Is serious gaming the holy grail for the wearables industry?

Author: R.B.C. van Baalen
University of Twente
P.O. Box 217, 7500AE Enschede
The Netherlands

Supervisor:

Dr. Ir. I.A.A.M. Ton Spil – a.a.m.spil@utwente.nl

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As subject for this Bachelor Thesis, I have reflected on the success of fitness apps for smartphones and subsequently analyzed the future of this branch with regard to the recent introduction of wearable technology devices. The focus has been mainly on the advantages these wearables can offer for serious gaming purposes and how they are perceived by potential customers. What is shown in this thesis is that although people show a lot of interest in both serious gaming and wearable devices, their combined practical added value is still very unknown among potential customers. The relevance of serious health gaming applications has been proven, , especially their user-friendliness and usefulness. The current adoption rate, combined with existing literature research and the results gathered from questions based on the PRIMA and TAM-model, shows that massive growth is likely to happen on the short term. Subsequently, the effects of this on the emergence of wearable devices has been researched. What is shown by the multi-method analysis of the Kano- and the TAM-model combined is that although respondents are convinced that activity tracking and fitness & health functionality is crucial for wearables, they do not yet know what functionality they are looking for. The perceived importance of serious health gaming functionalities have been questioned and the responses have shown that people do not yet really know what they are looking for in wearable devices. Information quality, absence of a dominant design and/or the currently offered wearable devices might explain this confusion. What can be concluded however is that those people who are looking to buy a wearable device are mainly curious towards these devices and see it as a must-have, without having any specific function for it in mind.

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1. INTRODUCTION

1.1 Relevance & Background

In this Bachelor Thesis, the focus will be on the current success and growth of serious health gaming apps, especially with health and fitness functionalities and how these influence the market adoption process of wearable technology devices. It is relevant to research serious health gaming for wearables for various reasons. At first, it is important considering developments in the general worldwide health. It is a fact that the world gets fatter every year. Obesity is a recurring problem that has worsened over the last few years. Living conditions that lead to obesity often start in childhood, next to that, obese children and adolescents are more likely to become obese adults . This exacerbates the public health urgency of this issue even more. (Engeland, T, Tverdal, & AJ, 2004) (Reilly, et al., 2003).

When looking at the prevention of obesity, healthy diet and physical activity behaviors are the main habits individuals should grow up with. These habits track into adulthood and therefore it is important to establish these behaviors as early as possible. (COAPIO, Medicine IO, 2012) (Koplan, Liverman, & Kraak, 2005)

Effective ways to achieve and maintain an healthier lifestyle are needed to improve the quality of life for the worldwide society. The emergence of technology that promotes an healthy lifestyle may offer an effective method for encouraging people to adopt healthy behaviors. Technology is pervasive in today's world and influences many aspects of our lives, including how we communicate, educate, and entertain ourselves. Children and young adults could especially be an interesting target group for serious health gaming, since they are generally most active with technologic tools. (Lenhart, et al., 2008) (Thompson, 2014).

When talking about pervasive technology, the smartphone is an obvious example. Worldwide, the number of smartphones exceeded the world population in 2014, within 5 years this will presumably be 1.5 smartphone per capita. This means that in 2019 11.5 billion mobile connected devices are spread among the world population (Cisco Visual Networking Index: Global Mobile Data Traffic Forecast Update, 2015). Next to that, the App Stores are the fastest adopted and growing innovation ever. It only took 17 months for the app store to get its first 50 million users. It is clear that apps have incorporated in our lives very quickly. When looking at the personal level, this gets confirmed. Data presented by Apple stated that the average person has 119 apps installed on his or her smartphone. (Apple inc. , 2015)

Given this adoption rate and the growth this industry has had over the last years the main focus has shifted towards the available applications on the smartphone to extend functionality. To provide an indication of the market size for apps, some numbers: From 2008 to 2015 the number of applications in Apple's App store has grown from 500 at introduction in 2008 to 1,5 million in 2015. The Google Play Store, the other main app store, currently has 1.3 million apps available. The revenue created by these apps was 8.3 billion dollars in 2014. (Statista: Stats and Facts about App Stores, 2015).

Regarding the fact that usage of smartphones is high, read in combination with the obesity problems and the enormous popularity of app downloads, the use of apps should have great potential to promote changes in behavior towards a healthy lifestyle. (West, et al., 2012). Health related software applications (i.e. health and fitness apps) that run on smartphones (such as RunKeeper, MyFitnessPal and Nike+ Running) are built-in with GPS (Global Positioning System), social networking capabilities (e.g. sharing on Facebook and Twitter), and sophisticated sensor technologies that provide details of physiological data (such as calories burnt, heart rate, blood glucose level and blood pressure) would improve the effectiveness and cost of health interventions. (Yoganathan & Kajanan, 2013) (Liu, Zhu, Holroyd, & Seng, 2011). In general, Fitness & Health applications can help in determining the right intensity and are often seen as personal trainers. (Liu, Zhu, Holroyd, & Seng, 2011).

In this paper I will focus on health and fitness apps which keep track of your activity and overall health. Features offered by these apps can help in performing exercises and cardio training. For these apps a wide variety of complementary devices is available and this number is growing quickly. Serious health gaming has been researched widely and there is a lot of information available on this topic.

Currently, wearable devices are an emerging technology and these devices will, according to major business information and research institutes, grow explosively in the very short future. Also, the fact that leading technology corporations are active within this market indicates the existence of a massive potential market. Wearables have been researched, but mainly from an technological point of view. The customer's acceptance for these devices and the added value for serious gaming purposes has not been researched however and therefore information from this viewpoint is lacking.

Wearables mainly build on the success of smartphones, which makes it an interesting market to take an extensive look at. The functionality of Health & Fitness apps on smartphones is already quite impressive. The emerging product category wearable devices can further enhance this trend. These wearables offer more extensive functionality due to the fact that they can collect physical body data. Little is known about wearable products by potential customers, therefore elaborating key product features and perceptions is crucial in this research. (Stevens, 2015)

These wearable technology devices are pushed onto the market while potential customers are not aware of the functionalities these devices can offer them. Potential customers do not know whether and why they should be interested in these products. Even if people are interested, they might still be in doubt which type of functionality really adds something to the array of devices they already own. Therefore it is interesting to examine the advantages wearables can offer for potential customers.

Manufacturers of wearable devices are massively focusing on health monitoring and promoting healthy lifestyles and therefore it is interesting to find out whether health functionality is the so-called 'killer-app' for wearable devices.

1.2 Research Question & Structure

The Research question addressed in this paper reads as follows:

To what extent does serious gaming influence the market adoption process of wearable technology products?

Within this paper, I will divide this main question into several sub-questions which help me answering the main research question. The following sub-questions should be answered:

- What is serious health gaming?
- What are wearables?
- How elapses the market acceptation process?
- What is the current and projected state of serious health gaming?
- To what extent are serious health games adopted?
- To what extent are wearable devices adopted?
- What are the key features that determine the success of wearable devices?

Whether health and fitness apps can be defined as serious health games has not yet been generally accepted. The degree to which a game is 'serious' is questionable and therefore it is important to make a clear distinction between conventional games and serious games. In Chapter 2.1, serious health games are defined to gain a clear understanding of what they actually encompass. Subsequently, it is important to find out what wearable devices actually are. Because most wearable devices are 'smart' iterations of already existing clothing or accessories it is important to emphasize the difference. Wearables are defined in chapter 2.2.

In chapter 2.3 some theories on market and technology acceptation are introduced. These theories are used later on in this thesis to help drawing conclusions. Before looking forward to the adoption of serious health gaming and wearables, it is important to find out what the current state of this industries are. Therefore these industries and their characteristics are introduced in chapter 2.5.

In chapter 3, the empirical part of this research is presented. It contains the results of the interview and questionnaire research conducted towards customer's perceptions on serious health gaming and wearable devices. At the end of this thesis, some conclusions are drawn from this information.

1.3 Research methods

In this bachelor thesis I will at first reflect on the success of fitness apps for smartphones. This reflection will be made by analyzing existing literature. This literature is analyzed with the goal to gain more insight in the current situation and the reason why these apps have become so successful.

Furthermore, I will use 40 interviews obtained through the PRIMA method from a previous study of Health Sciences at the University of Twente, to better understand the views of respondents on serious gaming. The respondents opinions will be qualitatively analyzed by mixed methods to get insight in the reasoning of respondents. This information helps me to get insight in current customer perceptions of serious gaming apps

These PRIMA-interviews have been conducted among a widespread array of respondents. These respondents are from varying backgrounds with ages from 15 to 55. The main part of respondents originated from the Netherlands, with a few exceptions from Germany. In the interviews, the opinions on the use of serious games have been queried. The responses have been assigned a tag, from very positive (++) to very negative (--). This coding process has been based on the method proposed by Miles & Huberman (1994). They divide qualitative data analysis into three different procedures: Data reduction, data display and conclusion drawing/verification. A graphical representation is shown in Appendix A2.

For the data reduction phase, coding has been chosen because it provides a good overview of the answers provided by respondents and their opinions on various aspects. The coding process has been based on theory by Miles & Huberman(1994, p. 56), who state that: "*Codes are tags or labels for assigning units of meaning to the descriptive or inferential information compiled during a study. Codes are usually attached to 'chunks' of varying size – words, phrases, sentences or whole paragraphs."*

As for data display, the available data has been statistically processed in Microsoft Office Excel to generate an insight into the responses, next to that this program made graphical presentation possible. The charts and figures resulting from this data processing can be found later in this thesis.

To find out how willing people are to adopt new technologies, it is important to acknowledge the market adoption process. To place this data in perspective, some well-known theories and models have been used. These models are the Diffusion of Innovations by Roger's, the Technology Acceptance Model (TAM) by Davis and the Product Life Cycle model by Vernon. These models are extensively described in the relevant chapters and in appendix A.

Next to that, I will carry out an online survey with questions based on the Kano model. The Kano Model of Customer Satisfaction classifies product attributes based on how they are perceived by customers and their effect on customer satisfaction. (Sauerwein, Bailom, Matzler, & Hinterhuber, 1996). This method distinguishes five different classifications in product attributes: Must-be, One-dimensional, Attractive, Indifferent and Reverse requirements. More information on the Kano Model of Customer Satisfaction can be found in Appendix A5. This method of questioning and analyzing creates an insight in the way potential customers perceive wearable products and serious game applications for these devices. It provides more information on the requirements for wearable products and the role serious gaming can play in that process. Because of the fact that wearables exist in different assemblies it is important to find out which functions are desired by potential customers.

I will use the knowledge gained from this analysis and connect them to the information on serious gaming gained from the interviews gained by the PRIMA-method. By making this connection, I can investigate the impact of serious gaming in the future success of wearables.

2. LITERATURE REVIEW

2.1 What is Serious Health Gaming?

An extensive literature search provides an overview of the current academic insights into the aspects of serious gaming. Academics have widely debated the topic of serious gaming and its influence on people's behavior. At first, the definition of serious gaming should be defined to gain a clear insight in the subject of this thesis. In table 1, several existing definitions are listed.

Games can exist in various forms and shapes. They can for instance be played as board-, card-, physical- and computer games. Gaming is not limited to these categories however and can be played in many more ways. Games are not only played with providing fun as the main purpose. Some games have other goals, like learning, training, education and motivating.

The continuous performance improvement of consumer level hardware has contributed to the rapid growth in the digital game market. Computer games, once limited to pure entertainment and storytelling, are now trying to propose new experiences. Examples of this are the use of games in training facilities and the development of games in virtual reality environments.

The words 'serious' and 'game' are usually not applicable to each other. 'serious' normally doesn't imply fun, while playing a game does. Despite the unusualness of linking these terms, studies claim that games can be applied in order to serve a useful purpose other than sole entertainment.

The first to draw the connection between play and education was Plato, who wrote this in The Republic (380 BC) . In this work, the use of games for the education of children was recommended. Plato stated: "*You can discover more about a person in an hour of play than in a year of conversation.'* (Michael & Chen, 2006).

When looking at the 'serious gaming' phenomenon in the current timeframe, it is clear that these types of games have grown

massively over the last few years. This is also reflected in the availability of definitions on this phenomenon. In table 1, the most influential and applicable definitions are listed.

Table 1: Definitions of Serious Games	
"Serious games differ fundamentally from their entertainment counterparts in that the applications have been designed with a specific meaningful purpose in mind.´	(Harteveld, Guimaráes, Mayer, & Bidarra, 2009)
"*Games may be played seriously or casually. We are concerned with serious games in the sense that these games have an explicit and carefully thought-out educational purpose and are not intended to be played primarily for amusement. This does not mean that serious games are not, or should not be, entertaining.*	(Abt, 1970)
"Any form of interactive computer-based game software for one or multiple players to be used on any platform and that has been developed with the intention to be more than entertainment."	(Ritterfeld, Cody, & Vorderer, 2009)
"games that do not have entertainment, enjoyment or fun as their primary purpose"	(Michael & Chen, 2006)
"A serious game has a goal different than entertainment alone, is based on ICT, and has a play element"	(Kranenburg, Slot, Staal, Leurdijk, & Burgmeijer, 2006)
"A serious game is a mental contest, played with a computer in accordance with specific rules, that uses entertainment to further government or corporate training, education, health, public policy, and strategic communication objectives"	(Zyda, 2005)

Table 1 shows the various existing definitions of serious games. Obviously, these definitions have some elements in common, there are also differences however. It is interesting to see which elements prevail in these definitions to find out what makes a game serious. From the definitions in Table 1 some elements have been extracted. Subsequently the presence of these elements in the various definitions have been checked. The results from this process are shown in Table 2.

Table 2: Serious gaming requirements from definitions

Definition	Meaningful Educational	Computer /ICT- based	Entertaining	Play element
(Harteveld, Guimaráes, Mayer, & Bidarra, 2009)	☑			
(Abt, 1970)	☑		☑	☑
(Ritterfeld, Cody, & Vorderer, 2009)	☑	☑	☑	
(Michael & Chen, 2006)	☑			
(Kranenburg, Slot, Staal, Leurdijk, & Burgmeijer, 2006)	☑	☑		☑
(Zyda, 2005)	☑	☑	☑	☑

Table 2 clearly shows the difference in completeness from the various definitions. For this Bachelor Thesis I decided to focus on Zyda's definition, mainly for two reasons. At first, it is the most complete definition in my opinion since it fulfils all aspects that are mentioned. Next to that, it is the only definition that states health as a meaningful educational purpose. This highlights the importance of health for serious gaming purposes.

Health related software applications (i.e. health and fitness apps) that run on smartphones (such as RunKeeper, MyFitnessPal and Nike+ Running) are built-in with GPS (Global Positioning System), social networking capabilities (e.g. sharing on Facebook and Twitter), and sophisticated sensor technologies that provide details of physiological data (such as calories burnt, heart rate, blood glucose level and blood pressure) would improve the effectiveness and cost of health interventions. (Yoganathan & Kajanan, 2013) (Liu, Zhu, Holroyd, & Seng, 2011). Features offered by health and fitness apps can help in performing exercises and cardio training. Fitness & Health applications can help in determining the right intensity and are often seen as personal trainers. (Liu, Zhu, Holroyd, & Seng, 2011).

2.2 What are wearables?

When finding out whether serious games are the key feature for the success of wearables, it is important to consider the definition of wearable technology devices. Next to that, the technologies incorporated in these devices have been analyzed to provide an extensive overview of the different functions these wearable technology devices can offer.

When defining wearables, it is important to acknowledge the fact that these devices exist in various form factors. These form factors are often re-iterations of already existing devices like watches, glasses and bracelets. Next to that, wearable computing can also be incorporated in clothes, shoes and helmets. To define the difference between conventional wearables and wearable technology devices, the added functionality of the latter should be highlighted. In their definition, Tehrani & Michael emphasize the portability of wearables:

"The terms "wearable technology", "wearable devices", and "wearables" all refer to electronic technologies or computers that are incorporated into items of clothing and accessories which can comfortably be worn on the body". (Tehrani & Michael, March 2014)

According to (Tehrani & Michael, March 2014), wearable devices can perform many of the same computing tasks as mobile phones and laptop computers; however, in some cases, wearable technology can outperform these hand-held devices entirely. Wearable technology tends to be more sophisticated than hand-held technology on the market today because it can provide sensory and scanning features not typically seen in mobile and laptop devices, such as biofeedback and tracking of physiological function.

Generally, wearable technology will have some form of communications capability and will allow the wearer access to information in real time. Data-input capabilities are also a feature of such devices, as is local storage. Examples of wearable devices include watches, glasses, contact lenses, e-textiles and smart fabrics, headbands, beanies and caps, jewelry such as rings, bracelets, and hearing aid-like devices that are designed to look like earrings.

The implications and uses of wearable technology are far reaching and can influence the fields of health and medicine, fitness, aging, disabilities, education, transportation, enterprise, finance, gaming and music. The goal of wearable technologies in

each of these fields will be to smoothly incorporate functional, portable electronics and computers into individuals' daily lives. (Tehrani & Michael, March 2014)

As stated above, wearable technology devices differ from their conventional counterparts in their ability to monitor several physical functions. Next to that, computational power, communications and data-input capabilities, as well as local storage are characteristics of wearable technology devices. Mentioned above is a very broad and long definition. In his report on Wearable Computing, Steve Mann provided a more concise definition for wearable devices. (Mann, 2014) stated:

"*Wearable computing is the study or practice of inventing, designing, building, or using miniature body-borne computational and sensory devices. Wearable computers may be worn under, over, or in clothing, or may also be themselves clothes."*

The definitions mentioned above all contain the aspects of computational power and sensory devices. To find out which functions are currently feasible for these devices, previous research (Butte, Ekelund, & Westerterp, 2012) and currently available wearable products have been analyzed to form an extensive overview. This overview can be found in Appendix B1 & B2. It is based on the following scheme which is provided by literature. It features the components of physical activity that we are currently able to measure with monitors with varying levels of accuracy and precision. These functionalities are based on a user pattern which consists of the consumer market, instead of professional institutes. There is a significant difference in the available technologies for both markets because some technologies can only be used by qualified professionals. Table B1 and B2 in the appendix show more information on the consumer market technologies and the functions it can offer.

1. Total physical activity
2. Duration, frequency, and intensity of physical activity
3. Sleep and awake time
4. Sedentary, light, moderate, and vigorous levels of physical activity during awake time
5. Prediction of Total Energy Expenditure, Physical Activity Energy Expenditure, and Sleeping Metabolic Rate
6. Classification of locomotive activities (walking, jogging, running)
7. Walking (number of steps, stride, speed, distance)
8. Posture (lying, sitting, standing)

(Butte, Ekelund, & Westerterp, 2012)

These functionalities becoming available to the mainstream market lead to an array of new possibilities and functionalities. When thinking about applications for wearables, the collection of movement and heartbeat data is very straightforward. (Pyattaev, Johnsson, Andreev, & Koucheryavy, 2015)

This gets confirmed by (Rawassizadeh, Price, & Petre, 2015) who state that wearables could be a significant boon to mHealth technologies. They claim that smart wearables could host more bio-sensors and take more accurate measurements than the simple accelerometer-based wristbands & smartphones. These wearables are interesting because they enhance functionality of existing technologies. This is mainly due to the fact that wearables are something you wear, which means that it can collect personal physical information throughout the day.

According to Business Insider, wearables are currently booming. They estimated that this industry will have a compound annual growth rate of 35%. Next to that, they stated that in 2015, a total of 33 million wearable devices will ship. This should grow to 148 million in 2019. CCS Insight published market data which are somewhat comparable. According to them, shipments of smart wearables are expected to grow from 9.7 million in 2013 to 135 million in 2018. According to this source, 22 million wearables will be sold in 2014. When comparing the current market data with the forecasted data, it is obvious that wearables still have a giant leap forwards to make. This is also supported by CCS Insight's Director of Forecasting, Marina Koytcheva. (Deacon & Koytcheva, 2014)

When asked about her opinion on the wearable industry, she stated: "the wearables market is in its Stone Age right now. There needs to be huge improvements to broaden their appeal. This is particularly acute when it comes to devices for women: wearables need to quickly move on from black, clunky devices; fortunately we're starting to see the first steps in this direction."

Various form factors can come to mind when thinking about wearable devices. The smartwatch may be the first, since Apple recently introduced the highly-anticipated Apple Watch. Other form factors are also possible however since fitness bands and smart glasses also have been available. Currently wearable devices come down to two main groups, head-worn devices like glasses (Google Glass) and wrist-worn devices like fitness bands (Fitbit) and smartwatches(Apple Watch). The future will probably feature different designs. (Danova, 2014)

2.3 The market acceptation process

To find out whether and how the market adoption process of wearable devices is influenced by serious gaming applications, it is important to shortly elaborate on the process which describes the acceptance of new products. This process has been heavily examined from different disciplines, therefore only the most known and influential will be used within this thesis. Because this thesis focusses on both technology and market success, the market acceptation process will be examined from these two disciplines.

At first, it is important to find out which people would be interested in buying a wearable devices. Since wearable devices are a new innovation, Roger's diffusion of innovations curve fits nicely. It has been chosen because it is one of the main models for market success, next to that it has been widely discussed and used within my study. In his book, Diffusion of Innovations, Rogers describes how innovations are adopted among the mass market and divides this market into five categories. Every category has its own characteristics and therefore have different buying motives. This leads to the diffusion of innovations theory which is attached in appendix A1.

In his Curve, Rogers broke down the population into five different segments, based on their propensity to adopt a new innovation. The population is divided into innovators, early adopters, early majorities, late majorities and laggards. Each group has its own "personality", at least as far as its attitude to a particular innovation goes. Every group represents a certain market share which reflects on the group size, together they form the complete market.

This curve also represents a time element. It describes the groups within the population that will adopt the innovation at a certain point of time within the introduction process. This process is called the Product Life Cycle model which features four states products generally go through. These states are introduction, growth, maturity and decline.

In this process Innovators are the first to adopt new products. This is in contrast with the Laggards, who will adopt innovations in the end of the product life cycle, after the rest of the population. (Rogers, 1971). More information on Roger's population categories can be found in table A1 in the appendix.

When talking about wearable technology devices, it is important to find out in which phase of the market adoption process this industry is currently engaged. Therefore, market data has been obtained to gather more information about the served share of the market.

Looking at adoption of innovations from the technologic viewpoint, the acceptation process of technology should be considered. To find out more about technology acceptance, it is important to search for customer perceptions of these devices. Whether people are willing to adopt wearable devices in their daily lives has been researched in a questionnaire based on the Technology Acceptance Model (TAM) by Davis(1989). This model has been chosen because it is highly relevant for this thesis topic and next to that, it is one of the main frameworks for researching the acceptance of technology. This is also reflected in the high amount of citations and the fact that it has been continuously studied and expanded in multiple major updates. In this thesis, the first, original version of the model has been used because it covers the most important basic aspects. The TAM-model incorporates several building blocks which all represent a required aspect in the adoption process of technology. A graphical representation of the TAM-model can be found in the appendix A3.

The TAM model has both served as the basis for the questionnaire research conducted as well as the interviews. Based on this model some questions have been constructed to find out how people think about the various parts within this model. In the TAM model, the focus is on five different aspects: Perceived Usefulness (U) ; Perceived Ease of use (E) ; Attitude toward using (A) ; Intention to Use (B) and Actual System Use

These different parts together form the reasoning for people to accept or refuse new technologies. In chapters 3.1 and 3.2 the results to the conducted interviews and questionnaire are presented

2.4 Theory relevance

In chapter 2.1 up to 2.3, the theories used in this thesis have been introduced. These theories all have different functions however and therefore an overview of the relevant theories and their functions within this research shows how they affect each other. This is important because it explains some of the crosslinks made later in this thesis.

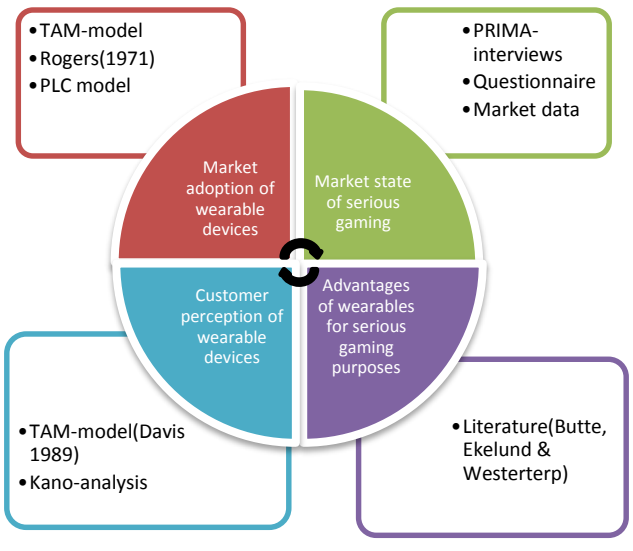


Figure 1: Theory relevance

Figure 1 shows the most important phases of the research conducted and which methods, theories and models have been used to gather and analyze the relevant data.

2.5 What is the current and projected state of serious health gaming for the smartphone industry?

Since the wearable industry is still in its infancy, extensive market data for this segment lacks. By focusing on the state of serious gaming for smartphones, valuable data can be gathered because smartphones and wearables are very related to each other. In addition to that, analyzing the state of serious gaming for smartphones gives an insight in market size, applications, and the degree to which these games are played on a daily basis.

The mobile Health app market has made some significant progress along the industry hype cycle. It may not be the number one topic on mobile congresses or thought leader events, but over the period of the last two years, the perception of mobile Health has become increasingly business oriented. In other words, the mobile Health app market has already entered the commercialization phase. The number of mobile Health apps that are published on the two leading platforms, iOS and Android, has more than doubled in only 2.5 years to reach more than 100,000 apps (Q1 2014). The market revenue reached USD 2.4bn in 2013 and is projected to grow to USD 26bn by the end of 2017.

When combining the high usage rate of smartphones with the enormous popularity of app downloads, it can be concluded that the usage of smartphone applications should have great potential to promote changes in behavior. This can for instance be towards a healthier lifestyle. (West, et al., 2012).

According to a report by Flurry Analytics, the growth in the average daily use of mobile Health apps on iOS devices is 62%. This is a lot higher when compared to the growth rate of the entire market, which is 33%. This means that mobile Health apps are used 87% more than other apps on a daily basis (Khalaf, 2014). This is also reflected in the wide range of fitness and health accessories for iPhone and iPad. In addition, software providers have developed platforms that collect data from various apps and devices that track your health, to build a platform that collects all your personal physical information (i.e. Apple Health).

When looking at the current mobile Health apps, fitness apps are by far the biggest category. These apps contribute 30,9% to the total amount of mobile Health apps available. These fitness apps are mobile Health apps which are available for the consumer market and therefore smartphone and wearable device manufacturers will focus on the development of these functionalities. This leads to the fact that serious health gaming for consumers might differ from their more professional counterparts which are mainly aimed at professional healthcare institutions. Where professional healthcare serious gaming is more focused towards diseases and handicaps, the consumer counterpart aims for improving lifestyles by promoting physical activity and healthy inner care. (Jahns, 2014)

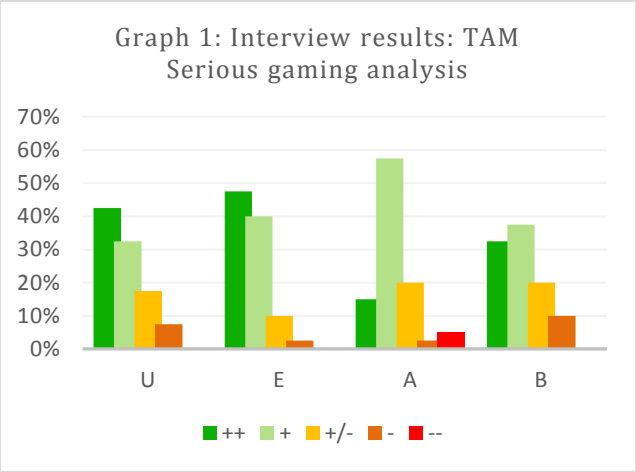
3. EMPIRICAL RESEARCH

3.1 Adoption of serious health gaming

The adoption of serious health gaming can be clarified by using the TAM-model by Davis. This model has been introduced in chapter 2.3 and highlights the different aspects which influence the adoption of technology process. These are listed on the next page.

- Perceived Usefulness (U)
- Perceived Ease of use (E)
- Attitude toward using (A)
- Intention to Use (B)
- Actual System Use

At first, it is important to find out whether people are willing to accept serious gaming. When looking at personal opinions on serious games, data gained from 40 interviews based on the PRIMA method comes in useful. These interviews have been conducted among a widespread array of respondents. More information on the data gathering process can be found in chapter 1.3. In the interviews, the opinions on the use of serious games have been queried. The relevant results are presented in graph 1 below.



For the factors U, E, A and B, the interviews give a clear insight. What we see from this data is that people in general are very willing to adopt serious games. This is also supported by the data presented in Table 5. This table shows the relative distribution of answers for the different categorized answers. The total of positive reactions for all the different TAM-model factors is above 70%. These numbers show that most people have confidence in serious gaming.

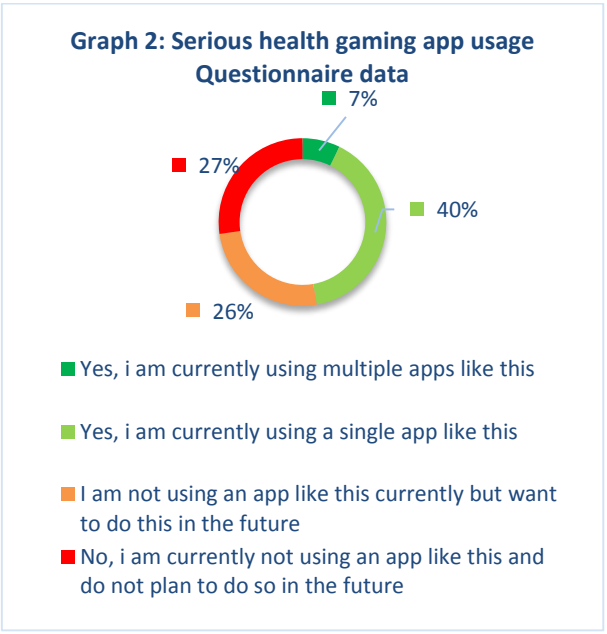
What we see very clearly in this graph is that respondents have a positive opinion on the relevance of serious gaming for improving their personal health. Next to that, respondents are confident in the user-friendliness of serious games. The attitude towards serious gaming is predominantly positive and this has a great effect on the willingness of people to use serious gaming in their everyday life.

The factors U and E deserve some extra notice, since the answers from the interviews show that people have a lot of confidence in both the Perceived Usefulness as well as the user-friendliness of serious games. This is probably caused by the added functionality and user-friendliness apps on their smartphones offer since most people associate serious gaming with a mobile app, played on their smartphone.

When looking at the actual usage of fitness apps, the questionnaire provides additional data. When asked about the usage of fitness and running apps, the response is quite two-sided. Currently 47% of the respondents is using one or more fitness apps. On the other hand, 53% states that they are not using apps like these. 26% of the respondents claim however that they are willing to use these in the future. This shows that fitness apps have been adopted widely, although not to a degree that sets an industry standard.

The willingness towards adoption is very clear however, which will obviously lead to a wider spread adoption of this technology.

When looking at the Product Life Cycle, serious health gaming can be considered as a growing phenomenon which will become bigger over the coming period.



When looking at Roger's Diffusion of Innovation curve, the adoption of serious health gaming is approximately in the late early majority. Therefore the late majority and laggards should still be convinced. The data gained from the interviews show promise on this point, since 75% of respondents perceives these apps as useful. Following from this data, 73% of respondents claims they have the intention to use these apps. This data shows the massive potential market of these applications. Considering the huge size of this market currently, it provides a good basis for industries that are related to the serious health gaming industry.

3.2 Adoption of Wearables

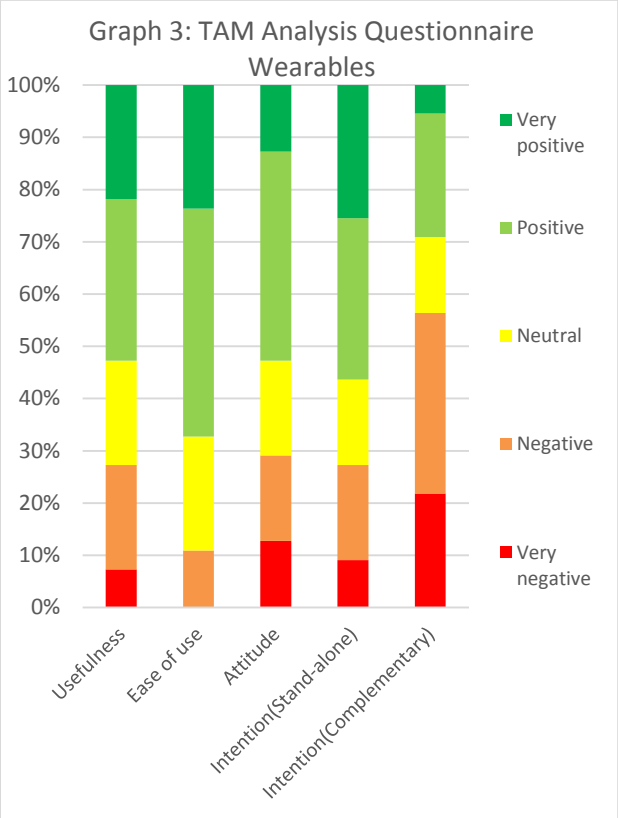
Currently for most people the smartphone is the main device of choice . (Stevens, 2015) These devices have been widely spread and the technology has advanced to a degree in which everyone can find a smartphone that suits their needs. Whether looking at cheap or expensive smartphones, the most basic technologies incorporated correspond and so do the functions offered. When looking at the product life cycle (Vernon, 1979), it is clear that these devices have become mature. As shown before in this thesis, the massive success of the smartphone industry heavily influences the development of new applications and therewith also the introduction of serious gaming for individuals. Market data has shown that serious health gaming apps are quickly becoming a success over the last few years. Next to that, data by Flurry Analytics shows that fitness apps are used way more on a daily basis than other apps.

The success and growth of serious gaming apps, especially with health and fitness functionalities together with the development of new technologies and the growing ability to equip small devices with new technology for the mainstream market lead to a new group of products which can be worn (Pyattaev, Johnsson, Andreev, & Koucheryavy, 2015) in which the tech world is creating a future of wearable devices. They promise to entertain consumers and help in adopting a healthier lifestyle.

Technology companies' interests in health and wellness have sparked the creation of a myriad of wearable devices, from fitness bands that monitor activity and sleep patterns to flexible patches that can detect movement, body temperature, heart rate,

hydration level and more. These devices produce data that, often enabled with analytics, can be used by consumers to manage their health and by healthcare organizations to improve care and potentially reduce costs through systems such as remote patient monitoring. For more information on the sensors present in wearable technology, check back to chapter 2.2 or appendix B1 & B2. Data generated by personal devices can be used by insurers and employers to better manage health, wellness and Introduction healthcare costs, and by pharmaceutical and life sciences companies to run more robust clinical trials and capture data to support outcomes-based reimbursement. Many consumers believe wearables can dramatically improve their health (Barnes, et al., 2014)

To find out whether these statements are true and which functions are really desired by the potential market a questionnaire research has been carried out. At first, the opinion of potential customers towards wearable devices has been researched. This research is based on the TAM-model by Davis(1989) which is described in chapter 2.5.



When looking at the TAM analysis conducted in the questionnaire, several observations can be made. At first, it is clear that the respondents were convinced in the ease of use wearable devices can offer. The majority of respondents came up with a positive answer. Next to that, the share of negative answers is relatively seen very low, only 6 people were negative on this aspect. When looking at the other factors influencing technology acceptation, it is clear to see that the perceived usefulness, attitude towards using and intention to use are relatively positive. The majority of respondents answered positively towards these aspects and are therefore showing that they are willing to adopt this new technology. What must be noted for intention however is that respondents are clearly more positive towards wearables that can be used as a stand-alone device when compared to those that can only function as complementary device. This could possibly be caused by the associations people have with smart electronic devices. Currently most smart device can fulfill a wide variety of functions which is reflected in the great availability of all-in-one devices like consoles, computers, laptops, tablets and even hybrid devices.

The TAM-model also incorporates a building block which measures the actual system use. In the questionnaire conducted, questions have been asked about the current usage of wearable devices. The results to these questions are presented in appendix C1.

When looking at this data, it is very clear that a small share of the respondents is currently using a wearable device. Only 16% states that they use wearables. Within this sample, no dominant group can be identified since there is no device category that has been represented more than the others. When comparing this adoption rate with the estimations by Business Insider and CCS Insight, some similarities come to mind.

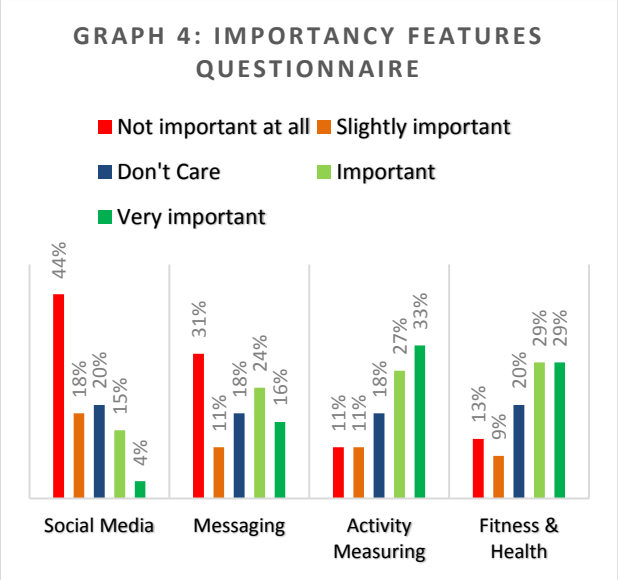
Both Business Insider and CCS Insight claim that the current adoption rate of wearable devices still has a lot to grow before reaching it's potential. BI states that in 2015, a total of 33 million wearable devices will ship. This should grow to 148 million in 2019. CCS Insight published market data which are somewhat comparable. According to them, shipments of smart wearables are expected to grow from 22 million in 2014 to 135 million in 2018.

When looking at the data gained from the questionnaire this data gets somewhat confirmed. The TAM-analysis shows that respondents in general have a positive opinion on wearable devices and are convinced in the ease of use and usefulness these wearables can offer. Next to that, the majority of people claims they have the intention to use wearable devices in the future. What has to be noted however is that this applies for wearables which can be used as a stand-alone device. The questionnaire has shown that people are not so eager to adopt complementary wearable devices. Lastly, the attitude towards using wearables is also predominantly positive. This TAM analysis shows that people are confident in the wearable product category. The technology gets accepted by the majority of respondents when looking at the TAM-analysis, this shows the massive market potential which is available for these devices.

The current usage rate might be low, but when looking at the TAM-model the breakthrough point has been reached. Next to that, Roger's diffusion of innovation curve shows that diffusion of innovations gets faster over time in the first stages of the product life cycle. Considering the current usage rate and the market acceptation of wearable devices, it is likely that the wearable industry will grow rapidly in the short-term.

3.3 Perceived feature importance

The previous chapters have shown that people are willing to adopt wearable devices. The TAM analysis has shown that people are confident in the wearable product category. The technology gets accepted by the majority of respondents, this shows the massive market potential which is available for these devices. The current usage rate might be low, but this data promises a bright future for this industry. Within the questionnaire research, respondents have also been asked which features are most important for wearable devices in their opinion. The most important categories have been chosen, based on the performance of these apps on smartphones. The added value wearables can offer for these various functions have been shown and outlined thoroughly within the questionnaire. These questions were asked based on a Likert scale from 1-5 in which 1 represents 'not important at all' and 5 'very important' The results from these questions are shown in graph 4.

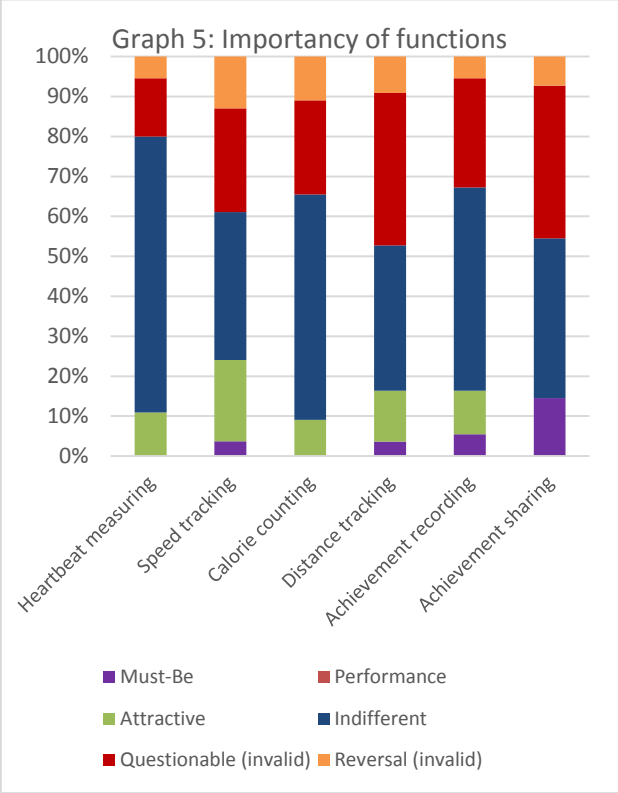


This graph shows the most important functions for wearable devices and how their importance is perceived in the minds of potential customers. What is clear is that social media functions are not perceived important by potential customers. The majority of respondents stated that these functions are not important if they were looking to buy a wearable. This is somewhat surprising because social media has grown enormously as a consequence of the mobilization of devices. Apps like Twitter & Facebook are the most popular ones on the different app stores, according to their data. Messaging functions are a more doubtful category. The responses are dubitable and do not show a clear image. 31% of respondents claim that these functions are not important at all. On the other hand, 40% of respondents think these functions are at least important.

When looking at Activity measuring and Fitness & Health functionality, the opinion of respondents is very clearly shifted to the positive side. Respondents think these functions are absolutely important and would be the main functionalities people are looking for in wearable devices. This can partly be explained by the enormous popularity of these apps for smartphones. It can also be explained by the additional functionalities wearable devices can offer. This is supported by (Tehrani & Michael, March 2014), who state that wearable devices can perform many of the same computing tasks as mobile phones and laptop computers; however, in some cases, wearable technology can outperform these hand-held devices entirely. Wearable technology tends to be more sophisticated than hand-held technology on the market today because it can provide sensory and scanning features not typically seen in mobile and laptop devices, such as biofeedback and tracking of physiological function. These functions are most applicable for activity tracking and fitness & health functionality.

Literature research provided an overview of technologies which can currently be incorporated in wearable devices. These technologies have their own functionalities and can be used for various app specific functions. To find out which functions are currently offered for wearable devices, information on currently existing applications have been gathered. Subsequently, existing wearable devices have been analyzed to form an extensive overview of available functions. This overview can be found in the appendix B1 & B2.

Following from this overview, a questionnaire has been spread to find out which functions are perceived as most important by respondents. These questions asked are based on the Kano model. The Kano Model of Customer Satisfaction classifies product attributes based on how they are perceived by customers and their effect on customer satisfaction. (Sauerwein, Bailom, Matzler, & Hinterhuber, 1996). This method distinguishes five different classifications in product attributes, placed in appendix A5. The results from the questionnaire research conducted have been categorized according to the Kano Model. The results are presented in graph 5 below.



This graph clearly shows that there is a lot of confusion present among respondents. The high amount of responses that led to an indifferent classification shows that respondents did not really know which aspects are good and bad in wearable devices. This is highlighted by the high amount of responses that led to an invalid categorization. For those who did know what to look for in wearables, the unimportance of achievement sharing is notable. This may incorporate the fact that people are not willing to share their personal data with relatives.

4. ANALYSIS

What we see very clearly in chapter 3.1 is that respondents to the interview have a positive opinion on the relevance of serious gaming for improving their personal health. Next to that, respondents are confident in the user-friendliness of serious games. The attitude towards serious gaming is predominantly positive and this has a great effect on the willingness of people to use serious gaming in their everyday life. Also, the responses to the interviews have shown that people have a lot of confidence in the usefulness and user-friendliness of serious games. These results correspond with conducted questionnaire research (graph 1) and existing literature like Zyda; West et al and Jahns, who describe the different factors that led to recent successes of serious health gaming.

When asked about the usage of fitness and running apps, the response is more two-sided. There is however a majority that is using these apps or have the intention to use them on the short term. This shows that although fitness apps have been adopted

widely, they did not yet reach their full market potential. When analyzing this data with Diffusion of Innovations and the Product Life Cycle in mind , serious health gaming can be placed in the phase of the late early majority. This incorporates the fact that serious health gaming is adopted and accepted by approximately half of the population, which are characterized by their high propensity towards innovations. The rest of the population, who are generally far more conservative, still haven't adopted these games however.

The positive perception of usefulness and user-friendliness shows however that serious health gaming has overcome the breakthrough point and will probably grow very fast in the short term. With this knowledge, it is interesting to look at the side effects this causes for the wearable industry.

When comparing this data to the data on wearable devices gathered by the questionnaire, some similarities arise. Respondents are also predominantly positive towards wearable devices and most importantly appreciate the usefulness and ease of use these devices can offer. These similarities in people's mindset may lead to a situation in which wearables and serious gaming can function as complementary technologies which are strengthening each other

This gets confirmed by questionnaire data (Graph 4). This data shows that people are far more interested in activity measuring and fitness & health functionalities when compared to other popular features like messaging and social media. Next to that, the statements of Rawassizadeh et al; Stevens; Danova and Tehrani & Michael confirm the importance of serious health gaming for wearable devices.

The data gathered by the questionnaire based on the Technology Acceptance Model shows the willingness of respondents to adopt wearables as new products. As stated before, the main factor for this are the usefulness and ease of use wearable devices can offer. Respondents perceive these factors as very positive and are therefore likely to accept this technology. When looking at the other factors influencing technology acceptation, it is clear to see that the attitude towards using and intention to use are perceived more doubtful but still relatively positive.

What these results mainly show is that wearable devices have not yet been accepted and adopted up to a degree which serious health gaming has already achieved. This is also reflected in the current usage rate of both technologies. The current usage rate might be low, but when looking at the TAM-model in combination with Diffusion of Innovations and the PLC, it is likely that the breakthrough point has been approached.

What can be concluded from the data gathered by the interviews and questionnaire combined is that although serious gaming and wearable devices are alike in most parts of the TAM analysis, they mainly differ when looking at the current adoption rate and the intention to use them in the short term. Serious health gaming is clearly ahead of wearables and can therefore function as the killer feature for these devices.

To find out which serious health gaming functionality is the main reason why people are looking to buy wearable devices, the Kano-model based questionnaire comes in useful. This model identifies various product characteristics based on customer perception by a specific framing of questions. What the data gathered by this survey research shows is that activity measuring and fitness & health applications are clearly perceived as most important. At the same time however, this analysis shows that respondents do not really know which specific functions they are looking for. The answers often led to an answer classification of 'Indifferent' which means that respondents do not care whether this function is available on the wearable device. This is in line with the lack of confidence people have in the information quality serious health gaming can deliver. Results of this interview research (which can be found in appendix C1) has shown that respondents do think that serious health gaming provides additional data which might be valuable for activity tracking. At the same time they strongly doubt the quality of this information.

What is noteworthy about this finding is that although people have strong doubts about the information quality of serious health gaming and the features within wearables that add value to them, respondents still think that wearables are useful and easy to use. Considering these facts and the customer's perception derived from the TAM-analysis, as well as the current usage rate and the it is likely that the wearable industry will grow rapidly in the short-term. This can be clarified by referring to diffusion of Innovations (Rogers, 1971) and the Product Life Cycle (Vernon, 1979) which show that adoption of innovations gets faster over time in the first stages of the product life cycle. This finding supports the statements of business intelligence institutes like BI and CCS Insight. It is likely that in the beginning, potential customers will be adopting wearables merely for the reason of eagerness.

5. CONCLUSIONS

In this Bachelor Thesis, I tried to outline the success and growth of serious health gaming apps. Consequently the future of the wearable industry has been analyzed by gathering information on the acceptation process potential customers have to go through. This process has been elaborated on, from both the technical as well as the market perspective. The research question to be answered in this thesis has been the following:

To what extent does serious gaming influence the market adoption process of wearable technology products?

To find an answer for this question, a multi-method approach has been used. This existed of an extensive literature review, analysis of interviews based on the PRIMA-method and a questionnaire research design. What has been underlying these research methods are the Technology Acceptance Model (TAM) by Davis (1989), the Kano model by Kano (1984) ,Diffusion of Innovations by Roger's (1971) and the Product Life Cycle Model by Vernon (1979).

When looking at the results these methods have led to, it is clear that serious health gaming is perceived positive by current and potential customers. This is mainly due to the fact that these apps are perceived useful and user-friendly which leads to an overall positive attitude. Next to that, people who currently do not use these apps are inclined to do so in the short term. Comparing these findings to existing literature, some confirmation can be found when looking at the main characteristics of a serious health game. Literature mainly emphasizes the meaningful educational purpose, entertainment and play elements incorporated into serious health gaming. This is reflected in the interview results which highlight these same characteristics. Serious health gaming still has some issues to fix however, especially the perceived information quality is perceived badly by respondents. If this quality is actually relatively low, this might be a drawback in the practical added value of these games for health purposes.

When looking at the current state of serious health gaming, it is clear that about half of the respondents is currently using one of or more of these applications. Another quarter is willing to use such an application on the short term. When analyzing this with the TAM-model and subsequently the diffusion of innovations and product life cycle model, it seems clear that massive market growth will be achieved on the short term. This is mainly due to

the fact that the current adoption rate and customer perception is characteristic for the market phase in which fast growth is normally achieved. This opens up new possibilities for related industries which are able to join this success.

One of these industries could be the wearable technology devices industry if serious health gaming functionality proves that it is the 'killer-app' for this industry. Technology giants are massively focusing on health monitoring and promoting healthy lifestyles and therefore it is interesting to find out whether people perceive this functionality as the most important for wearables.

First, the interest of people in wearable devices has been investigated. This has been done by spreading a TAM and Kano-based questionnaire. Results from this questionnaire mainly show that people are interested in wearable devices and also have the intention to use them. The current usage rate is very low but the perceived usefulness and user-friendliness is considered positive.

With this information, an analysis for the future of this industry can be made. This analysis is based on a multi method research approach which has been conducted. The used methods have originated from the technological as well as the consumer market viewpoint. In this analysis, it became clear that the perception of people towards wearables is slowly but steadily becoming more positive. Considering the TAM, PLC model and Roger's Diffusion of Innovations, it is likely that this technology will grow massively over the coming years because it emphasizes the infancy of this industry. With this information in mind, it is interesting to take a look at the features people are looking for in wearable devices. A literature and field research has been conducted to find out what is currently technologically feasible and with this information a questionnaire has been constructed. People were asked to rank the most used features by importance and this has resulted in the situation in which activity tracking and fitness & health functionality are perceived as most important.

Because activity tracking and fitness & health functionality can consist of very different features and aspects, a study towards the technological possibilities and their customer perception has been conducted within this questionnaire. This has been based on the Kano method which distinguishes the customer satisfaction of different features. The results to these questions however show that although respondents are convinced that activity tracking and fitness & health functionality is crucial for wearables, they do not yet know exactly what they are looking for.

What might explain this confusion is a situation which is caused by several aspects. At first, interview research has shown that although people think serious health gaming provides useful physical data, the quality of this information is not convincing at all. People have massive doubts over this quality and if this perception is well-grounded, it has smashing consequences for the practical use of these games. Next to that, the added value of wearables, which have mainly measurement benefits, is questionable. It is likely however that information quality will improve in the coming years and therefore the quality perception of people will likely improve.

Another source of confusion is the wide variety of currently available wearable devices. There is no standard specification whatsoever and therefore functionalities vary enormously. This is mainly caused by the infancy of the industry and will probably fade out over time.

When looking at the general trend, it seems that people's attitude towards wearable devices is positive. The current adoption rate does not yet reflect this however. Therefore, it is likely that people who are currently looking to buy a wearable device are mainly curious towards these devices and see it as a must-have, without having any specific function for it in mind. The low adoption rate, combined with the doubts over functionalities wearables should offer lead to a situation which causes a lot of confusion among potential customers. This will very likely change in the future when more is known on the developments and capabilities of these devices. The positive acceptance of serious health gaming and wearable devices, together with the improved information quality and development of a dominant design should highly contribute towards a healthier worldwide lifestyle in the very near future.

6. DISCUSSION

In this bachelor thesis I tried to figure out whether serious health gaming is the reason for people to buy a wearable device. I came to this subject when I heard about the new wearables coming to the market and the fact that most people in my close circle were interested in buying them without knowing which functionality really adds value when compared to already possessed devices.

I started this thesis with a literature research. In this process I mainly searched for articles which are related to serious gaming or to wearable devices because articles that incorporate both are not existing. This literature added some new insights for me personally which are processed in this thesis. What may lead to some information discrepancy however is the fact that scientific papers on serious gaming almost always solely contain information smartphones. This may be a source of error since functionality can differ among devices. Next to that, electronic developments go very fast and therefore even recent theories are outdated very fast.

After the literature search, it was time to process the interview data of serious gaming. The data was provided as part of an assignment for the study Health Sciences. I have analyzed these interviews manually by classifying the different answers from respondents. This facilitated a better and more detailed overview of users perceptions on serious gaming. The manual processing was time-consuming but was important for acquiring new insights. The quality of the interviews was dual; some interviews were of a poor quality and not usable as part of academic research, while other interviews were very helpful. As for the profile of respondents for these interviews, it was generally very mixed. The ages of respondents ranges from 15 to 55 and various nationalities are represented.

After the data collection according to the PRIMA-method, information on wearables had to be gathered. This has been done by spreading a questionnaire among relatives. It has led to 56 respondents. It provided a nice profile of potential customer perceptions on wearables and serious gaming applications for these devices. As for the personal characteristics of the respondents, little is known because the research has been conducted anonymously. I've chosen for an anonymous method of collecting the data because it often leads to more respondents when comparing it to researches in which personal data is necessary to provide. Next to that, the fact that information is collected anonymously often leads to more distinct answers and less socially desirable statements. The personal characteristics of these respondents can be estimated however. It has been spread on personal social media accounts and among contacts within my phonebook. It is therefore likely that the majority of respondents is aged between 16 and 30. This may negatively affect the reliability and generalizability of the research conducted. On the other hand, this personal profile nicely fits into the consumer categories of Roger's diffusion of Innovations which is used. Since wearables are still in its infancy, young people are often most likely to adopt it at first.

7. REFERENCES

1. Abt, C. (1970). *Serious Games.* New York, U.S.A. : Macmillan Company of Canada Limited.
2. Apple inc. . (2015). WWDC. *Apple Worldwide Developers Conference.* San Francisco: Apple.
3. Barnes, K., Connolly, C., Tsouderos, T., Comer, B., Haflett, S., Cholera, U., & O'Neal, J. (2014). *Healt wearables: Early days.* PwC.
4. Breuer, J., & Bente, G. (2010). Why so serious? On the Relation of Serious Games and Learning. *Journal for Computer Game Culture*, 7 - 24.
5. Butte, N. F., Ekelund, U., & Westerterp, K. R. (2012). Assessing Physical Activity Using Wearable Monitors: Measures of Physical Activity. *Official Journal of the American College of Sports Medicine*, S7 - S9.
6. *Cisco Visual Networking Index: Global Mobile Data Traffic Forecast Update*. (2015, April 20). Retrieved from Cisco.com: http://www.cisco.com/c/en/us/solutions/service-provider/visual-networking-index-vni/index.html#~mobilevni
7. COAPIO, Medicine IO. (2012). *Accelerating progress in obesity prevention: Solving the weight of the nation.* USA: National Acadamies Press .
8. Danova, T. (2014). The Wearable Computing Market Report: Growth Trends, Consumer Attitudes And Why Smartwatches Will Dominate. *Business Insider Intelligence*, 1-29.
9. Davis, F. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS Quarterly 13*, 319-340.
10. Deacon, H., & Koytcheva, M. (2014, August). *Smartwatches and Smart Bands Dominate Fast-Growing Wearables Market.* Retrieved from CCS Insight: http://www.ccsinsight.com/press/company-news/1944-smartwatches-and-smart-bands-dominate-fast-growing-wearables-market
11. Direito, A., Pfaeffli Dale, L., Shields, E., Dobson, R., Whittaker, R., & Maddison, R. (2014). Do physical activity and dietary smartphone applications incorporate evidence-based behaviour change techniques? *BMC Public Health*.
12. Engeland, A., T, B., Tverdal, A., & AJ, S. (2004). Obesity in adolescence and adulthood and the risk of adult mortality. *Epidemiology*, 79 - 85.
13. Guglielmo, C. (2014, March 3). *Forbes: The Case Against Wearables, Or Why We Won't All Look Like The Borg This Year*. Retrieved from Forbes.com: http://www.forbes.com/sites/connieguglielmo/2014/02/12/the-case-against-wearables/
14. Harteveld, C., Guimaráes, R., Mayer, I., & Bidarra, R. (2009). *Balancing Pedagogy, Game, and Reality. The Design Philosophy of LEVEE PATROLLER.* Sage Publications.
15. Jahns, R. (2014). *mHealth App Developer Economics 2014*. Berlin, Germany: Research2guidance.
16. Kano, N., & al, e. (1984). Attractive Quality and Must Be Quality. *The Journal of Japanese Society for Quality Control*, 39 - 48.
17. Khalaf, S. (2014, June 19). *Flurry; Health and Fitness Apps Finally Take Off, Fueled by Fitness Fanatics*. Retrieved from Flurry.com: http://www.flurry.com/blog/flurry-insights/health-and-fitness-apps-finally-take-fueled-fitness-fanatics#.VTko1iHtlBc
18. Koplan, J., Liverman, C., & Kraak, V. (2005). *Preventing childhood obesity: Health in the balance.* Washington D.C.: National Academies Press.
19. Kranenburg, K. v., Slot, M., Staal, M., Leurdijk, A., & Burgmeijer, J. (2006). *Serious Gaming: Onderzoek naar knelpunten en mogelijkheden van serious gaming.* Delft: TNO.
20. Lam Po Tang, S. (2007). Recent developments in flexible wearable electronics for monitoring applications. *The Institute of Measurment and Control*, 283 - 300.
21. Lenhart, A., Kahne, J., Middaugh, E., Macgill, A., Evans, C., & Vitak, J. (2008, September 16). *Teens, Video Games and Civics.* Retrieved from PewResearchCenter: http://www.pewinternet.org/2008/09/16/teens-video-games-and-civics/
22. Liu, C., Zhu, Q., Holroyd, K., & Seng, E. (2011). Status and trends of mobile-health applications for iOS devices: A developer's perspective. *The Journal of Systems and Software*.
23. Mann, S. (2014). Wearable Computing. *The Encyclopedia of Human-Computer Interaction, 2nd Ed*.
24. Michael, D., & Chen, S. (2006). *Serious Games: Games That Educate, Train and Inform.* Boston: Thomson Course Technology PTR.
25. Miles, M. B., & Huberman, A. M. (1994). *Qualitative Data Analysis.* London: Sage Publications.
26. Pedersen, I. (2014). Are Wearables Really Ready to Wear? *IEEE Technology and Society Magazine*, 16 - 18.
27. Pyattaev, A., Johnsson, K., Andreev, S., & Koucheryavy, Y. (2015). Communication Challenges in High-Density Deployments of Wearable Wireless Devices. *IEEE Wireless Communications*, 12 - 18.
28. Rawassizadeh, R., Price, B. A., & Petre, M. (2015). Wearables: Has the Age of Smartwatches Finally Arrived? *Communications of the ACM Vol. 85 No.1*, 45 - 47.
29. Reilly, J., Methven, E., McDowell, Z., Hacking, B., Alexander, D., Stewart, L., & Kelnar, C. (2003). Health consequences of obesity. *Arch Dis Child*, 748 - 752.
30. Ritterfeld, U., Cody, M., & Vorderer, P. (2009). *Serious Games: Mechanisms and Effects.* Mahwah, NJ: NJ: Routledge.
31. Rogers, E. M. (1971). *Diffusion of Innovations.* New York: The Free Press.

32. Sauerwein, E., Bailom, F., Matzler, K., & Hinterhuber, H. (1996). The Kano Model: How to delight your customers. *Preprints Volume I of the IX. International Working Seminar on Production Economics*, (pp. 313 - 327). Innsbruck, Austria.

33. *Statista: Stats and Facts about App Stores*. (2015, April 15). Retrieved from Statista.com: http://www.statista.com/topics/1729/app-stores/

34. Stevens, C. (2015). *WEARABLES: geek chic or the latest 'must have' consumer tech?* GfK.

35. Tehrani, K., & Michael, A. (March 2014). Wearable Technology and Wearable Devices: Everything You Need to Know. *Wearable Devices Magazine, WearableDevices.com*.

36. Thompson, D. (2014). What Serious Video Games Can Offer Child Obesity Prevention. *JMIR Serious Games*.

37. Vernon, R. (1979). The product cycle hypothesis in a new international environment. *Oxford Bulletin of Economics and Statistics*, 255 - 267.

38. West, J., Cougar, P., Hanson, C., Barnes, M., Giraud-Carrier, C., & Barrett, J. (2012). There's an App for That; Content Analysis of Paid Health and Fitness Apps. *Journal of Medical Internet Research*, 1- 12.

39. Yoganathan, D., & Kajanan, S. (2013). *Persuasive Technology for Smartphone Fitness Apps.* Singapore: Department of Information Systems, School of Computing, National University of Singapore.

40. Zimmerman, E., & Salen, K. (2003). *Rules of Play: Game Design Fundamentals.* MIT Press.

41. Zyda, M. (2005). From Visual Simulation to Virtual Reality to Games.

7.1 Appendix

A1: Roger's Diffusion of Innovations Theory

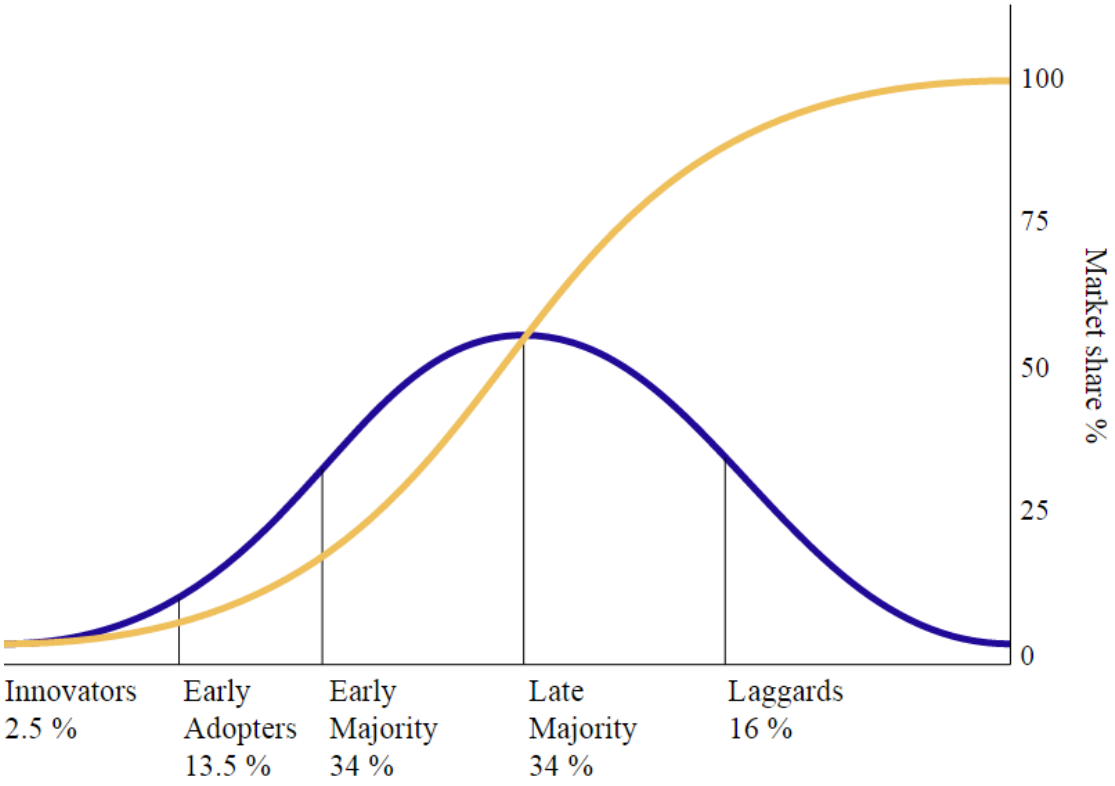
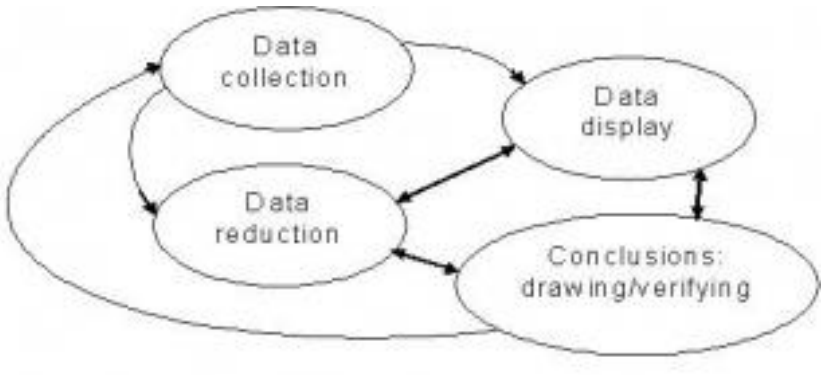


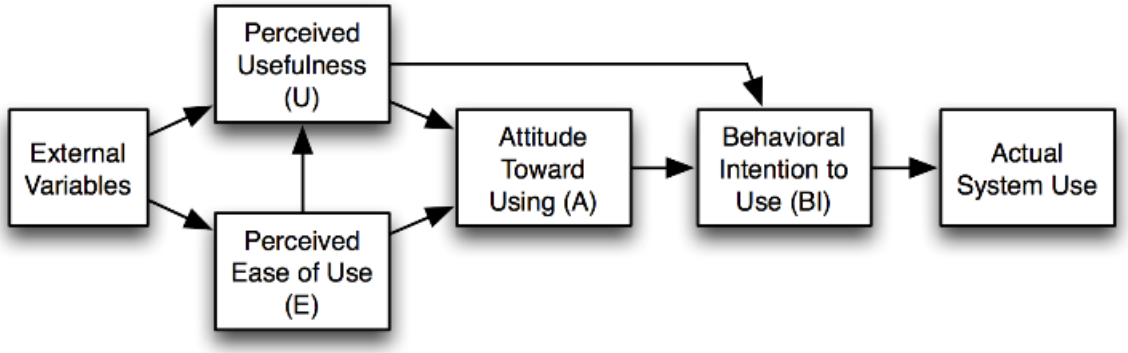
Table A1: Roger's Adopter Categories	
Adopter categories	**Definition**
Innovators	Innovators are willing to take risks, have the highest social status, have financial liquidity, are social and have closest contact to scientific sources and interaction with other innovators. Their risk tolerance allows them to adopt technologies that may ultimately fail.
Early adopters	These individuals have the highest degree of opinion leadership among the adopter categories. Early adopters have a higher social status, financial liquidity, advanced education and are more socially forward than late adopters. They are more discreet in adoption choices than innovators use judicious choice of adoption to help them maintain a central communication position.
Early Majority	They adopt an innovation after a varying degree of time that is significantly longer than the innovators and early adopters. Early Majority have above average social status, contact with early adopters and seldom hold positions of opinion leadership in a system
Late Majority	Adopt an innovation after the average participant. These individuals approach an innovation with a high degree of skepticism and Late Majority have below average social status, little financial liquidity, in contact with others in late majority and early majority and little opinion leadership.
Laggards	Individuals in this category show little to no opinion leadership. These individuals typically have an aversion towards change. Laggards typically tend to be focused on "traditions", lowest social status, lowest financial liquidity, oldest among adopters, and in contact with only family and close friends.

A2 Qualitative Data Analysis (Miles & Huberman, 1994)

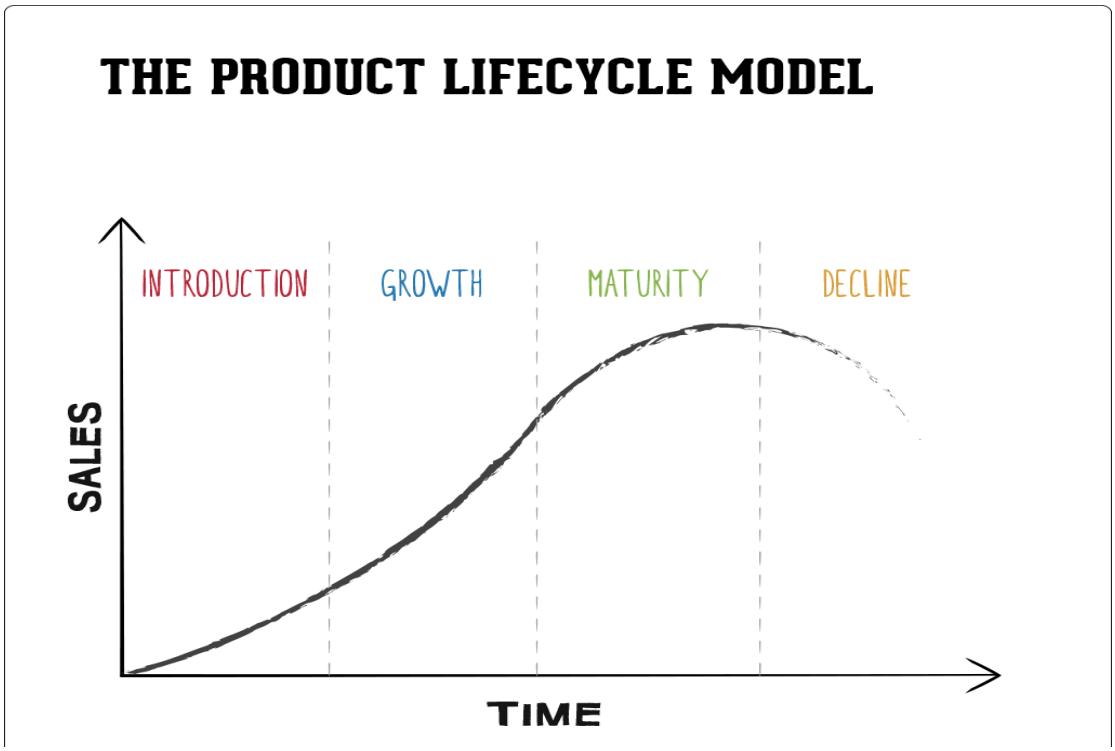


(Miles & Huberman, 1994)

A3 Technology Acceptance Model *(Davis, 1989)*



A4 Product Life Cycle Model *(Vernon, 1979)*



A5 Kano Model Analysis *(Kano, N et al., 1984) (Sauerwein, Bailom, Matzler, & Hinterhuber, 1996)*

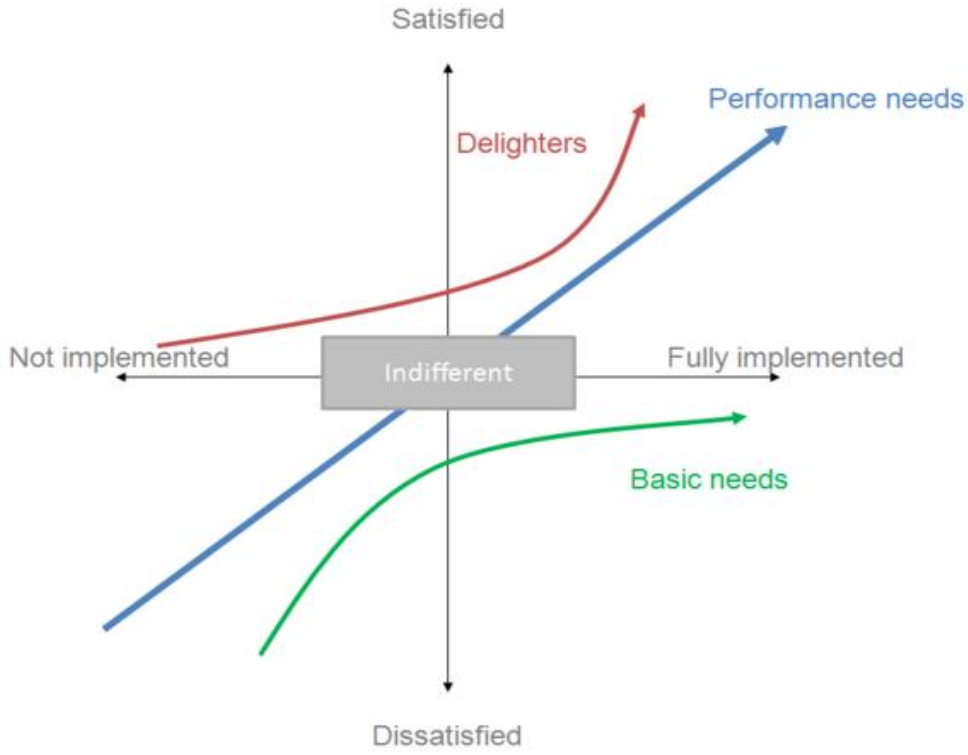


Table A5: Kano model categories	
Must- be	Taken for granted when fulfilled but result in extreme dissatisfaction when not fulfilled. Fulfilling the must-be requirements will only lead to a state of "not dissatisfied".
Attractive	Attractive requirements are those product criteria which have the greatest influence on how satisfied a customer will be with a given product. Result in satisfaction when fulfilled and dissatisfaction when not fulfilled.
One-dimensional	In One-dimensional requirements, customer satisfaction is proportional to the level of fulfillment - the higher the level of fulfillment, the higher the customer's satisfaction and vice versa. One-dimensional requirements are usually explicitly demanded by the customer.
Indifferent	Aspects that are neither good nor bad, and they do not result in satisfaction or dissatisfaction
Reverse	High degree of achievement resulting in dissatisfaction and highlights the fact that not all customers are alike

B1 Wearable Technologies & Functions.

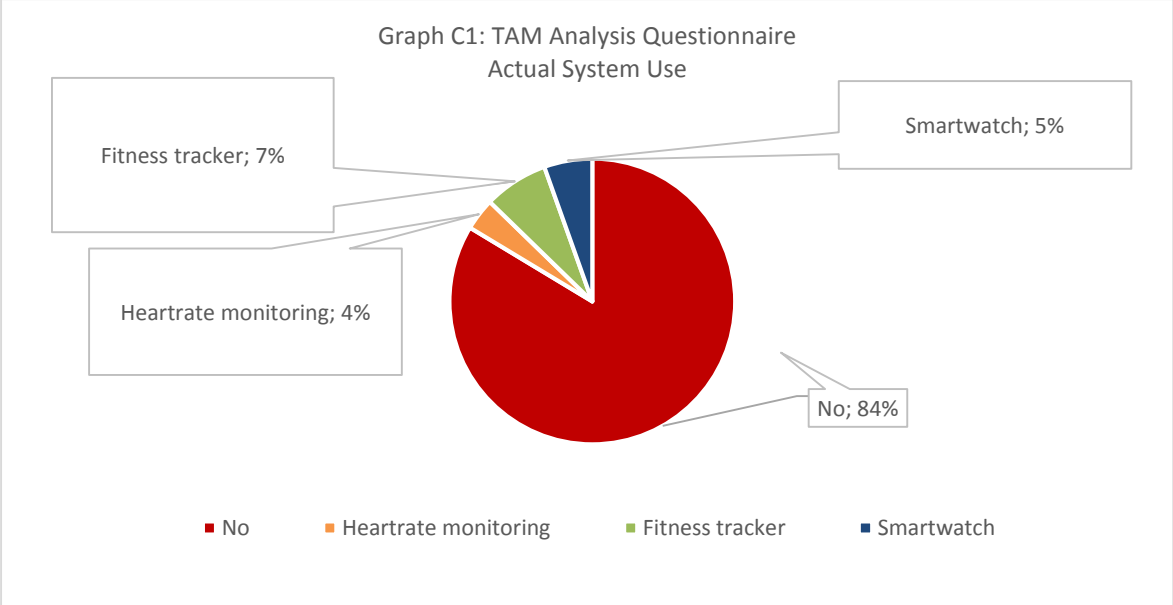
Table B1: Wearable Technologies & Functions	
Technology	**Function**
Pedometer	Pedometers are most accurate at step counting, less accurate in distance estimates, and even less accurate at estimating Energy Expenditure.
GPS	A Global Positioning System (GPS) is a satellite-based system that can provide information on a person's location, neighborhood context, mode of transportation, and speed of locomotion
Accelerometer	Record motion in one or more planes and provide an indication of the frequency, duration, and intensity of physical activity
Heart rate monitor	Lightweight devices that monitor the current heart rate and can be used to predict Energy Expenditure resulting from physical activity.
Bluetooth	A computing and telecommunications industry specification that describes how mobile phones, computers and other devices equipped with can easily interconnect with each other
Wi-fi	a local area wireless computer networking technology that allows electronic devices to network over various radio bands.

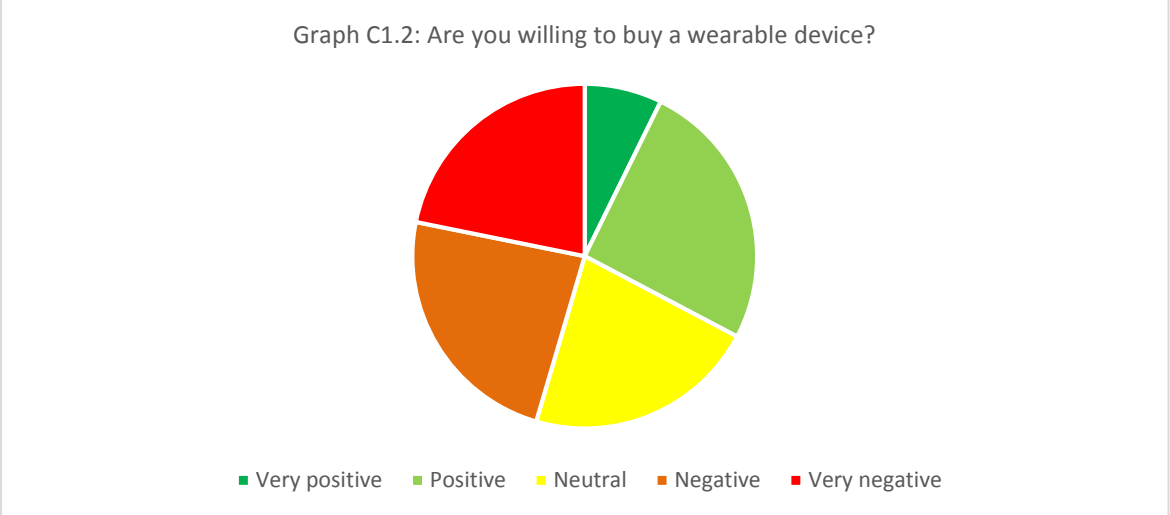
B2 Technologies, measurements & data/functions in wearable devices.

Table B2: Technologies, measurements & data/functions in wearable devices.		
Technology	**Measurements**	**Data/function**
Pedometer	Step counting, distance estimation	Distance + speed tracking. calorie counting
GPS	Distance tracking, speed tracking, mode of movement	Distance + speed tracking, recording achievements
Accelerometer	Speed tracking	Speed tracking
Heart rate monitor	Heart rate monitoring, Energy Expenditure	Heartbeat measuring + calorie counting
Bluetooth	Interconnects devices	Sharing capability + expandability
Wi-fi	Networking capability, location estimation	Sharing capability + expandability

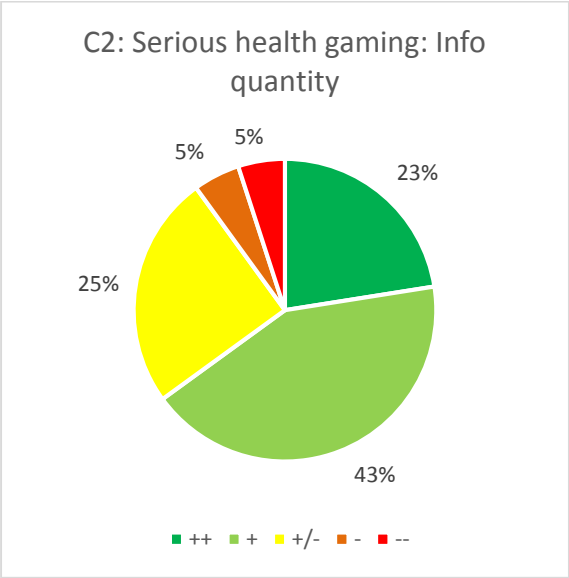
(Butte, Ekelund, & Westerterp, 2012) / (Yoganathan & Kajanan, 2013)

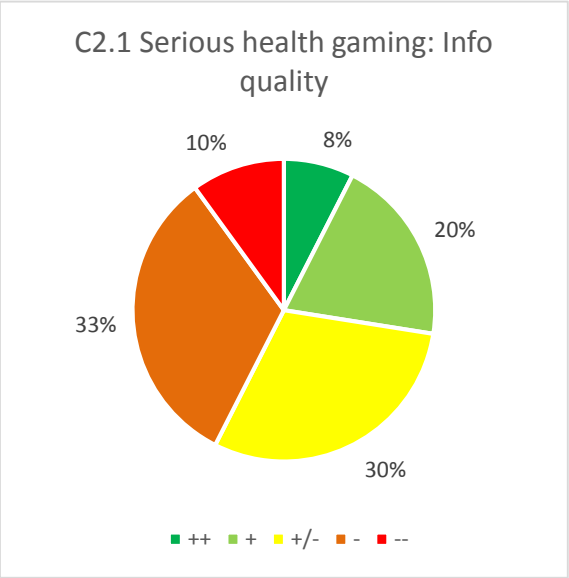
C1 : Graph TAM Analysis Questionnaire





C2: Interview analysis: information quantity & quality





D1: PRIMA-interview template (DUTCH)

Datum interview:	
Naam interviewer:	
Naam geïnterviewde:	
Leeftijd:	
Geslacht:	
Hoogst genoten opleiding?	

P	In hoeverre past een SERIOUS GAME in uw dagelijkse routine?
P1	De meeste SERIOUS GAME systemen dragen bij aan verschillende leef en werk processen. Kunt u de belangrijkste processen/activiteiten noemen waarbij u de computer gebruikt? Dit hoeft dus niet persé via een SERIOUS GAME te zijn.
P 2	Welke media gebruikt u het meest om in contact te komen met andere mensen? (mail, apps, social media)? Vanaf welke apparaten maakt u het meest gebruik om dat te doen?
P 3	Welke uitzonderingen of verstoringen maken dat een systeem als deze soms spaak loopt en dat u contact via andere wegen, dan via de computer, moet belopen?
REL	In hoeverre is een SERIOUS GAME voor u persoonlijk relevant?
R1	Denkt u dat het gebruik van een serious game uw persoonlijke gezondheid kan verbeteren? Welke aspecten zal het verbeteren en in welke mate: + inzicht + monitoring
R2	Denkt u dat het gebruik van een SERIOUS GAME gemakkelijk gaat zijn? Waarom wel, waarom niet?
R3	Vind u het goed dat de informatie die u levert over uw gezondheid, gebruikt kan worden voor groot statistisch onderzoek (uw medische gegevens zijn dus niet meer gekoppeld aan u als persoon)? Waarom wel, waarom niet?
R4	Vind u het goed medische professionals gebruik maken van gegevens die u heeft ingevoerd bij het stellen van diagnoses en behandelingen? Waarom wel, waarom niet?
R 5	Op welke punten zou de inzet van ICT voor u van persoonlijk belang kunnen zijn? + aan wat voor soort toepassing denkt u dan? + voor welk doel of in welke situatie te gebruiken?
R6	In hoeverre draagt ICT bij in de informatie die u binnenkrijgt, zoals social media en mail?
INF	Wat is de kwaliteit van de informatie?
I1	Denkt u dat de kwantiteit van medische informatie die u krijgt toeneemt als u een SERIOUS GAME gebruikt?

	+ Heeft u er makkelijker toegang tot? + Leidt de combinatie van informatie die u aanlevert en die van artsen tot synergie? + Denkt u dat een SERIOUS GAME over voldoende informatie beschikt om een goed inzicht te krijgen in uw persoonlijke gezondheid? + Denkt u dat een SERIOUS GAME u informatie kan geven over elk aspect van uw gezondheid?
I2	Denkt u dat de kwaliteit van medische informatie die u krijgt toeneemt als u een SERIOUS GAME gebruikt? + Zal de informatie (meer) fouten bevatten? + Zal de informatie consistent zijn?
I3	Denkt u dat u over voldoende medische kennis beschikt om de gegevens aangedragen door een SERIOUS GAME zelf te kunnen intepreteren? + Heeft u hier andere media voor nodig? (Internet, telefonisch contact met arts(-assistent)?
I4	Welke informatie bent u bereidt te delen met het SERIOUS GAME? + Lichaamsgegevens (Hartslag, bloeddruk) + Gewoontes (Drinken, roken, andere verslavingen) + Omgeving (gezondheid van werk- en woonomgeving)
M	Welke middelen heeft u beschikbaar/ wilt u beschikbaar stellen?
M1	Over welke ICT-faciliteiten beschikt u ? + Hardware (Smartphone, PC, laptop, tablet) + Software (besturingsysteem) + Communicatie (webcam, Wifi-verbinding, 3/4G)
M2	Van welke ICT-faciliteiten wilt u gebruik maken bij het gebruik van SERIOUS GAME? + Hardware
M3	Denkt u dat de leverancier van een SERIOUS GAME systeem u het volgende voldoende kan bieden in combinatie met uw eigen ICT-faciliteiten? Waarom wel, waarom niet? + Betrouwbaarheid + beschikbaarheid + Veiligheid/privacy
M4	Denkt u voldoende ondersteuning te krijgen als u een SERIOUS GAME wilt gebruiken? + scholing + management support
M5	Hoeveel van uw eigen middelen wilt u inzetten voor succesvol gebruik van een SERIOUS GAME? + Tijd + Geld
M6	Wilt u thuis gebruik kunnen maken van medische meetapparatuur?
A	Attitude: wat is uw houding tegenover SERIOUS GAME en ICT?
A1	In hoeverre bent u er van overtuigd dat ICT toepassingen nodig zijn om de kwaliteit van het leven te verbeteren + Hoeveel ervaring? + Hoeveel tijd ervoor over? + Zijn er positieve ervaringen uit het verleden? + Hoe vaak gebruikt u internet?
A2	Voelt u sociale druk om een SERIOUS GAME te gebruiken? + Heeft u het weleens besproken met een kennis + Heeft u er weleens over gehoord in de media?
A3	In hoeverre denkt u dat uw privacy in het geding is, bij het gebruik van een SERIOUS GAME? + Denkt u dat het systeem gehackt kan worden? + Denkt u dat de verkeerde mensen (andere artsen, verpleegkundigen) uw informatie kunnen gaan raadplegen?
A4	Wordt u door uw omgeving gestimuleerd om aan de veranderingen deel te nemen?
Slot	*Tot slot, in korte bewordingen: Wat denkt u dat de cruciale factoren zijn om een SERIOUS GAME wel of niet te gebruiken?/ Heeft u daarnaast nog iets wat u kwijt wilt?/ Ten slotte wil ik u van harte bedanken voor dit interview!*

D2 : Questionnaire template

Do you own a smartphone?
Are you, or are you willing to use an health app like Nike+ (or RunKeeper, Strava, etc.)
Which app specific functions are crucial in your opinion
In which sports are you currently engaged?
Why are you using fitness apps? (Please check the 3 most important reasons)
Which devices are you currently using to keep track of your activity?
How frequently are you using activity tracking devices on average?
Would you be interested in buying a wearable device?
If you were interested in buying a wearable device, would you have preference towards one from the same company as your smartphone?
Are you currently using a wearable device? If yes, which?
How important are social media functions for wearable devices in your opinion?
How important are messaging functions for wearable devices in your opinion?
How important are actvity measuring functions for wearable devices in your opinion?
How important are fitness & health functions for wearable devices in your opinion?
If you have any remarks or explanations you can leave them here
How important is heartbeat measuring functionality for wearable devices in your opinion?
How important is speed tracking functionality for wearable devices in your opinion?
How important is calorie counting functionality for wearable devices in your opinion?
How important is distance tracking functionality for wearable devices in your opinion?
How important is achievement recording functionality for wearable devices in your opinion?
How important is the possibility of sharing achievements in your opinion?
If you have any remarks on the questions asked above, let it know in this text box.
Do you expect wearables will provide added value in everyday use?
Do you expect wearables will be easy to use and user-friendly?
Do you want to use a wearable as a stand-alone device?
Do you want to use a wearable as a complementary device?
Would you be willing to wear a wearable device the entire day, even during sleep?
How often per week are you willing to use wearable devices?
Would you be willing to share your data gained from the wearable device with the developers to provide better feedback?
If you have any remarks on the questions asked above, let it know in this text box.
Would it be a problem for you if social media functions are lacking for wearable devices? (Facebook/Twitter/Instagram etc.)
Would it be a problem for you if actvity measuring functions are lacking in wearable devices?
Would it be a problem for you if fitness & health functions are lacking in wearable devices?
Would it be a problem for you if messaging functions are lacking in wearable devices?
Would it be a problem if wearable devices are not capable of capturing your heartbeat?
Would it be a problem if wearable devices are not capable of tracking your speed while working out?
Would it be a problem if wearable devices are not able to track the calories you burned while working out?
Would it be a problem if wearable devices are not able to track the covered distance of your workout?
Would it be a problem if wearables are not capable of recording the achievements you reached?
Would it be a problem if achievement sharing functionality lacks on wearable devices?
Would it be a problem for you if a wearable device cannot be used without carrying a smartphone?
Would it be a problem for you to wear a wearable device the entire day, even during sleep?
Would it be a problem if data gained from the wearable device would be shared to provide better feedback?

7.2 Planning & Milestones

Date	Activity
Q3 – 23 april 2015	General literature research + research proposal
25 april 2015	**Deadline proposal**
26 april – 6 may 2015	Literature research
Week 20	Supervisor meeting, review in-progress
6 -13 may 205	Analyzing PRIMA-interviews.
13 – 25 may 2015	Constructing Kano-model based questionnaire + Literature research
Week 22	Supervisor meeting, review in-progress
25 – 30 may	Analyze interview data to results + Constructing questionnaire
31 may – 7 June 2015	Analyze questionnaire data to results + Writing paper
Week 24	Supervisor meeting, review in-progress (pre-final)
8 – 14 June 2015	Improving paper for pre-final submission
15 June 2015	***Pre-final thesis submission***
19 June 2015	***Green light decision***
Week 25	*Supervisor meeting, pre-final feedback*
16 – 25 June 2015	*Improving paper after feedback*
25 June 2015	***Final thesis submission***
2 July 2015	***Bachelor Thesis Conference***