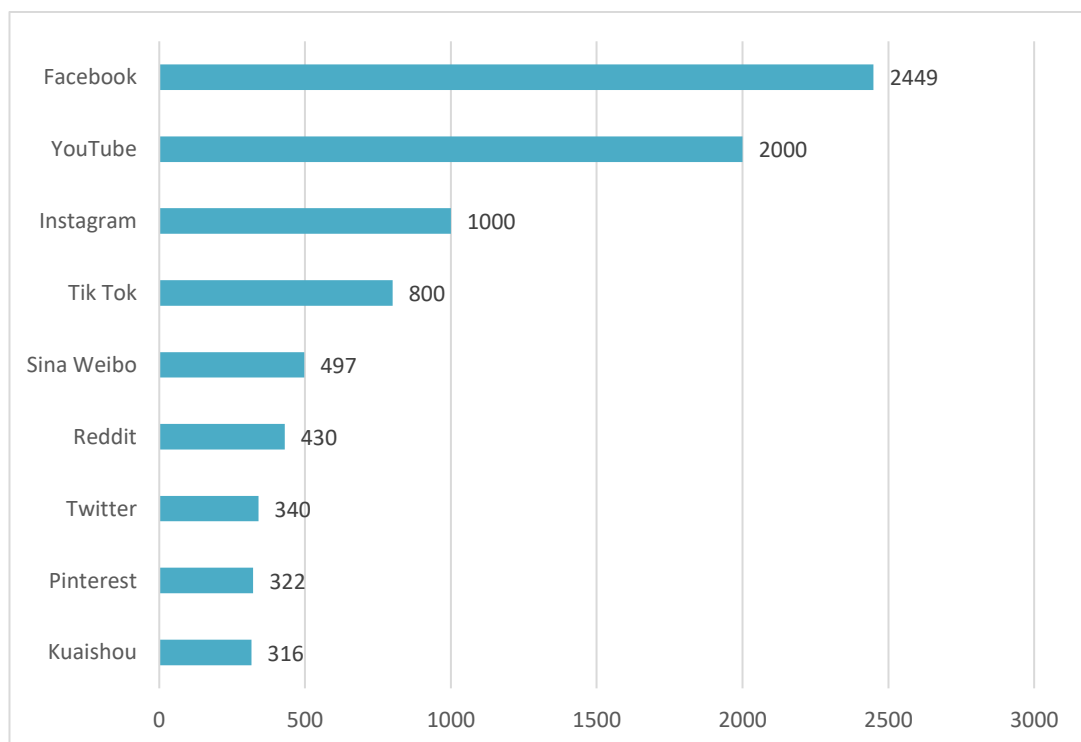


Chart 1. Most popular social networks worldwide as of January 2020, ranked by number of active users (in millions) (Statista, 2020) excluding online chat platforms

The growth of multiple social media sites are good examples of this. Facebook membership is good example of this. As the end of June 2017 Facebook had nearly 2 billion users, covering 72% of North American total population for example, and 17,7% in

Asia (Internet World Stats, 2017). As the graph above shows, in January 2020 Facebook had nearly 2.5 billion active users (Statista, 2020). In 25.1.2020 Instagram had over 1 billion users who posted over 500 million daily stories to their feeds (Instagram, www-pages, 2020). As with the internet and wearable devices, social networking sites can also take advantage of mobile technology and could provide another avenue for health promotion interventions. (Boyd & Ellison, 2007). Self-trackers often find value and comfort in sharing their personal data with other people on social media or specialized physical activity tracking platforms and apps like Strava and providing support to others engaged in similar pursuits ('communal self-tracking') (Lupton, 2016).

In this study social media covered Facebook, YouTube, Instagram, Reddit, Twitter, public blog postings and online marketplaces such as Amazon.com and Ebay.com.

2.2.2 Wearable devices and self-tracking

Small 'smart' devices equipped with digital sensors are referred as 'wearables'. These wearable devices have been developed for and can be worn on human bodies to monitor and measure their activities and biometrics. There are multiple different devices in this category such as smartwatches, wristbands, headbands, devices that can clip on clothing, pendants and rings (Salmela, Valtonen & Lupton, 2018).

The concept of "self-tracking" have begun to emerge in discussion of ways in which people can monitor and record features of their lives. Self-tracking is also part of life-logging, personal analytics and personal informatics. In self-tracking after the data is connected data is presented in visual format such as graphs or other visualizations to make sense of them. Different wearable devices are common tools for self-tracking (Lupton, 2016). A major attraction of self-tracking for many users is using the information they collect on themselves to optimize and improve their lives (Eagle & Greene, 2014). Self-tracking is not always about health and medical issues, but these are key elements. In addition, people reflect how provided information can be used to improve their lives in some way (Lupton, 2016).

After collecting and presenting data, knowledge is represented as tool to achieve better health, higher-quality sleep, greater control over mood swings, improved management of chronic conditions, more relaxed self, less stress, increased work productivity and so on. Self-optimization is often pleasurable, because it is often undertaken for purely personal reasons, and the data are kept private or shared only with limited and selected others (Eagle & Greene, 2014).

Wearable devices have gained significant share of markets and have many potential applications, particularly in healthcare and self-monitoring. The market for wearable self-measurement devices is growing fast, CSS Insight forecasts market value to be over 34 billion USD at the end of 2020, compared to 14 billion USD at the end of 2016. Marketwise China is one of the largest markets for wearable devices, and their market is estimated to reach 39,4 billion Yuan (5,74 billion USD) (CSS Insight, 2016).

In wearable devices there are still matter about ecosystem device is working on (Android or iPhone). For example, iWatch product sheet states iPhone as requirement for functions (Apple www-pages, 2020). As Android devices, Samsung devices are iPhone compatible, but have several options limited such as S Health function, daily workout recommendations and SOS-function to be mentioned (Samsung www-pages, 2020).

Wearable devices use different sensors, such as gyroscope, accelerometer, SpO2, HR-sensor and pulse sensor to collect personal daily data and data from surrounding environment, then Bluetooth or internet connection to exchange information, and often touch screen or speech recognition to interact with user (Jia, Wang, Wen, Liang, Gao & Lei, 2018). Typically, the trackers are worn on the wrist, and come with a smartphone app (and sometimes also online software) to allow users to track their activities relating to physical activity, sleep and sometimes diet, over a prolonged period (Carol, Ryan, Ambrosi & Edney, 2017).

In 2014, 70% of consumers were aware of wearable technology and 15% of them used wearable technology, such as smart watches and fitness bands in their daily lives. Most common user group of wearable devices were young adults (18-34) making nearly half

of total owners of fitness bands (49%). Both men and women were found to wear fitness bands in nearly equal numbers (Nielsen Connected Life Report, 2014).

Growing speeds of internet available throughout the globe does help usage of wearable devices as most of them use 3G/4G connection to interact with phone. At the start of 2022 Cisco Visual Networking Index estimates that there would be nearly 420 billion 5G connections worldwide also (Cisco Visual Networking Index, 2017). In addition, usage of both internet and mobile phone subscriptions have been steadily growing in every continent, but especially in Asia, South America and Africa (Internet World Stats, 2017).

As a result of growing mobile internet connections, wearable devices have greatly improved their user experiences and information exchange capabilities relative to conventional electronic devices (Jia, Wang, Wen, Liang, Gao & Lei, 2018). People can share their personal data from wearable device to phone and from phone to social media sites or applications such as Strava. Social media tool like Strava offers people ways to measure their performance, connecting with friends and comparing performances, but also offering emergency beacon. (Strava www-pages, 2020).

Purpose of wearable devices and applications are not to increase the amount of information that a user needs to consume, instead they make information to more understandable (Mishra, 2015, 247). Devices offer various ways to follow one's performance in daily level, such as sleep quality tracking, activity score, amount of rest needed, workout score and sharing workout with personal coach. (Polar Vantage fact sheet, 2019). Different biometric sensors such as pulse tracking, blood pressure, skin conductivity and blood oximetry can fill in the gaps, giving precise information about physiological changes that occur during various times of day and during various activities (Eagle & Greene, 2014, 21).

2.2.3 Functions of wearable devices

Fundamentals of healthy life and well-being are often lifestyle related choices and behaviors. THL and WHO both recommend appropriate physical activity, in addition restful sleep also supports recovery from daily stress and long-term stress (Porkka-

Heiskanen, Zitting & Wigren, 2013). Both factors contribute to overall wellbeing along with healthy diet and moderate use of alcohol (Ruokavirasto, www-pages, 2020). Carol, Ryan, Ambrosi & Edney (2017) performed cross-sectional study regarding people opinions of real time monitoring which found out that 89% of current and 54% of former users agreed that real time monitoring was useful. There are still challenges in key aspects of health and well-being, even they are well known. Issues might be stress, poor sleep, physical inactivity or overweight. Mentioned issues may all cause adverse health outcomes and reduce quality of life (Firstbeat, 2014).

Most wearable devices are designed to ‘nudge’ users into ‘good habits’ by following sleep patterns and quality, amount of exercise and steps, amount of water consumed during day and stress levels (Salmela, Valtonen & Lupton, 2018). Some brands calculate “Readiness score” (ŌURA) or similar, which is used to guide person to make better lifestyle related choices. Readiness score is shown visually and synced to application also. Purpose of readiness is to let people know their score, and then force them to decide whether, or not they are rested enough to tackle life demands and challenges (ŌURA www-pages, 2020).

Wearable technologies generate personal data such as heart rates, physical activity, sleep cycles, calories consumed, body temperature, menstrual and fertility cycles, sexual activities and encounters, body weights and moods (Salmela, Valtonen & Lupton, 2018).

2.2.4 Reliability of wearable devices and technologies

According to ISO 9126, the usability characteristic is defined as “the capability of the software product to be understood, learned, used, and attractive for the user, when used under specified conditions” (ISO 9126-2 2001); it is subdivided into four sub-characteristics:

1. Understandability: “the capability of the software product to enable the user to understand whether the software is suitable, and how it can be used for particular tasks and conditions of use”.

2. Learnability: “the capability of the software product to enable the user to learn its application”.
3. Operability: “the capability of the software product to enable the user to operate and control it”.
4. Attractiveness: “the capability of the software product to be attractive to the user”

There have been various studies regarding reliability of self-measurement devices. O’Connell, Laighin & Quinlan (2017) tested five different activity monitors simultaneously, and participants had to participate in certain activities, such as indoor cycling, outdoor cycling, taking elevator, deskwork, washing dishes, automobile driving and indoor rowing. Study found out that every device showed false positive steps. Reliability of step tracking ability have also been studied in laboratory conditions by using treadmill. Study tested 33 healthy adult volunteers, who did participate to 30 minutes treadmill walking test at 4,6km/h speed, test was re-tested also one week after primary test. Result of the study did show that seven out of the ten trackers were reliable enough, two trackers and applications showed inaccuracy regarding step count. (Kooiman, Dontje, Sprenger, Krijnen, Schans & Groot, 2015).

As to physical activity, mobile technologies provide data at very high sampling rates (10-500 times per second) that support measuring of phenomena (e.g., physical activity) that previously was poorly understood because limited measurement (Kumar, Nilssen, Abernethy, Patrick, Pavel, Riley, Shar, Spring, Spruijt-Metz & Hedeker, 2013). Reliability of heart rate monitoring tested by Wang, Yi & Bagchi (2017) found out that HRM is accurate during resting, but less accurate with body motion. This is caused because signal is affected by motion artifacts. In future accuracy and reliability of mobile hearth rate monitoring could be improved by discarding unreliable data and by using noise cancellation.

Fitness and activity trackers are simple, and mostly low-priced method to capture different physiological parameters. Passler, Bohrer, Blöchinger & Senner (2019) tested VO₂max and energy expenditure reliability of multiple different activity and fitness trackers, but none of the tested trackers could not show valid results for sports, health care or rehabilitative applications. Trackers proved to be most accurate in energy expenditure (kCal), but estimates were usually significantly underestimated. Provided

results can be used as a rough assessment and for personal use. VO2max accuracy had great variation between different devices.

2.2.5 Ethics of Wearable Technologies

With wearable devices individual can use data analysis to develop services that act as a personal coach, giving prompts to help a person to change his behaviors. Coach could encourage person to change living habits to more healthy way or affect sleeping habits or even help quit smoking. Devices on market already provide feedback about health-related habits by encouraging more physically active lifestyle and rising conscious what they eat or how much water do they consume. Personal data analysis could take this a bit further and affect decisions one make, system could also track person's location for safety purposes (Eagle & Greene, 2014). Providing accurate information about one's location and sharing it to internet could be problematic as proven in 2018, when Guardian newspaper found out how locations shared to Strava revealed U.S army military bases in Syria for example. In locations like Afghanistan, Djibouti and Syria, the users of Strava seem to be almost exclusively foreign military personnel, meaning that bases stand out brightly (Hern 2018).

It is also problematic how third-party companies store and collect the data to provide feedback for customers. Solution might be for example local gathering and storing of data. For example, mobile phones have capability to store data locally, on the device itself. Capabilities of mobile phones have increased in recent years, and even tiny handheld devices have computing capabilities of a much larger machine. Electronic Communications Privacy Act of 1986 makes possible in some cases, that when person's data is on the server, law enforcement and government officials can search those data without a warrant for example. Instead data stored to own personal device requires search warrant (Eagle & Greene, 2014).

Because data handled with cloud storages and within wearable devices can reveal highly personal information such as location, sensitive health conditions, weight, moods and emotions, concerns do exist regarding ethics. The public trend has encouraged people to share their information on social media also for the public good. Data

is especially vulnerable when device is synchronizing data with cloud server, therefore encryption in the consumer end would be solution (Kumar, Nilsen, Abernethy, Patrick, Pavel, Riley, Shar, Spring, Spruijt-Metz & Hedeker, 2013).

As wearable self-measurement devices are used all round the clock, they can be viewed intimate. For example, wearable smart rings can be viewed intimate in several ways as worn on the body and becomes part of the body, augmenting and decorating it and monitoring its functions. As device is worn 24/7, it's taking place in the very private spaces and situations, such as bed and bedroom shared only with your sexual partners, children or companion animals, if anyone. Mentioned devices generates and stores intimate information about wearers' sleep habits and can reveal some previously unknown dimensions of their sleep patterns (Salmela, Valtonen & Lupton, 2018).

3 RESEARCH METHODOLOGY

3.1 Data collection

This study will be conducted by using qualitative research methods by observing the following social media channels: Facebook, YouTube, Instagram, Reddit, Twitter, public blog postings and online marketplaces such as Amazon.com and Ebay.com. Information collected and analyzed is primarily non-quantitative in character and consists textual materials such as blog postings, microblogging and public opinion postings to social media news feed. Information collected consists also various pictures, containing text taken from social media (Saldana, 2011, 3-4).

In social media various data are available and processed differently. This type of data can be risky to review unless participant voluntarily posts it for an open internet. Collecting and analyzing these materials are comparable to the process for paper documents, only added with some electronic and digital context to consider such as advertising postings, possible internet trolling and one's own emotions while typing posting for example. As digital data people are posting data as their own experiences, data provided can be potentially rich and significant (Saldana, 2011, 57-58).

As social media study, study was conducted only in open social media channels to prevent ethical issues caused by restrictions of data handling. In general, public access to information means it's free for public use. Amount of data in internet is huge, and therefore limiting data collection time was mandatory (Saldana, 2011, 57). Therefore, data will be handled as single short words, phrases and sentences that summarizes most common themes and meanings of data (Auerbach & Silverstein, 2003).

3.2 Data analysis

Auerbach & Silverstein (2003, 43) presented following steps that were conducted in this study while analyzing data:

- 1. Explicitly state your research concerns and theoretical framework.*
- 2. Select the relevant text for further analysis. Do this by reading through your raw text with Step 1 in mind and highlighting relevant text.*
- 3. Record repeating ideas by grouping together related passages of relevant text.*
- 4. Organize themes by grouping repeating ideas into coherent categories.*

In data analysis, this study will use qualitative content analysis systematically examine texts and visualizations in media, such as texts, internet sites and pictures. Data will be found wholly from internet and then gathered in one large Excel sheet. Screenshots from mobile phone will be back upped to folders and text will be transferred to same Excel file (Saldana, 2011, 10)

Analyzed data will be both quantitative and qualitative in some form, because after transferring data to Excel whole file will be analyzed by counting the number of the particular key words and phrases (Saldana, 2011, 63)

3.3 Research ethics /validity

As knowledge is constructed within the individual, such factors as gender, age, ethnicity, sexual orientation, economic class, and so on, may subconsciously frame one's observations of the world and research. Therefore, it is hard to find any "neutral," "bias-free," or "objective" lenses for qualitative researchers. There are guidelines available to enhance the credibility and trustworthiness of study (Saldana, 2011, 23). In this study research will follow the responsible conduct of research by Finnish national board on research integrity (TENK).

This study will follow TENK guidelines as research will be conducted by such meticulousness, integrity and accuracy as possible while conducting research. Data presenting, handling and evaluation will follow scientific guidelines. All data acquisition methods are listed in separate chapter and fulfill scientific criteria and are ethically justified. After presenting study, study will be published to Theseus. While conducting research, other researcher will be respected by citing their publications appropriately. Thesis plan will be approved by supervisor, and data will be stored anonymously and privately. Study will contain material and citations solely from internet, unbiased researcher opinions.

Participants of this study will be selected randomly throughout the internet from multiple different social media platforms. As purpose is to find people's opinions, gender, race, and age might affect opinions. Therefore, it is necessary to gather a data large enough to find out themes in wider scale. Some social media platforms are anonymous and doesn't reveal gender, race nor age of people behind postings. The people involved with this study are called informants. Data gathered from informants will be voluntarily given as data is collected from public social media channels (Saldana, 2011, 25).

4 RESULTS

Data collection provided multiple citations from social media, some were short sentences with couple of words, and some were longer and consisted over 5 sentences. Data contains 371 sentences collected from various sources and 34 pictures; combined resulting to 421 sentences in total.

4.1 Reasons to purchase and use wearable device

This study found out that people in social media had different demands when purchasing wearable devices. Demands varies from high-tech demands to long lasting , pure sleep tracking or appearance-based demands. Reasons varied a lot in different consumer groups. Results of this study were categorized to 3 common themes and one miscellaneous category.

4.1.1 Fitness tracking

Topic of fitness tracking were brought up in social media. Especially social media active users tend to be interested in fitness tracking functions. In social media channels especially Instagram, Facebook and online marketplaces had active discussion about fitness trackers. There were also plenty of different blogs and reviews of customers regarding different functions and “top-lists” of current devices.

Most common functions people wished from their fitness trackers were ability to keep track on daily steps, sleep tracking and guidelines for healthy living.

“It has really kept me motivated to keep stepping up my game, ensure I get good amount of exercise, sleep, water and step count.”

“Replaced my original band with this one. It looks so much better. Sturdy nice looking leather band feels and looks great.”

“Canvas strap is extremely comfortable to wear and good looking.”

As tracker is used round the clock, appearance of device is also important factor in social media, as tracker should also be elegant enough, so one could wear it even at festive occasions and at work. Therefore, changeable wristband collected positive praises from social media users. Also, changeable display with color touchscreen was function that people liked about device they already own, or from next device.

“As I’m buying watch for my daily use, I need to be able wear it with my suit too.”

Functions people wished from wrist-based fitness watch were focused to overall health and lifestyle coaching, such as pedometer, pulse meter, weight tracking, notifications and sleep tracking. Many people praised devices to be waterproof, as it is possible to keep track in swimming activity also. Some activity trackers keep track on daily activity, as in some trackers it is possible to choose specific workout, this ability was must have for some users, but other found it useless.

“It’s given me a push to get moving with the hourly reminders. I really feel much healthier & really wish I’d bought a fitbit before now.”

“I am a person who uses a tracker to count steps, make sure heart rate goes into the right zone, to check distance and performance during shorter runs, for swimming and sleep monitoring”

“I’m a casual exerciser who would like a fitness tracker that records heart rate, sleep tracking and steps and/or activity.”

In addition to common watch-based trackers some trackers are integrated within different accessories compared to common wristwatch, such as rings. Market have been expanded in self-tracker rings while conducting study, at the start of study there were only first device coming to market, while now there are multiple choices for customers. Ring-based device people criticized it’s “360-view of health” as multiple users find it agonizing to hear daily how unrested you are, even you felt like had good sleep, or drank too much coffee, or maybe alcohol. As some users found mentioned functions agonizing, others found them useful and though that their sleep quality and step count have been increasing steadily while using device.

People who use wearable technology daily for fitness tracking certain technologies proved more important than others: measuring pulse from wrist or finger capillary arteries, high battery capacity and customization.

“The OURA ring adds value as a reminder of the importance of good sleep hygiene, especially in a crazy city like New York. It might not get your sleep duration or cycles correct every time, but it often does a pretty good job and serves as a reminder that sleep is crucially important to staying healthy.”

“For me, the major “stick” was the readiness score and resting heart rate data. When I was sick, or when I drank more than one alcoholic beverage, my heart rate shot up and my readiness score declined. Too much caffeine, or a late night on my laptop also dropped my readiness.”

4.1.2 Goal-orientated training

In social media people are sharing various data regarding their performance, training and workouts, therefore in this study we clearly created group “goal-orientated training”.

People with these types of needs were clearly aware of different technologies such as GPS accuracy, battery life or need of strap-based HR-monitoring while performing triathlon for example. Devices mentioned by users were also little bit different than for example fitness trackers, for example Garmin 945 multisport watch weighted 60g compared to Garmin Vivosmart 4 fitness tracker watch weighted only 16g, bulky appearance seems to be common reason that people in social media tend to use sport watches mainly with activities, not to follow their daily steps, sleep or other data provided by wearable devices.

“Any combination of multisports can be set up. I have used it for duathlons, brick runs and one pool-based triathlon. Once configured, the watch

needs only a single button push when going from activity to transition and another when coming out of transition.”

“As I’m training for marathon, sportwatch is must, all of the features and ability to provide lots of information while running.”

People had often reason to purchase sport watches because regular training, such as running, biking, skiing or swimming. Devices provide often multisport modes, so one can pick activity they are performing. Reasons also varied between jogging to competitive sports. It is possible to share results of workouts or compare results with other people. Sport watches also include smart coaches that help people with recovery times for example, and some users find recovery times and coach programs useful.

“Personally, I like to follow Polar training suggestions to train light or more, was surprised how useful function this is.”

“I’m able to increase my performance especially for short sprints because of heart rate zones”

“Polar’s competition generally track and store a lot more types of potentially useful data, however, for most, these are meaningless or gimmicky data. However, the Training Load and Recovery Status available with Polar’s ecosystem is in my opinion the reason why they are leaders.”

Devices designed for goal-oriented training have developed from pure HRM devices to multisport watches, therefore also usability have been increased. Users willing to buy multisport watches do require easy usability in terms of simple Bluetooth connection, fast charge and touch display to mention. Some users have had negative experiences about touchscreen while doing workout, as sweat or swimming may affect usability of touchscreen functions.

In addition of ‘modern’ functions people tend to purchase sport watches purely as stopwatch or timekeeper while performing exercise or just to follow their heart rate.

“Stopwatch function is must, because I love to perform Coopers test often.”

4.1.3 Sleep tracking

People tend to value ability to follow their daily routines easily, with some support also. Good example for these daily routines is sleep tracking, people in the internet were discussing a lot of importance of good sleep and how well are their devices performing about sleep tracking. Most devices discussed shows numerical value regarding how much “well-slept” time one spent in each night, some devices also have their own numerical values such as rested score, witch calculates various variables such as movements while sleeping, heartbeat, SpO2 and creates its own score based these multiple readings.

Reason to purchase a device solely because of sleep tracking is controversial, because many social media users do use tracker also as a regular watch or fitness band too. But from answers there were clearly user group that raised sleep tracking as most important function in device.

“I use sleep stages for an assessment of my sleep routine rather than recovery. If I get lower results than normal or have lots of awake periods, I try to assess how I could improve it through bedtime habits, supplements etc. If it’s truly awful, then I will take the day easier, but this is usually illustrated by prior measurements.”

“I’ve been searching for a decent product to track my sleep and help me sleep better. For the last 6 months I’ve had trouble sleeping...in particular waking up and feeling ready for the day.”

4.1.4 Miscellaneous

Miscellaneous category has some opinions, that suit none above reasons to purchase a device. In this category some people wanted tracker or smart watch to function part of technology that eases their mobile phone use for example, as giving notifications or possibility to receive calls.

"I really only use it as a normal time telling watch that gives me notifications from my mobile which it does with any easy read screen and navigation. Email alerts arrive with the first couple of lines along with WhatsApp, Facebook and messenger. Exactly what I wanted at a great price. It's light comfortable and that's a week without charging the battery. I don't use the app that much and it was a bit fiddly to set up."

Some trackers on market have ability to set up alarm as "silent alarm" so you don't need to wake up your partner. People have shared their experiences with this function and find it very useful. Silent alarm can be used for multiple ways as people have found out, drinking reminder, eating reminder, medications and even helping with overnight feeding of baby.

"We have a near 5 month old that we still get up to do an overnight feeding with. My wife and I alternate nights of doing it so other can get a full night sleep every other night. Silent alarm lets one of us wake up without disturbing the other with a noisy alarm."

"Can't live without silent alarm<3"

"I use silent alarm to remind me for my medication"

4.2 User experiences

4.2.1 Positive experiences

As people had certain reasons to purchase device, people positive opinions were generally same as their reasons to purchase the device. For example, when user expected to get working sleep tracker, user often praised sleep tracking abilities if they worked as expected. Some positive experiences were regarding the quality of device or positive experiences of usage of the device. There were also positive experiences regarding health improvement because usage of the device or improved motivation.

Even though the product quality is not mentioned as reason to purchase, multiple experiences have some sort of positive or negative opinions regarding quality. Positive quality related phrases include such as “light, durable, comfortable”.

“Sleep info is amazing. Tells you when you have rem, deep and light sleep. Scan bar codes for food which adds calories etc. Doesn't vibrate during the night like some.”

“Comfortable, light and looks good. It picked up GPS and my heart rate really fast in my first run and was even quick on intervals which my last watch wasn't. It synced to my phone first time and I have played around in the Flow software and chosen the sports I want and being able to easily customise the screens was an added bonus. I need to have a better look in the software as there is so much there, (running programmes, sleep and recovery)”

“I love the fact that you get more in depth sleep monitoring with the Versa, telling you the time you spend in each sleep stage etc.”

As positive experiences, people also shared their experiences regarding applications they do use with wearable technologies to analyze their data or to socialize with other people with similar interests. People found out communities being interesting and “thumbs up / kudo”-function to be encouraging while using devices. Most devices share ability to share training data to online or mobile platforms such as Strava. Manufacturers also have their own applications such as Garmin Connect or Polar Flow that share similar social features.

“The thumbs-up 'kudo' is so encouraging to give and receive, the banter between people is really fun.... but really it's all about helping people improve their fitness and health. It honestly makes you feel good, and people need that.”

“Strava is a great way to connect with the fitness community. I use it to track my runs, my rides, the bio feedback is really useful... sometimes I'll even wear my heart rate monitor in the car and post it (which always makes for some interesting content and comments.)”

“I use Strava for many reasons: Motivation, networking, trash-talking, community... and just fun.”

Social media users found additional coaching and fitness features also helpful, such as guides to improve physical abilities or guides helping to relax. There are also guides for weight loss and other healthy habits, such as sleeping enough, remembering to relax and reminders to keep moving regularly (notification if no steps are taken in desired amount of time except at night”).

“I think that sports watch is not a replacement for a coach, but it’s an extra layer of help and is indispensable when a coach is not available.”

“Fitbit motivated me to build on a goal. And I’ll keep changing it and improving it.”

“I am more likely to prepare for bed by taking a bath or reserving time for reading.”

“wearing the OURA ring has caused me to cut back on booze even more than I had in the time period before wearing the ring.”

4.2.2 Negative experiences

Negative experiences in wearable devices came most often because device lacked some functionality it promised, such as pedometer function didn’t worked as promised, touchscreen wasn’t sensitive enough, or too sensitive, sleep tracker didn’t worked out or battery life was too short compared to advertising.

“I ordered a Fitbit Alte 2 months ago but sent it back because the step count was significantly overestimated. I don t expect the step count to be 100% but when you do 500 steps and the count says 1240...that’s not good enough.”

“Apparently last night I was on REM sleep while doing the dishes. It's not the most enthusiastic activity but sure as hell I was asleep. So how can I trust any the other parameters?”

“Although I am happy with the monitoring on the whole, the older Fitbit's will recognise when you sleep whether it's a short nap or overnight. With the Versa, it will only recognise your sleep if it's over 3 hours so you lose that ability to monitor your sleep if you have a short nap. It's not a deal breaker, but it would be nice to have that information.”

Especially new wearable smart rings gained some negative feedback because users experiences readiness scores and sleep quality analysis too unpleasant, one user experienced and described this as information overload.

“At its worst, the OURA ring feels more like a tool of neuroticism than of self-care. Health and wellness can often feel like information overload and I simply don't want to wake up and anxiously check my sleep score anymore.”

“Do I really need ring to tell me how I slept?”

“I decided to stop wearing my OURA ring after seeing a LinkedIn connection post yet another article on how important sleep is and why the risk for a whole host of terrible diseases is higher if you're not sleeping like a champ.”

Wearable devices are piece of technology, therefore size of the screen, pixel count and resolution do matter. In applications provided by manufacturers usability gained some criticism.

“I find some of the details on the graphs bit small to read. It does have all the functions other brands have such as sleep, step and heart rate trends etc.”

“The app is near impossible to get any useful information from, the strap is iffy at best and the sleep monitor has a mind of its own.”

“Screen is sometimes unresponsive”

“The display is VERY dim even when backlit & it cannot be adjusted.”

“The touchscreen is sensitive, perhaps a little too so. You activate the screen with movement or touch, thus it's easy to trigger and push into a variety of settings from time to time.”

Multiple postings criticized poor battery quality or comfortability of tracker armband. Some people experienced problems with wristband allergic reactions or similar behavior. Some trackers included changeable canvas or even leather wristband to reduce irritation caused by default rubber band. People criticized easily trackers that felt uncomfortable or too bulky in wrist, because especially fitness trackers should be used round the clock.

“Default rubber band doesn’t suit for me. I was able to wear it for couple of hours tops”

“Fitbit burned my arm”

“It gives me rash”

4.3 Development ideas

A purpose in this study was to collect users development ideas and seek new innovations from social media. Because of huge userbase this study was expecting some new features that might not be yet innovated or might be still in early development. Most development ideas turned out to be features already available in other device.

Interesting development idea rose from posting forum regarding wearable devices and their synchronization with smart homes. Multiple people wished ability to follow or update their information to application by using simple voice commands over application provided. Now one must log weight manually by opening app in smart phone or computer, current weight can be heard via smart sound system, but not logged in.

“I would like to tell Alexa to “log my weight of xxx pounds” and have it recorded on the Polar Flow web site.”

Conversation brought up many similar ideas such as hearing daily overview via speakers or amount of sleep automatically at morning. Problem is that currently you can only hear something already logged, not log something by using voice or hearing latest figurine of exercise before synchronizing it to app. Automatic synchronization varies

between devices, and it takes some time often, therefore making it constant would remove problem mentioned above.

“It would be wonderful to hear amount of sleep automatically without sync”

“In my device automatic sync takes ages, maybe over 30min”

Most manufacturers have their own applications to analyze data (Samsung Health, Garmin Connect, Polar Flow, Fitbit). Users of social media found additional applications for mobile phones annoying and wished for some universal application that could handle all the data from wearable device. Now some users reported to have multiple applications installed for different brands.

“The device requires you to install an additional app by Huawei, which I find a little annoying.”

“WHY there is no possibility to use Samsung pre-installed app with Huawei? This would be great improvement, now I have app for Garmin, Huawei and Samsung..”

Some users experience also problems with different mobile phone operating systems (iPhone & Android). These problems were more common with iPhone users, as iPhone restricts some functions of some devices, such as Samsung smart watches all functions does not support iPhone nor all applications. iWatch is also exclusively available to iPhone on the other hand, even some Android users might want to use it.

“My hubby bought me accidentally iWatch... I own Huawei phone”

“as iPhone user I dislike fact that some functions of my watch aren't available for me.”

“I love the look of iWatch, sadly I'm using Android.”

There are multiple period trackers available to mobile phones via application stores, but built-in trackers do lack some functionality and tools to track periods are often accessed via mobile interface. Developing better period and female health tracking

features were ideas from some users. Fitbit and Garmin have both female health functions within their applications (Fitbit www-pages, 2020) (Garmin www-pages, 2020), but both lack any functionality in devices.

“Better period tracker”

“I need to open app to see my ovulation”

5 CONCLUSIONS

5.1 Results

While purchasing devices people tend to value functions over usability. People wanted device often for a specific purpose, such as fitness tracking, goal-oriented training, sleep tracking or as a regular watch. In experiences, people were more focused on quality of products and how did functions work in daily use. People also wanted that advertising promises were claimed, and especially battery durability, sleep tracking and touchscreen were major negative experiences.

Health related reasons such as improving physical condition or keeping count of daily activity because of fitness were key reasons to purchase devices. In addition, overall health and daily stress levels and hectic lifestyle was major reason, as multiple trackers were equipped with sleep trackers, sleep analysis and some form of stress analysis. As customers are becoming more aware of data, they require new functions such as SpO₂, which have been added in most devices quite recently.

Users tend to value data that is easily accessed and recorded, as synchronizing might be automated, but users are wishing real time synchronizations that work with home automation and report data without even opening one's mobile device. Mobile applications should be developed as universal as possible and different devices should support both iPhone and Android operating systems.

As consumers do their purchases based by commercials and information from various sources like social media, claiming advertisements is important factor to companies producing wearable devices. Especially battery duration, durability of straps, allergic reactions, applications and poor touch screens angered users in social media mainly because advertisements promised something else. Also, missing or sub-par working functions were important part of negative experiences.

While planning this study, there were plenty of expectations to future development ideas, as people often share their opinion in social media. But instead, in social media people tend to share their experiences and reasons more easily than future development ideas. Especially ideas regarding new measuring possibilities were completely missing from data collected during research, excluding improvements wished for women health tracking functions. There were development ideas regarding home automatization, smart homes and smart speakers, universal applications to analyze data with mobile devices and functionality over multiple mobile platforms (iPhone and Android).

5.2 Study

Timescale of the qualitative research is hard to estimate, as amount of data required for data collecting and handling were surprisingly long. Also gathering information regarding conceptual framework proved to be hard, as topic of the study was large. Some viewpoints, such as mHealth have been removed on purpose, even they were present in some previous version of Thesis. Original timetable was following:

Original timetable of Thesis 2017

Ideation of the Thesis	January-August 2018
Finishing project plan	August-September 2018
Explorative literature research	June 2018-October 2018
Data collection and analysis / experiences	November 2017- November 2018
Writing the Thesis	November 2018 – December 2018
Presenting the Thesis	December 2018

Timetable was exceeded generously, mainly because explorative literature research timescale was too tight. Now data collection happened between June 2018 – December 2019 and writing November 2019-March 2020.

Data collected for this thesis were mainly r scientific articles, because most books written about wearable devices are focused to mHealth or technical data of devices. Data contains also information from different manufacturers and newspapers online pages and internet statistics. While collecting data original key words included “heart rate sensor, heart rate monitor and wearable device” these keywords provided search results with more technical focus and slowed down data collection. After July 2019 keywords were changed to “wearable, tracker and wearable device” with mentioned keywords search and data collecting became easier.

Writing the thesis took lots of more time than planned, as some parts of thesis were made faster than other, especially results section were formatted multiple times during process.

Whole process gave me tools to perform scientific research and use certain databases, especially internet-based databases were used, because amount of English scientific literature is small at Finnish libraries. In keyword placing AND, OR, NOT proved to be useful, especially NOT, while trying to sort out too technology centered articles. Some interesting articles were behind paywall and not accessible by all means from our school databases, this did affect parts of the study.

6 DISCUSSION

6.1 Future and development of wearable devices

Technology behind wearable self-measurement devices is developing constantly, and some innovations will be available to consumer market in near future. Especially pos-

sibilities to connect wearable devices to existing smart homes are developing constantly. For example, even now installing apps to virtual assistant AI units is simple such as Alexa. Once your app is installed and account aligned with Alexa, the assistant will be able to read various elements of data from your account (for example Fitbit account, Polar account) and relay them back to you. You might ask for example steps, distance covered, last logged weight, your resting heart rate, any water consumption you've logged that day, or even the remaining battery life on your device. This information comes directly from the app rather than from the device itself, which means you will only hear information that has already been synced. (Wareable, 2019).

As smart homes and constant data collection is becoming even common, people can self-track parts of his life and habits passively. Biometric sensors and applications could be capable of sending messages to third party, such as doctor or social media. Nowadays people are using automatic information sharing mostly at social media, but using this wide amount of data with medical professional could benefit one's health (Eagle & Greene, 2014). This fitness and health data could be used to provide a proactive and predictive approach toward health care and management. As many parameters such as weight, heart rate, blood pressure, pulse, SpO2 to mention, are collected routinely on frequent basis, there is opportunity to analyze their trends in larger scale and long term to gain useful insights (Mishra, 2015, 250).

Multiple different applications provided by manufacturers of wearable devices are challenge, as challenges remain regarding development and research, as application for promoting physical activity, with development and evaluation started multiple years ago. Results of research might be published over 5 years later, by which time operation system and technologies have undergone substantial changes in functionality, design and overall use (Murray, Hekler, Andersson, Collins, Doherty, Hollis, Rivera, West & Wyatt, 2016).

Mobile and wearable devices can be used as platform for delivery of health behavior interventions. Applications and wearable devices can be used as tools to motivate and engage users in their own fitness levels, devices can be also used as tools for delivering health-related information and self-knowledge (Aitken & Gauntlett, 2013). As people are becoming aware regarding good sleep meaning to overall health, people are more

willing to their sleep habits. People want to ensure that they achieve sleep that is deemed restorative and health-enhancing. (Salmela, Valtonen & Lupton, 2018).

6.1.1 Future research

In this study people had several reasons to purchase wearable devices, both positive and negative experiences and some development ideas. Majority of reasons to purchase wearable device was because their ability to increase physical activity, so possible future research could focus finding out connection between activity tracker usage and health benefits. As regular physical activity has been connected to improved health effects, mentioned research could be conducted by blind experiment for example with similar control groups.

As devices are becoming more intimate, as stated by Salmela, Valtonen & Lupton, 2018, possible future research could be applied also about psychological effects of wearable devices, as some people mentioned wearable to be “tool of neuroticism”.

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