University of Bergen

Master Thesis in Information Science
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Design and Development of a Healthy Lifestyle Tool for Mobile Devices

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Abstract

According to World Health Organization the worldwide prevalence of obesity nearly doubled between 1980 and 2008, emphasizing its level of significance. Obesity is often resulting from a sedentary lifestyle, which is also often connected to depression, cardiovascular diseases, diabetes, cancers etc.

With modern technology we have new tools for handling these kind of issues. Mobile health (mHealth) is a field which is addressing issues related to health. Pre-experimental investigation indicate a strong correlation between mHealth tools and increased physical activity.

In this thesis a mHealth tool has been developed using Design Science methodology. The application has been evaluated by both regular users and expert users in order to meet usability requirements. The system evaluation has reached satisfactory scores in terms of functionality and usability. In addition a field expert has provided her view on the potential to promote both physical and mental health using the app.

It was possible to demonstrate that the app had a positive effect on the users and as well as the focus group in terms of promoting physical activity. User testing has also shown the appreciation of the various features such as social networking and route/activity creation. Due to the social nature of the features it could be expected that more ideas would be generated by new users and thus leading to new development iterations. The developed app is already a product available for free download. There is enough data collected by the app to document its good effect.

Long term effect of the app has yet to be probed in a different setting and beyond the time and scope of this thesis. That will require resources and experts of other fields to work together. Future work suggests that one way would be to conduct a proper clinical trial.

Acknowledgements

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A big thanks goes to the department of engineering & information technologies at University of Sydney, Australia, where I had an exchange semester during my masters. Through a series of interesting subjects, and great professors, I have learned a lot which has been really useful in this thesis. This is also where I got inspired to work with mobile technologies to promote health, and active lifestyle, as it was a big focus area on USYD.

Next I would like to thank all the master students of department of Information Science and Media studies, at the University of Bergen, who helped me with user testing, and providing crucial feedback. A big thank you goes to all the other people who also participated with the evaluation.

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1 Introduction

In these days, sedentary life style is becoming an increasing prevalent problem. People tend to be less active, which in conjunction with unhealthy eating habits, is resulting in high rates of obesity (Owen et al., 2010). Technologies such as the Computer and TV are influencing people to stay inactive for longer periods.

The World health organization (WHO) has stated that inactivity is the fourth most leading risk factor for global mortality, and that the worldwide prevalence of obesity nearly doubled between 1990 and 2008 (Who int, 2016). What is surprising is the severity of health risks from this sedentary lifestyle. Harvard Medical School (2015) finds an accelerated chance of diabetes, high cholesterol and heart disease, primarily due to cardiovascular problems.

It is interesting to note that this applies to the “average” person who now spends more than half their waking day sitting still. In the American Journal of Preventative Medicine (Correction: Sedentary Time and Its Association With Risk for Disease Incidence, Mortality, and Hospitalization in Adults, 2015) echoes these findings, also concluding that they cannot simply be dealt with by occasional strenuous exercise like going to the gym once in a while. The rapid technological advances which have led to this problem, e.g like computers in the office, can also be re-applied toward designing a non-intrusive solution, that will address this problem.

While it is often necessary to sit still for hours on end, there is no need for this time to be uninterrupted. For the rest of our careers, good habits in terms of taking regular breaks will prove invaluable, and ways to emphasise this in the workplace, schools or at home is essential.

Imagine the following scenario:
A typical person is either spending countless hours at school or at work, sitting still in front of e.g a computer, or a lecturer. After the days is over, the person goes home. Afterwards, the person sits down in front of the computer or the TV, until its time for bed, where the person will be laying for approximately the next 8 hours or so, before the cycle repeats.

This person is living a life that is becoming increasingly more common. The upside is that availability of technology, such as mobile phones, is quite good. It is estimated that by 2017 there will be 4.77 billion phone users (Statista, 2016). Smart phones, phones that are more like small computers, are seen all around us, and they are capable of doing what a personal computer can do. As many people are equipped with a mobile phone at all time, it can be utilized for the users advantage, and provide opportunities that were not possible just a few years ago.

Research has shown that there is no doubt that we are becoming more and more sedentary. As a result public health recommendations propose that we engage in at least 150 minutes per week of moderate to vigorous activity to help prevent chronic conditions such cardiovascular disease, diabetes, obesity and some types of cancers (Owen et al., 2010). The questions is how to actually encourage people to go through with it.

In order to address the problem of sedentary lifestyle, this project will focus on the development of a mobile health application, a.k.a mHealth, that will provide various solutions to counter inactivity. More specifically a social fitness app will be developed, where there is a great focus on social interaction, and physical activity. The concept is roughly that a user will be able to establish a network of friends, by finding people in the nearby area with similar interests. The users would be able to communicate, and arrange activities together. The application encourages the users to create various routes or activities, which will reward them with points. Furthermore, this allows for competition, which might be a good incentive to maintain a motivation for physical activity over time.

1.1 Research Questions

The thesis aims to answer the following research questions:

- ***Is it possible to develop a mobile health application that can promote an active lifestyle?***
- ***Can mHealth reduce sedentary lifestyle?***
- ***Can the social network features encourage to more activity?***
- ***Can a social fitness application such as moveFit promote psychological health?***

1.2 Chapter Overview

This thesis consists of 10 chapters. This section will provide a short summary of each chapter.

Chapter 1: This chapter gives an introduction to the thesis and the main topic, it presents the research questions, as well as the structure of the thesis.
Chapter 2: This chapter gives a literature overview and presents similar work.
Chapter 3: This chapter provides an overview of methods and methodology.
Chapter 4: This chapter gives an overview of the development process and the actual artefact that has been built.
Chapter 5: This chapter presents evaluation, analysis and results.
Chapter 6: This chapter examines the data collected from the developed artefact.
Chapter 7: This chapter elaborates on discussion of the thesis.
Chapter 8: This chapter presents further work and conclusion.
Chapter 9: This chapter gives an overview of the references used.
Chapter 10: This chapter contains all the appendices used.

2 Literature Review and Theories

In this chapter relevant literature and theories will be reviewed. More specifically, we will look into how big of a threat has sedentary lifestyle become and what the consequences are. Moreover, which tools and technologies have been proposed as a solution will be examined, as well as the importance of usability of these tools.

2.1 Mobile Health

The main topic of this master thesis is Mobile health(mHealth). It encompasses how to use mobile technology to enhance health in general, but also non-communicable diseases (NCDs), also known as chronic diseases, such as cardiovascular diseases, heart failure, and diabetes (WHO, 2016). These types of diseases kill 38 million people each year, according to WHO.

Everything from informing the user about healthy options, to actually monitor, and improve the users health by healthcare delivery, is considered mHealth. The most common usage is done via text messages, mobile apps, and wearable devices (Guides.lib.unc.edu, 2016). According to WHO Global Observatory for eHealth (electronic health) mHealth is defined as "medical and public health practice supported by mobile devices (MD), such as phones, patient monitoring devices, PDAs, and other wireless devices".

Health is a field that is becoming an increased focus area in terms of applying information technologies (Germanakos, Mourlas and Samaras, 2005). As a result a new sub field has emerged, namely eHealth (electronic health), where again mHealth is a sub-group. Several developers and scientists have gone together to build systems that can help people suffering from different health problems, on a mobile platform. The main benefit is that nowadays most people carry a mobile phone at all time, allowing several interesting application to be developed, by utilizing the smartphones capabilities. Some of these applications will be reviewed in this chapter.

2.1.1 Status of Health Problems

Health problems related to sedentary lifestyle are factual. Manson et al., (2004) have written a paper about the severity of sedentary lifestyle. Already when the paper was written in 2004 obesity and sedentary life style was escalating on a global level, becoming an epidemic. The chronic diseases that came along with these issues were causing 300 000 premature deaths, and $90 billion in direct health care costs in the United States alone (Manson et al., 2004). They write in their paper that clinicians are not aware of how to handle these issues, and lack guidelines and practice tools to address the problems. The figure below is showing the growth of obesity in US adults.

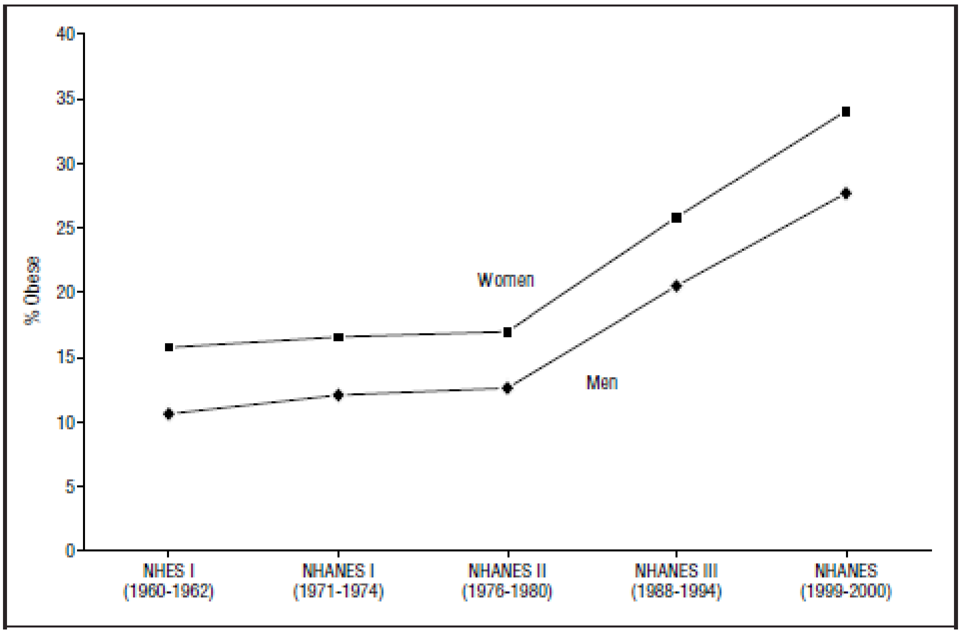


Figure 2-1: Percentage of US adults classified as obese (The escalating pandemics of obesity and sedentary lifestyle, 2004)

we can see from the chart that from 1976-1980 and outwards the rate of obesity has had an exponential growth. This problem is not only related to adults, there is a similar trend in overweight among children and adolescents.

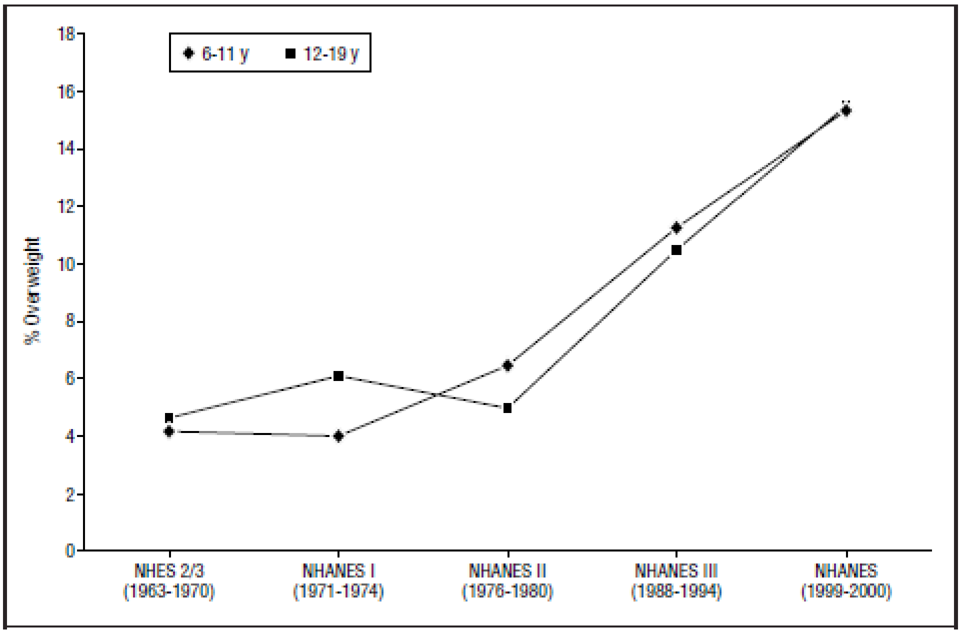


Figure 2-2: Percentage overweight among children and young adults (The escalating pandemics of obesity and sedentary lifestyle, 2004)

As we can see from the chart, there is an exponential growth in overweight from around 1980 to 2000 and onwards.

2.1.2 mHealth Research Status

Reports from 2014 show that there were about 100 000 mHealth apps listed in the two major app stores, provided by Apple and Android (Ali, Chew and Yap, 2016) The annual revenue of the health related mobile apps marked is projected to reach more than US$ 26 billion by next year 2017, from its value of 2.4 billion in 2013, which is quite significant. This gives an indication on how attractive mHealth is, and that people are actually big consumers of these types of applications..

A paper reviewing current status of mHealth research (Ali, Chew and Yap, 2016) have looked at how mHealth research has evolved with changes in mobile technologies throughout the latter years. They have looked at relevant literature from *PubMed*, *Journal of Medical Internet Research* and *Telemedicine Journal and eHealth,* in total 1690 articles was found, in which 515 studies remained after removing duplicates, and less relevant papers. They mainly reviewed the articles that was published with the topic mHealth, and analysed which kind of devices where used, and in which year they were relevant. They found that largely after 2012 most mHealth related applications were implemented on devices such as smartphones, tablets, PC, and Ipods. Before that, personal digital assistants (PDA) as well as basic feature phones, were the most used devices. They also found that after 2012 smart devices were highly used in mHealth research (173 of 289 articles, 59.9%).

Below we see a graph illustrating A) the most used devices, and B) their functionalities.

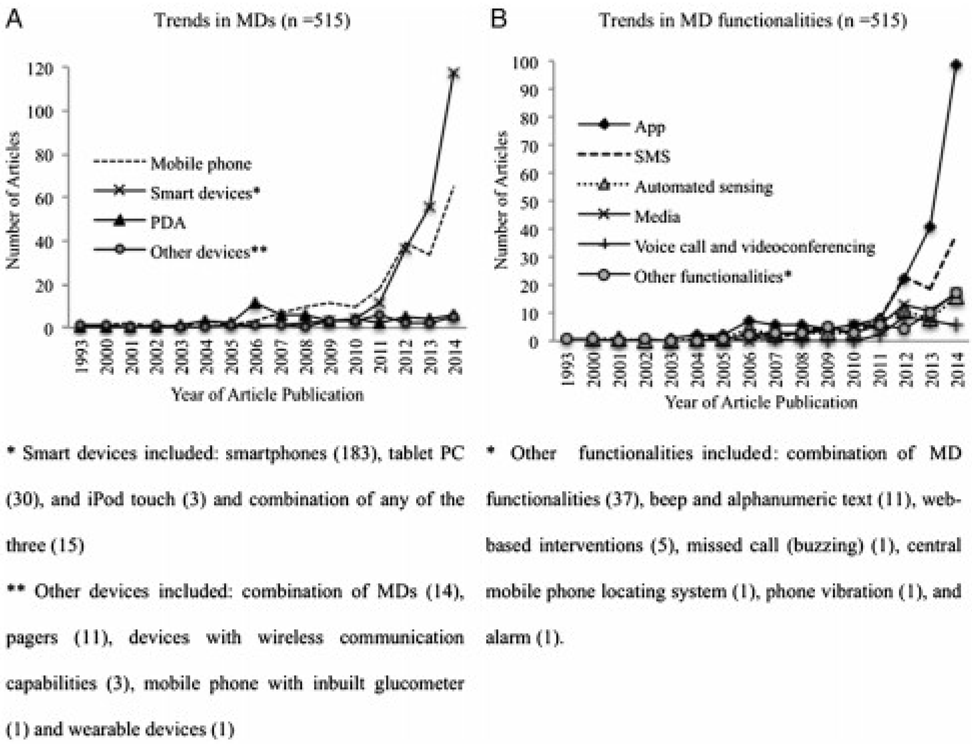


Figure 2-3: Trends and functionalities in MD (Evloution and current status of mhealth research: a systematic review, 2016)

The graph shows us that from 2011 there was a rapid growth in usage of smart devices, and mobile phones. We can also see that from 2011-2012 there was a big increase in app usage. This supports the claim that with advancements within mobile devices and technology, mHealth gains popularity.

Furthermore they found that chronic medical conditions have clearly been a big focus of mHealth research, which is of particular interest to this project, as these diseases are targets to be dealt with.

The graph below illustrates A) trends in terms of medical conditions addressed, and B) the purpose of mHealth interventions.

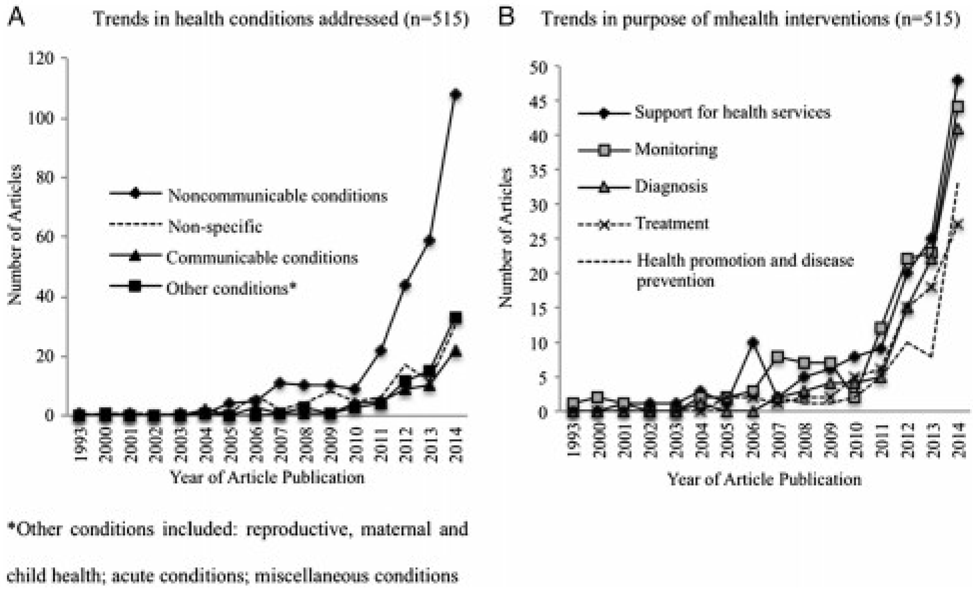


Figure 2-4: Trends in health conditions, and purpose of mhealth interventions (Evloution and current status of mhealth research: a systematic review, 2016)

From the graphs we see that NCD i.e. chronic diseases are being focused on to a great extent from 2010 and outwards. We also see that there are several different approaches, and methods used. Most popular were *Support for health services*, *Monitoring*, and *Diagnosis,* also gaining a lot of attention from 2011 and outwards. We can see that there is a correlation between the rapid usage of mobile devices around 2011 and the usage of these interventions in the same period! They conclude in their paper that mHealth research has evolved with advances in MD, and that chronic diseases are a big focus within mHealth these days.

2.1.2 Sedentary Lifestyle Issues

The main problem with sedentary lifestyle are the following diseases one can develop, which can lead to terminally illness. Like mentioned before, WHO claims that sedentary lifestyle is the fourth leading risk of death, caused by heart failure, diabetes etc. There is also no doubt that there is a strong link between physical activity and good health (Katzmarzyk, 2010).

However there are also mental or psychological issues related to sedentary lifestyle. According to a paper by (Teychenne, Costigan and Parker, 2015) depression is not necessarily the only mental disorder one can acquire from sedentary lifestyle, but also maybe anxiety.

They define sedentary lifestyle or behaviour as activities that require minimal body movement, which is resulting in low energy expenditure, similar to resting level (1.0 to 1.5 metabolic equivalent (METs). This includes computer usage, gaming, television, and even travelling. Teychenne et al. (2015) have looked at other studies which have found that there are positive relations between depression and low self-esteem and sedentary lifestyle, however not much have been found in regard to anxiety. They performed a literature study, where 983 studies where examined, and 9 were included in the review. Out of the remaining papers, 5 suggested that there was a positive association between sedentary lifestyle and anxiety. Two cross sectional studies found both positive and null associations. Since they found only 9 relevant studies, they argue that it is not very much data to conclude from, but they are still able to derive so far that there is a positive correlation, which is backed up by 78% of the studies they have reviewed. They concluded the following "*there is moderate evidence suggesting that engaging in overall sedentary behaviour was linked to an increased risk of anxiety*".

2.1.3 Interventions to Sedentary Lifestyle

Another study conducted by Kendzor et al., (2016) have looked at how mobile phones have directly impacted sedentary lifestyle. They designed an intervention for the mobile phone, which would alert the user after sitting still for longer periods. There were 215 people participating in the experiment, 120 were in a control group, and 95 were monitored by the intervention for 7 days. They used the accelerometer in the phones to monitor movement. In addition to getting a prompt to move, they were given information about the negative health impacts of prolonged inactivity. They found a significant difference between the people who used the phone versus the control group without this device. The table below illustrates the results.

Table 2. Daily accelerometer estimates across valid wear days overall and by intervention group (N=215).

Accelerometer variables[a]	Total sample (N=215)	Intervention group (n=95)	Control group (n=120)	*P*
Mean daily wear time (minutes/day), mean (SD)	843.63 (99.38)	829.96 (96.28)	854.46 (100.86)	.07
Total days of observation (out of 7 possible), mean (SD)	5.87 (1.45)	5.74 (1.52)	5.98 (1.39)	.23
Sedentary, daily minutes, mean (SD)	531.64 (100.96)	507.20 (101.01)	550.99 (97.04)	.001
Sedentary, % of daily wear time, mean (SD)	62.92 (8.89)	61.08 (9.72)	64.38 (7.91)	.007
Active, daily minutes, mean (SD)	310.94 (80.59)	322.37 (88.01)	301.88 (73.30)	.06
Active, % of daily wear time, mean (SD)	36.96 (8.88)	38.87 (9.71)	35.44 (7.88)	.005
Light intensity, daily minutes, mean (SD)	215.12 (55.52)	222.83 (56.50)	209.01 (54.19)	.07
Light intensity, % of daily wear time, mean (SD)	25.54 (5.95)	26.87 (5.93)	24.49 (5.78)	.003
Moderate lifestyle intensity, daily minutes, mean (SD)	71.54 (31.07)	74.80 (35.90)	68.96 (26.51)	.17
Moderate lifestyle intensity, % of daily wear time, mean (SD)	8.53 (3.70)	9.03 (4.27)	8.14 (3.13)	.08
Inactive-to-active transitions, daily total, mean (SD)	94.17 (17.03)	94.53 (16.25)	93.88 (17.70)	.78
Total active minutes (10 minutes postprompt), mean (SD)[b]	2.44 (1.02)	2.59 (1.15)	2.32 (0.88)	.05

Figure 2-5: Activity measurement from wearable. (Impact of a Mobile Phone Intervention to reduce sedentary Behaviour in a community sample of adults: A quasi – experimental evaluation, 2016)

We can see that from daily active minutes (mean) there is a some difference, namely 88.01 vs 73.30

minutes, indicating that the phone users are less sedentary. Moreover they conclude "Overall, simple mobile phone prompts appear to be a promising strategy for reducing sedentary behaviour and increasing activity, although adequately powered and well-designed studies will be needed to confirm these preliminary findings."

Research by the students Cotten (MA) and Prapavessi (PhD) found that intervention by text messages via the phone, resulted in a net difference of 14.6 minutes between the control group, and those received text messages prompting activity (Cotten and Prapavessi, 2016). But what about more sophisticated applications that we have access nowadays?

Another study by Bond et al., (2014) aimed at lowering excessive sedentary time (SED). They applied a smartphone based intervention, more specifically senseWear Mini Armband (SWA) to monitor SED for the duration of 7 days. They prompted to be active for a certain time depending on how long they have been inactive. For instance 6 min activity for SED over 60 min. They found that the system yielded significant decrease in SED, and that short and frequent breaks from sitting still, are the most effective way to decrease SED, in contrast to longer breaks after longer periods.

SitCoach is a mobile application developed to monitor peoples activity, as well as alerting them when they are inactive for longer periods. It was developed as a part of a research project by Dantzig et al., (2012). They were targeting office worker, who are known to be sitting still for hours on end. Similar to previous studies examined, this one has also used the phone's accelerometer to monitor users movement. The results showed them that several participants were not aware of the harmfulness of sedentary lifestyle, and after getting to know this, the participants moved around, and got up from the chair when the alarm rung. They also stated, like many before, that this topic needs more research, and larger number of participants.

2.1 Human Computer Interaction

Human Computer Interaction (HCI) is an important part of application development, where there are different kinds of end users. HCI focuses on the interaction between the user, and some system, where cognitive approaches are used to asses the interface. For instance “The model human processor” (The Interaction Design Foundation, 2016). Booth (2014) gives an oversimplified definition of HCI: “*The Study of interaction between humans and computers*”.

HCI is an important research science as it offers methods and techniques that can make a system work functionally well, as well as being easy to use by the users (Booth, 2014). This is important as bad user-interface can lead to users not actually using the application. Evaluation of the usability of a computer system is often conducted by user testers. The purpose is to find errors, or features of the user interface that are bad or tedious to use. This often leads to findings that the developers might have overseen otherwise. Booth (2014) claims that the developers very often do not understand the user needs, resulting in a mismatch between the system and the user who adopt the system. Some common problems are: computer systems that require users to remember too much information, systems that intolerant of minor errors, the system does often not provide the necessary information when needed, or can be overwhelming with new information.

This thesis is very dependent upon a good user-interface, as it is assumed that there will be many non technical users. Thus HCI have become a high priority. *Chapter 5* will look deeper into user evaluation that has been conducted in regard to this application.

Nielsen (1995) developed 10 heuristics for evaluating usability in systems. For example if an application is to be evaluated by some user inter-face experts, they might use this *guideline* to assess the usability. The 10 heuristics are as following:

- Visibility of system status
- Match between the system and the real world
- User control and freedom
- Consistency and standards
- Error prevention
- Recognition rather than recall

- Flexibility and efficiency of use
- Aesthetic and minimalist design
- Help users recognize, diagnose, and recover from errors
- Help and documentation

System Usability Scale (SUS) is another form of HCI evaluation (John Brooke, 1996). This evaluation method is in contrast to the heuristic evaluation, assessed by "regular" users i.e. non HCI experts. The goal of SUS is to be able to measure usability across a wide range of different contexts. Chapter 5 is addressing this in more detail. Brooke describes this method as a "quick and dirty" due to the fact that is cheap in an industrial setting to execute. The SUS scale consists of 10 guidelines. These can be found in *Appendix A*.

2.2.1 Importance of HCI in mHealth

According to White (2016) 66% of the largest 100 hospitals in USA are providing health apps for their patients, suggesting that it is interesting for health institutions to provide this type of service. However in this case it was reported that the hospital produced apps are especially poor in terms of user experience, but also in functionality. This indicates that more work should be put down to create better apps with more appealing and easy to use user-interfaces. If a well produced application that meets the user/patient requirements is promoted by health institutions, it would probably lead to higher adoption and more seriousness around this type of health tools.

2.2.2 Material Design

The HCI development in this thesis is using some concepts based on Google's Material Design for Android. Material design is a comprehensive guideline for visual, motion, and interaction design across platforms and devices (Android, 2016). It is also considered a design language. One of the main goals of the material design was to have one single underlying system that unifies the user experience across platforms and devices. In that way the user get used to the same type of interface, making it easier for the user to manage or to merge into a new application with the same or similar design, as it is dictated by convention.

Material design focuses on the visual elements. Matias Durate, Google's director of Android user experience describes it as following: *"Unlike real paper, our digital material can expand and reform intelligently. Material has physical surfaces and edges. Seams and shadows provide meaning about what you can touch"* (Engadget, 2016). They have taken inspiration from materials such as ink and paper, but made the concepts more modern (Chester, 2016). Google says they want a simplistic look and a responsive design. They have focused a lot on shadow and lightning, colours, depth, and animations in their design language. Furthermore they have listed their guideline online so that developers can use them (Material design guidelines, 2016).

2.3 Related Work

There has been done a lot of research and work the latter years within mHealth. This section will look at similar work that has been carried out.

2.3.1 Mobile Health Devices and Projects

A study by Vickey & Breslin (2012) has looked into sharing habits on social network, while using a fitness application *Endomondo*. They looked at how people shared their results from the app on Twitter and analysed this data. They claim that "lack of motivation" is a key factor in why a person does not exercise. The authors have also studied what kind of persons use fitness app and published their results.

They write in their conclusion: "*Understanding a person's social network may be one key to better health, as technology continues to impact humanity. It is the hypothesis of the researcher statistics (the increase in global obesity) and research (the decline in overall physical activity) would suggest* *that the lack of habit forming exercise and the deficiency of structured exercise programs continues to be a challenge for those that wish to adopt a more healthy lifestyle. Whilst there are a wide range of mobile fitness applications currently available, until these technologies incorporate a more persuasive approach to behaviour change, minimal results directly related to the sharing of workouts using these applications will occur.*".

An interesting finding from the study was that the amount of data and users of this fitness app was increasing significantly over time, indicating a popular trend.

In a paper by Kumar et al (2013) describe how the availability of mHealth has decreased to cost of health care and improved well being in several ways. The paper authors claims that research showing good effects of mHealth is somewhat sparse and that this field is in need of rigorous studies in order to find potentials and challenges of mHealth. Moreover, the paper looks into opportunities and challenges in three areas of mHealth:

1. Evaluating assessments.
2. Evaluating interventions.
3. Reshape evidence generation using mHealth.

They conclude that the capabilities of mHealth constitute a new paradigm for evidence generation in health research and are promising.

An issue related to health application is privacy. Privacyrights.org (2016) elaborates on what is privacy risk for mHealth and fitness apps. They have analysed 43 health and fitness apps and highlighted the major consumer privacy risks. The applications that have been examined can be categorized as "diet and exercise programs; pregnancy trackers; behavioural and mental health coaches; symptom checkers that can link users to local health services; sleep and relaxation aids; and personal disease or chronic condition managers.". Some of the risk they found were:

- Smartphones are ideal tracking tools, revealing a users location.

- Demographic and medical data is not regulated in any way. The developers of the application determines the protection of the user privacy.
- The fitness and health applications often collects large amounts of personal information.
- Free to use software often share personal information to advertisers, and allow ad-networks to track the users.
- Many applications have poor security in general, making them vulnerable to attacks. E.g. unencrypted network.

These risks have been taken into account during the development of this thesis application. Privacy Rights Clearinghouse provides tips and information on how to avoid these kind of issues (Privacyrights.org, 2016).

2.3.1 Similar Applications

There are to this date several applications within the area of mhealth. The available apps are addressing different kinds of issues. Everything from spreading information to promoting higher level for activity. Here are some popular applications that have become popular over the latter years.

- Fitcorazy: "*Fitocracy caters to the competitive side that everyone has. The site grants you points for each workout activity you track, then awards you with badges and props for every milestone, similar to Foursquare. You can also sign up for challenges with friends or join community chat groups with members across the network.* "

- Map my fitness: "*With Map My Fitness, much like Daily Mile, you can map your running routes and track your progress through a mobile app. When you're finished, you can share it with your friends through Facebook. The site's food-logging feature also lets you keep track of what you eat, broken down by fat and calories, and share recipes with other members.* "

- Endomondo: "*The Endomondo Sports Tracker app turns GPS-enabled devices into a personal* *trainer and social motivator capable of tracking workouts, analysing performance, and can aid in the discovery of new routes, activities and insights into fitness so people become and stay active. The app is being used by companies including Harley Davidson, Kimberly-Clark and The Coca-Cola Company.* "

- Fitbit: "*Fitbit is a great way to improve your fitness while competing against friends and family – some large companies have even begun implementing the use of Fitbit as a health initiative for their staff! You can wait for the weekly leader-board to come out every Sunday night to see who has become champion, or engage your friends and family in a set challenge like the "Workweek Hustle" for additional motivation.*"

- Runtastic: "*Runtastic is a mobile fitness app that combines traditional fitness with mobile applications, social networking, and elements of gamification as a logical reaction to the Quantified Self movement. It consists of activity tracker, hardware related products, and services such as online training logs, detailed data analysis,comparison of others, and many more similar functions."*

These applications have been an inspiration for the development of this app. The social and activity features have especially been considered in this development.

3 Methods and Methodologies

The following chapter presents the methodologies used in this project and how they have been applied. The quantitative and qualitative methods that have been used will be discussed.

3.1 Multi methodology

This thesis will adopt a well known methodology that consists of two different methodologies, namely the multi methodology. The methodology is developed by Nunamaker, Chen & Purdin

(1990). The concept is that one combines both design science and system development, where the best features from both are being utilized. This method is both iterative and incremental which means that it will repeat its steps by going in cycles, and progress in an incremental order.

The first step of the method is the "*Theory building*". This step focuses on the initial stages of the project, such as planning and modelling. The next step, "systems developments" revolves around the actual application development. To begin with just as a simple prototype that will go through further testing and improvements. Moreover, evaluations will be conducted in order test functionality and usability, while l

Figure 3-1 below illustrates the main steps of the methodology.

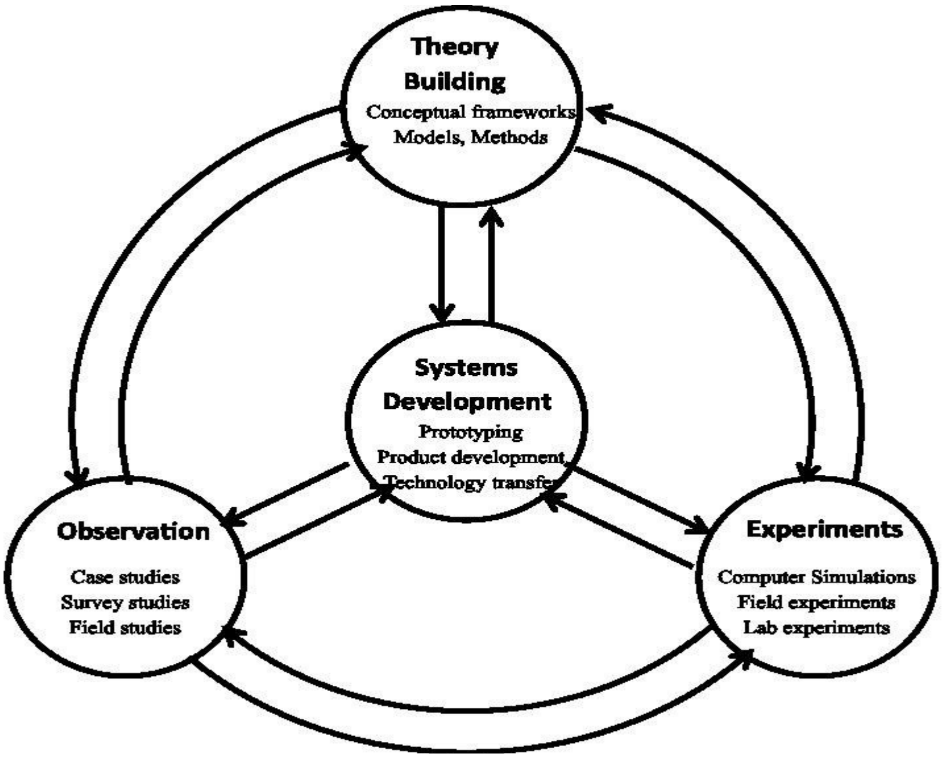


Figure 3-1: A multi methodological approach to IS research (Chen, Nunamaker & Purdin, 2001)

3.2 Design Science

Design Science and Behavioural Science are two paradigms that constitute information system research. They work as a framework to designing artefacts, by analyse, investigation, evaluation, as well as providing guidelines for research projects. Behavioural Science focuses on developing and verifying theories related to human or organization behaviour. The design science on the other hand is more concerned about developing original and innovative artefacts i.e. IT products that carries a usefulness to humans or organizations (Hevner,T.March,Park & Ram, 2004). The Design Science paradigm has been utilized in this thesis.

3.2.1 Design Science Guidelines

Hevner et al. (2004) encourages information system researchers to use the seven design science research guidelines, thus they have been used during the design and evaluation process. The idea is to get a better understanding of effective design research, and to use logical reasoning, and creativity when using these guidelines. Below is a table of the seven guidelines:

Guideline	*Description*
Design as an artefact	Design-science research must produce a viable artefact in the form of a construct, a model, a method, or an instantiation.
Problem relevance	The objective of design-science research is to develop technology-based solutions to important and relevant business problems.
Design evaluation	The utility, quality, and efficacy of a design artefact must be rigorously demonstrated via well-executed evaluation methods.
Research contributions	Effective design-science research must provide clear and verifiable contributions in the areas of the design artefact, design foundations, and/or design methodologies.
Research rigor	Design-science research relies upon the application of rigorous methods in both the construction and evaluation of the design artefact.

Design as a search process	The search for an effective artefact requires utilizing available means to reach desired ends while satisfying laws in the problem environment.
Communication of research	Design-science research must be presented effectively both to technology-oriented as well as management-oriented audiences.

(*Figure 3-2: Design Science Research Guidelines (Hevner et al., 2004, p. 83))*

Design as an Artefact

The first guideline is the criteria that design science must produce a viable artefact in the form of a construct, model, method, or instantiation. The artefact in this project is an application, fully functional, and already in use. It is a mobile device application, that is available to everyone with an Android operation system. The first half of this project was spent designing and developing the application. This is because the application is crucial in order to answer the research questions given in *Chapter 1*. The application is attempting to promote a more active and social lifestyle. Its doing this by combining social elements, gamification, and physical activities. The originality of the application lays in the combination of these different features that the app offers.

Problem Relevance

The second guideline goes like this: "*The objective of design-science research is to develop technology-based solutions to important and relevant business problems.*"

This is accomplished by creating an innovative artefact by using novel approaches. The problem this artefact is addressing is sedentary lifestyle, which is the fourth leading risk to death, considering the diseases it can lead to. The application is approaching this problem is several different ways. First method is that is has a movement tracking system, that monitors the users movement throughout the day while the application is active. Whenever the user is sedentary for a certain time period, the user is alerted and prompted to get up and move. At the same time, the user is informed about the benefits about being active, and the down sides of being inactive. If the user responds by actually moving, he or she is rewarded points. The second method the application is using is sociality. The app is prompting people to connect with other people who also have the app, and do some activities together. The third method is allowing the users to create routes or activities, where they can earn points, and ultimately compete with each other.

Design Evaluation

The third guideline read as follows: "*The utility, quality, and efficacy of a design artefact must be rigorously demonstrated via well-executed evaluation methods.*" It expresses the importance of evaluation of the artefact that has been developed for research purposes. There are several ways to evaluate an artefact, e.g functionality, performance, reliability, usability, efficiency etc. According to Hevner et al (2004) an artefact is considered finished when it satisfies the requirements it was meant to solve. In this project, both an end-user and an expert evaluation has been conducted. These testers have tested both usability, and functionality of the application. *Chapter 5* elaborates on how the evaluation was performed.

Research Contribution

The fourth guideline states: *"Effective design-science research must provide clear and verifiable contributions in the areas of the design artefact, design foundations, and/or design methodologies.* " In essence this means what is new about this contribution, which in this case is the developed artefact with its features. This artefact contributes by engaging users to be more active and social in their daily life, ultimately improving their health, physically, and possibly mentally. The artefact collects data directly related to the users actions, be it if they are active on inactive throughout the day, or whether they form connections with other people (sending/accepting friend-requests). The data that is generated is able to tell something about how this type of application i.e. mHealth can impact sedentary lifestyle.

Research Rigor

The fifth guideline tells us: "*Design-science research relies upon the application of rigorous methods in both the construction and evaluation of the design artefact.*" In this project Personal Kanban has been used as a methodology in order to manage and plan the work (Benson & Barry, 2011). The development process has been done iteratively and incrementally. Personal Kanban has allowed for management and planning of the workflow throughout the project.

The user interface has been evaluated using “heuristic evaluation” by Nielsen (1995) and “System usability scale” by Brooke (1996) where the purpose is to eliminate problems related to the usability. They are representing expert evaluation and end user evaluation respectively.

Design as Search Process

The sixth guideline says “*The search for an effective artefact requires utilizing available means to reach desired ends while satisfying laws in the problem environment.*” The search is representing a continuous improvement of an artefact, by incremental and iterative development. The means are the resources and actions necessary to develop the artefact. The end is the goal and the constrains, while the law are considered the uncontrollable forces in the environment (Hevner et al., 2004 p. 89). The search, i.e. the continuous improvement, has been satisfied by the use of Personal Kanban, prototyping, and test driven development. The application represents the goal, where the research question has been handled. The tools used throughout the development are the resources or the means. The uncontrollable forces are the continuous challenges that arises when developing. For instance the Azure cloud service back-end, and Xamarin were subjects for change during the development period, in which required adaptation. Thus the different criterias have been fulfilled in this project.

Communication of Research

The seventh and final guideline reads “*Design-science research must be presented effectively both to technology-oriented as well as management-oriented audiences*“. This guideline is stating how important it is to communicate the different aspects of the research to the audience. For instance what is the research domain, what is the goal, which literature is potentially supporting the research questions, what are the results etc. In this thesis the research question and domain in explicitly stated, as well as the relevant literature, methods, and results. It is formed to be understandable for both non technical and technical oriented audience. This is done by giving simple introductions and summaries of the content. On the other hand, the technical aspects are more comprehensible by the more technical users or experts. This might be the actual architecture and development process of the artefact.

3.3 Development Methods

This part will focus on the developing methodologies used in this project. Methodologies are important in software development as they help with structuring, planning, and governing the process of developing some information system. Several methods from Agile development have been adopted in this project. These will be elaborated here.

4.3.1 Personal Kanban

A kanban is a tool to visualize, organize, and complete work, and is considered an agile development method (Atlassian, 2016). It was developed so that everyone working on a project could get an overview of the working process, i.e. which tasks needs to be done, which are currently being worked on, and which tasks are already finished (Personal Kanban, 2016). Personal Kanban is a simplified version of Kanban, where the purpose is also to get a better understanding of the workload, suited for a single person. There are two main rules for Personal Kanban:

1. Visualize your work

2. Limit your work-in-progress

Visualize your work is about making an visual overview of the work that needs doing. One common way to do this is by creating a *Kanban Board* where the different tasks will be listed along with their statuses. The Kanban board can for instance be a white board, or created from a piece of paper. The board consists of three main kategories: *to do*, *doing*, and *done.* This is illustrated by the figure below.

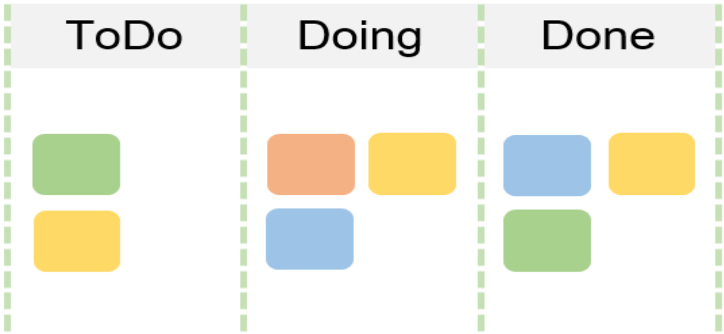


Figure 3-3: Kanban board (What is the difference between scrum, kanban, and XP?, http://www.testingexcellence.com/difference-between-scrum-kanban-xp-agile)

The *ToDo* section lists all the tasks that needs to be done. It acts like a product backlog. *Doing* represents all the different tasks that are currently being worked on, while *done* lists all the tasks that are completed. It is also possible to colour code the different tasks, e.g. red indicates high priority, while green might represent a simple task with low priority. During this thesis sticky notes have been used to represent task, on a blank page. They have not been colour coded, however they have been ordered by their “importance”.

In order to limit work in progress (WIP) on going task are selected carefully and in small numbers. This prevents an overwhelming workload, which may lead to more stress and inefficiency. By splitting up the workload and setting a time frame, one would get more work done and at the same time getter a better overview of the progress. This is a great benefit when time is a constraint and planning is important. The various tasks for the Kanban has been brought to attention from several sources, for instance from suggestions provided by a focus group, from authors own ideas, and also from user-evaluations. This is discussed further in this chapter as well as in *Chapter 5*.

3.3.2 Extreme programming

Extreme programming (XP) is a branch within *Agile Development* and includes a whole range of different developing methodologies that are considered modern and efficient. XP is based on short development cycles, so that one can from early on refer to an early version of the application (Extremeprogramming.org, 2016). The goal with XP is to be fast and efficient, yet maintain good quality. There are four main stages of XP: Coding, testing, listening, and designing.

3.3.2.1 Test Driven Development

Test driven development (TDD) is a practice that is closely knit to XP. The idea is to continuously test the code throughout the development, by unit testing i.e. the smallest testable parts of an application code is tested for errors (SearchSoftwareQuality, 2016). The process is iterative and is done until each unit is working properly. This ensures better quality and stability, which is resulting in better performance of the application as well as a shorter development time (www.tutorialspoint.com, 2016). The goal is to get something working immediately and perfect it later (SearchSoftwareQuality, 2016). TDD also allows the developer to test the code without having a user-interface.

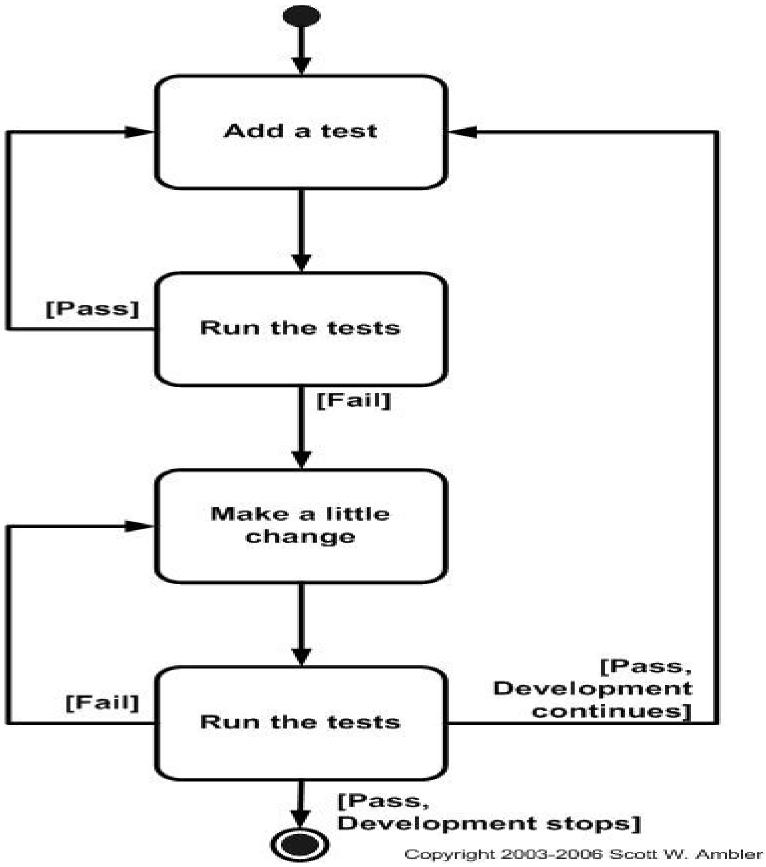


Figure 3-4: TDD steps (The Steps of test-first development (TFD), http://agiledata.org/essays/tdd.html)

The process goes as follows:

1. Create a new test
2. Run all the tests, see if the new test fails.
3. Write code that is supposed to pass the test
4. Run test, and if necessary re-factor code.
5. Repeat the steps.

During the development of this application, these stages have been followed in order to minimize errors. Not every piece of code has been tested, however complex and important feature-code has been tested properly with TDD.

3.3.2.2 Prototyping

Prototyping has been used during the development of this application. Prototyping is about making a simplified version of some system, with the purpose of testing different features in a context. It is often used when there is a high level of interaction with some system. Prototypes can be beneficial as users are able to evaluate the system before it is actually finished and provide valuable feedback in terms of improvement. This also helps with understanding the requirement which are user specific, which could otherwise not be thought of by the developer(s) (tutorialspoint.com, 2016).

In this project a focus group have been utilized, where the members have gotten access to the prototype, tested it, and given feedback. The focus group is discussed more in detail in later in this chapter. The prototype allows for both functionality and usability testing. Prototypes can have two dimensions, vertical and horizontal. The horizontal prototype displays the user interface and has less internal functions or business logic, while the vertical prototype focuses on the functionality. This project have touched both dimensions. Furthermore, there are several sub-groups of prototypes: Rapid, evolutionary, incremental, and extreme prototyping. In this case evolutionary prototyping has been used. This form of prototype revolve around building functioning prototypes with little functionality in the beginning and increases over time until the entire system has been built. The requirements from the evaluators are implemented as they are reported and understood (tutorialspoint.com, 2016). There are four steps for prototype development:

1. Identifying of content: First step is to figure out which are the most important features, and how to implement these.
2. Development of the prototype: This is where the prototype is developed, as well as the user-interface.
3. Evaluation of the prototype: This is where the prototype is being evaluated in regards to requirement specifications, and the user tests.
4. Improvement of the prototype: In case of deficiencies, the prototype is being modified or

improved.

3.4 Empirical Research Methods

This thesis have utilized the two main forms of research methods: *qualitative*, and *quantitative*. In this section these methods will be elaborated and as well as how they are combines into mixed methods. These methods are rather different, although they share one common feature; they are both focusing on collecting data, and analyse these to derive useful information.

4.4.1 Quantitative Methods

Quantitative methods emphasize objective measurements and the statistical, mathematical, or numerical analysis of data that is collected through polls, questionnaires, and surveys. (Libguides.usc.edu, 2016). The quantitative research focuses on gathering numerical data and generalizing it across groups of people. It is common to gather large quantities of data, thus its called quantitative research. The main characteristics of quantitative research are :

- The data is usually gathered using structured research instruments.
- The results are based on larger sample sizes that are representative of the population.
- The research study can usually be replicated or repeated, given its high reliability.
- Researcher has a clearly defined research question to which objective answers are sought.
- All aspects of the study are carefully designed before data is collected.
- Data are in the form of numbers and statistics, often arranged in tables, charts, figures, or other non-textual forms.
- Project can be used to generalize concepts more widely, predict future results, or investigate causal relationships.
- Researcher uses tools, such as questionnaires or computer software, to collect numerical data.

The goal is to classify features, count them, and create models that will help explaining what is derived or observed from the data. In this thesis surveys have been used in the quantitative research part.

3.4.2 Qualitative Methods

The word qualitative implies an emphasis on the qualities of entities and on processes and meanings that are not experimentally examined or measured in terms of quantity, amount, intensity, or frequency. Qualitative researchers stress the socially constructed nature of reality, the relationship between the researcher and what is studied (Libguides.usc.edu, 2016).

In contrast to quantitative research, which is more about large quantities and generalist research, qualitative research focuses on fewer instances or sources and more in-depth research on the topic based on these instances. An example might be performing a semi structured interview with a few candidates who may be experts within a certain field. Observation is also a common way of conducting qualitative research. In this case, the researcher observes the candidates while they for instance perform some tasks e.g. evaluating an app. Qualitative research is somewhat disputed as the interpretation of the data can be subjective.

3.4.3 Mixed Methods

In this project both quantitative and qualitative research methods have been used and combined resulting in mixed research methods (Ltd, 2016).

Quantitative Survey

For the quantitative research three different surveys have been used. The surveys have been both structured and semi-structured in the sense that they have predefined response alternatives, as well as comment fields. The first survey is for “normal” users i.e. end users without any required technical background in IT. This survey is based on System Usability Scale (SUS) (Brooke, 1996) and it aims to find out how non experts handle an artefact such as the app developed in this thesis. The intention with that is to see whether it is easy or hard to use and understand the app. The users were given predefined tasks to perform and then they answered the survey.

The second survey is aimed at “expert” users i.e. those who actually have background in IT. Master students at University of Bergen (UiB) were asked to participate. They were given the same set of tasks to perform and then answered the survey Nielsen's heuristics Nielsen (1995). As with the first survey, it is structured.

The last survey is more related to the actual users, in terms of what their subjective opinions on the application are and physical activity. This survey is semi structured as it is possible to write comments in addition to the predefined answers. This survey was given to the focus group.

Qualitative Interview

The qualitative research is in this project based on interviews and observations. There are several ways to conduct an interview, in this case it was done face to face, where interviewer was taking notes. This type of interview was an expert elicitation interview. Formal expert elicitation is a structured approach to systematically consult experts on uncertain issues. It is often used where there is a lack of data or knowledge on a topic and to further develop qualitative issues such as definitions or assumptions (Knol et al., 2010).

In this case the expert was interviewed to get a better understanding of how physical activity and mHealth can affect mental health, as this is otherwise difficult to measure within the framework of this thesis. The interview was semi-structured, meaning it contained both open-ended and closed questions. During the interview, a pre-made script was used as a guideline. The candidate was carefully chosen. In this case it was a field expert, more specifically a licensed psychologist working at Helse Bergen, with three years of counselling experience. The goal was to get an expert's opinion on whether the developed artefact actually have the potential to help answer the research questions at hand. It is assumed that a person with psychology background could help assess whether the functionality of the app would have a positive effect on mental and/or physical health. One of the main advantages with interview is that the interviewer can ask more questions, or follow-up questions when things might get interesting or difficult. See *Chapter 5* for more details of the interview.

Qualitative focus group

A focus group is a form of group interview where there are several participants in addition to the moderator. There is also a emphasis in the questioning on a particular fairly tightly defined topic (Bryman, 2012). However in this case, the focus group is bit different than the conventional one. This focus group has operated via social media, i.e. Facebook, Skype, and email, and can therefore be considered a form of social media focus group (Carpenter, 2016). The members have not met physically in focus group session, but they were aware of each-others presence in the prototype and cloud communicate via messages in the app. The members of the focus group have contributed from the initial development phase to the very end. They have served as advisers in the sense that they have tested the application as a prototype for each iteration and provided suggestions for both improvements and new content. The focus group have consisted of five people.

Qualitative observation

Observation is another qualitative method that has been used in this project during the evaluation and data collection process. In this case controlled environment observation has been used which refers to the participants who are performing specific tasks in a controlled environment (Roger et al., 2011). While the participants are performing the given tasks, the evaluation leader is observing them to see what kind of problems that may occur. This is useful as the evaluators can communicate their problems as they happen and the evaluator leader can take notes and analyse them later.

4 Development of the Application

In this chapter the design and the development process of *MoveFit*, the artefact developed in this thesis, will be presented. The content of the application will be described and show-cased. Moreover the tools and technologies used during the development will be elaborated in detail.

4.1 Establishing Requirements

Setting requirements is an important part of software development, as it helps to define the users needs and figuring out the scope of the system. This is done by stating in detail what the system should be able to do and how one should go about to accomplish that. The requirements are set in the initial part of the development and it is important that they are clearly stated so that there will be no ambiguity when developers starts pursing them (Sommerville and Sawyer,1999). The requirements have been divided into two groups, functional and non-functional. Functional requirements describe the behaviour of the system, while the non-functional requirements enhance the performance characteristics of the system. (Roger et al. 2011).

4.1.1 User Groups

Health is a topic that interest most people as it is very important. Many people think that they should take better care of their health. A problem is that it is often hard to know where to start, but also to find and keep motivation. Mobile health has proven to be an efficient tool for motivating and promoting an active lifestyle as we have seen from mHealth research in *Chapter 2*. Questions such as who are eligible to use mHealth systems needs to be asked. The user group for this application is rather wide. The app is available to general public, thus reaching all kinds of user groups. However, as the goal is to promote an active lifestyle, those who are not already very active are the ideal user group. These people can again be divided into several sub groups. Below are some example scenarios of who may benefit the most from this application. Lets assume all of these are smartphone owners and know how to use them.

Scenario 1: Person A

For instance we have a sedentary person whose age is within the range 18-30 and works at an office sitting still in front of the computer all day. Person A is not physically active throughout the day, by for instance doing sports, or other activities. This person is not able to meet the activity requirements set by WHO, where an adult at this age should engage in 150 minutes of moderate intensity activity during a week (Who.int, 2016). Therefore this person is subject to be affected by bad health, whether it is overweight, depression etc. Person A might have a good social life, but is simply just not active enough. Person A is neither negatively inclined towards good health, nor physical activity, but lacks knowledge and motivation to do something to change the lifestyle.

In order to prevent bad health down the line, Person A would benefit from a reminder that will make the person more aware when he or she has been sedentary for too long. Additional gain would be to get informed about the health benefits of being active throughout the day. Person A's smartphone is always within reach.

Scenario 2: Person B

This is a person within age range 30-65, who is overweight due to low physical activity. As a result Person B has become depressed, resulting in persistent inactivity. This is making it harder for the person to socialize, as self-esteem is also affected, ultimately making the person lonely. Person B wants to do something to improve the lifestyle, by being more active and social.

In this case Person B would benefit from getting in touch with other people, maybe people in the same situation. It would also be easier to do something active if there is a purpose and a fun way to do it. For instance by going for a walk with someone new one would get acquainted and at the same time get some exercise.

Scenario 3: Person C

Person C is above 67 years old and is somewhat active, but not enough according to WHO recommendations. This person has diabetes and cardiovascular disease. The doctors have told him or her to be more active. The only problem is that Person C finds physical activities extremely boring and lacks general motivation. Person 3 is motivated and triggered by competition.

As motivation might be hard to come by, this user would benefit from a system allowing for competition between friends or family, where the users would earn points from being active. Being able to do activities that would benefit others as well, could provide the user a sense of purpose. For instance by sharing your own hiking route with friends, or images taken from the various routes.

4.1.2 Functional Requirements

- The application should provide an intuitive and simple user-interface that is manageable by most people. The application should also be visualizing all data in a nice and logical way.
- The application should alert the users when they are inactive and inform them about the benefits of being active throughout the day.
- The application should allow the users to create various activities and share these with others.
- The application should allow users to establish friendships and socialize, by sending friend-request and prompting the receiver to accept. The user should also be able to delete friends, or reject friend-requests.
- The application should allow users to communicate via text messages privately, so that they can arrange a meeting for an activity.
- The application should allow the users to track their progress in terms of how active they are and the amount of points earned from the various activities.
- The application should allow the users to view routes or activities that are nearby, as well as friends who are nearby.
- The application should give the users the possibility to view other peoples progress via a scoreboard, as well as searching for specific people via a search-bar.

- The user should be able to create a profile visible for others, where the user can post images and write about them selves.
- The user should be able to edit their content such as deleting an activity they have made, or change their profile.
- The user should have access to a tool for checking their BMI and BMR.
- The user should be able to change basic settings in the application such as activity alarm interval and distance unit displayed (Imperial vs Metric).
- The application should be able to provide location based content.

4.1.3 Non-functional Requirements

- The application should be responsive and fast.
- The data in the application should be updated on demand, or regularly.
- The application should be available to everyone.
- The application should be self explanatory.
- The application should visually motivate and attract people.
- The application should encourage creativity in terms of self made content.
- The application should provide necessary information when needed.

4.1.4 Demanded Requirements

In order for the application to function there is a need for certain hardware such as:

- Android device w/ accelerometer
- Internet connection and GPS.

4.2 Modelling

An application is a complex artefact, thus it would be of great benefit if one could describe or explain the system to anyone in an easy manner. This is where modelling and simplification comes in hand. Modelling is used as a tool to make simplified models of a system with the purpose of describing it with as little complexity a possible. This is known as “software modelling” and is a common technique used by developers (www.tutorialspoint.com, 2016). They use it both to sketch a model of a system i.e. design the system, before they develop it. Later, other developers or users can see the model and get an overview of how the system is build and how it works. This is an important step in the design process.

Unified modelling Language (UML) is a popular language for modelling in software development. With this language one may create conceptual models of different systems in a standardised way, allowing for interoperability. The model will show classes, where related methods/functions and data is presented. This gives an overview of which components the system consists of, as well as how they communicate with each other i.e. what is the data flow (www.tutorialspoint.com, 2016) . There are 3 main steps in the development of a UML model:

1. Analysis: The first step is to identify which objects that are present and describe these. The objects should be classified by their area of responsibility i.e. by which functions the objects, or the classes have.
2. Design: The second step focuses on requirement specification, e.g. what features are needed in |order to perform different tasks or functions. The classes or objects are being defined and classified by their functionality. They are also placed conveniently in relation to each-other, with their functionality kept in mind.
3. Implementation: The third step is the actual implementation of the system that the model has been a template for. The implementation is made with an arbitrary programming language.

Below is an UML model created in the initial phase. The model is not accurately representing the end result, however it is showing the foundation on which it is built upon.

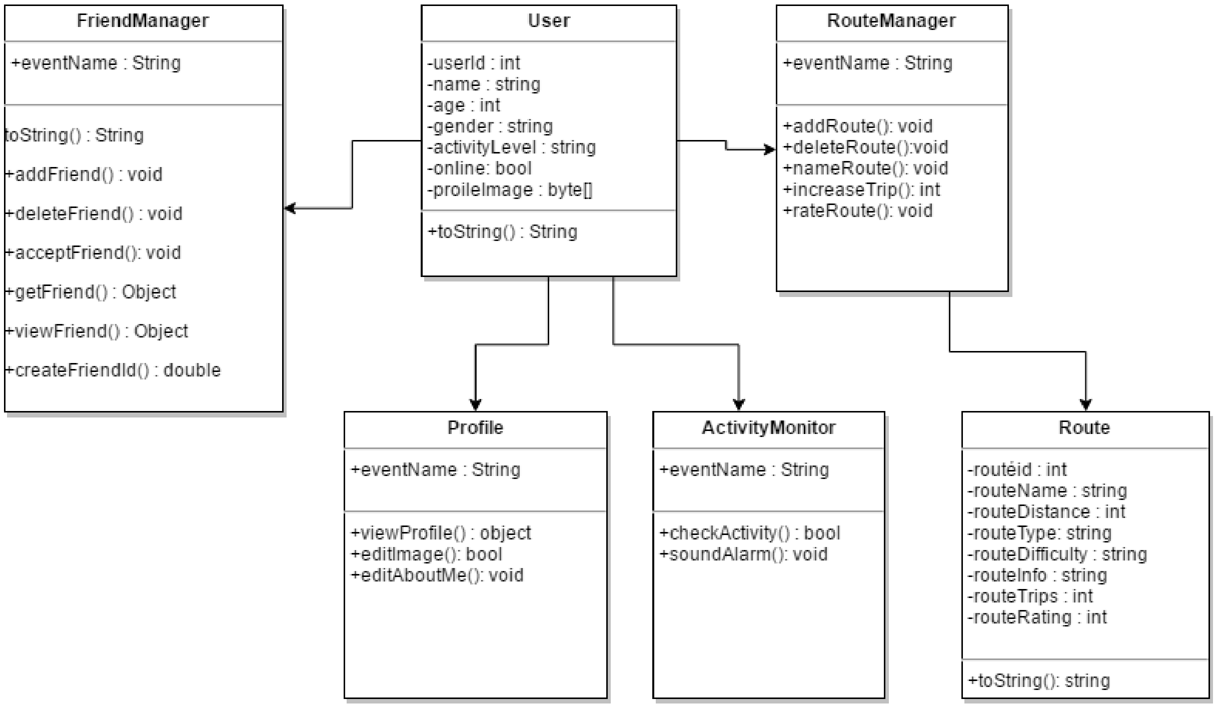


Figure 4-1: Initial UML model.

4.3 MoveFit System Description

In this section the content of the application will be presented. The content is illustrated with images in section 4.7.

Figure 4-2 below illustrates the basic life cycle of an very important component of the Android application. More specifically, it shows the life cycle of one activity in the application. In Android development, an activity is represented by a class and a layout which is the screen that the user will see on their phone. An application consists of several views and the user can often navigate through these views. In contrast to having just one starting point, such as a main method, the Android system operates with these activities, which each have their own starting point, or main method. As we can see from the figure there are methods that dictate what is going to happen in the different states, such as when the activity is started, created, paused, or simply exited. The starting point is the onCreate method which initializes the whole class and the layout associated to it.

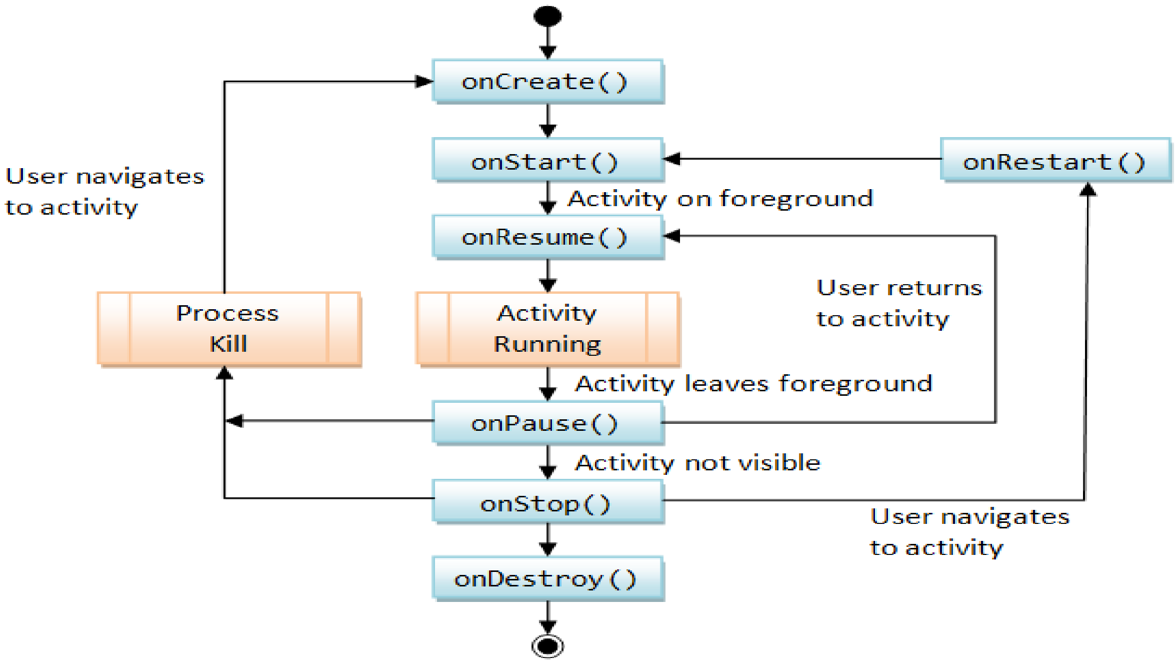


Figure 4-2: Android activity' lifecycle (Activity's lifecycle, https://www.ntu.edu.sg/home/ehchua/programming/android/Android_BasicsMore.html)

The developed application consists of many different activities and fragments. These are the screens with content that the users see when they are running the app.

Application Content

The first screen the user will see is the login screen. In the login screen the user will have the option of logging in via either Facebook or Google, or the possibility of signing up with a new account created via the login service. Some data will be collected from the user's existing account, depending on the login method they have used. The data collected consists of user profile-image, name, and login provider-id, which is used to generate a unique user id in the system. After the login screen the user will see the application logo, which is show in *section 4.7*. Next the user will be in the main menu, however before being able to proceed, as a first time user, the user is prompted with two windows: The first window is welcoming the new user and giving some basic information about the app and its purpose. The next window asks the user to state name, gender, and current activity level. This is selected from a list of five alternatives based on Harris Benedict Equation (Bmi-calculator.net, 2016):

- Sedentary (little/no exercise, desk job)
- Lightly active (sports 1-3 days/week)
- Moderately active (exercise/sports 6-7 days/week)
- Very active (exercise every day, or exercising 2x/day)
- Extra active (exercise 2 or more times per day).

The reason why the user is asked to provide activity level is to see whether the already active users are the ones mainly using this app.

After completing the registration, the user will be able to freely navigate the app. The users have access to two menus, left menu and right menu. There is also a toolbar placed on the very top of the screen by convention. The toolbar shows the users status, whether he or she is online or not. There is also an animated *hamburger* icon to the left, which allows the user to open the left menu. On the right side of the toolbar there is an arrow for accessing the right menu. In the middle of the screen there are three buttons. These shows an animation where *score*, *nearby routes*, and *total distance moved* is displayed.

Both the right and left menu are drawer menus, meaning they are *sweep-able* from the edges of the screen. The right menu is showing first a list of top three friends as sorted by points. The second list is showing all the user's friends with a mini profile. The user is able to access the respective user's profile from here and the message dialogue for the specific user. The idea is that it should be fast and easy to send and read messages from your friends.

The right menu consists of the following tabs: *User Profile, Scoreboard, Routes, Social, Settings, About,* and *Logout.*

Profile

By clicking the user profile a new window will appear. This is displaying an overview of the user's profile. The user can load an image from the image gallery as a profile picture or as showing parts from some route. Furthermore the user can write something about him/her self. Age, name, and gender is also listed automatically in the profile. All these data are public, meaning they are available for others to view in the app. The profile screen also contains a button leading to a new screen consisting of a BMI and BMR calculator (Bmi-calculator.net, 2016). These data will perish after use. The calculator is meant to be a fun tool for the users to monitor the potential changes over time.

Scoreboard

The next tab leads to a scoreboard when clicked. This gives an overview of people and routes nearby. The people nearby-scoreboard shows people in the range from 1 km to 100 km from the user, depending on the distance the user has set. Information displayed is the users profile image collected from either Facebook or Google, name, age, gender, and score. The user can sort the list by these attributes. By default it is sorted by score. The user can also search for a specific person in a search-bar. In the toolbar the user can switch to the route-scoreboard. The information displayed here is an image of the route type e.g. walking person image for a walking *route, route name, route review, route distance,* and *route-type*. The content is sortable by those attributes and the user can also search for a specific route in the search-bar.

Routes

This tab leads to the route menu when clicked. This is a fragment layout menu, meaning the user can swipe side ways to navigate the different screens. There are three fragments, or screens: *Map, Find Routes,* and *My Routes*. The fist screen shows a map of the users current position, as well as routes that are in the area, depending on the distance settings. There is also a *create route* button which leads to a new screen called *route creator*, where the user can create a route. The screen shows a map, as well as and status image and text, indicating whether a route is currently being created or not. The colour code orange means no route is being created, green means route creating in progress, and red means route has been finished. Then route will be uploaded to the cloud. Further down the user can select the type of route to create, e.g. running, skiing, or kayaking. This is displayed in a scrollable list.

After selecting a route the user can click a start button on the bottom of the screen. This will first display a dialogue box asking the user if he or she wants to activate live tracking feature, which means the route will be drawn on the map live while performing the route. When the user has selected yes or no, the route creation will start as a service running in the background, thus allowing the user to do other things in the app, or on the device. The user would actually have to move in order to create the route, as the route is being created based on the GPS location points. These points are taken depending on two conditions: time interval and distance moved. When a certain time has elapsed, circa 45 seconds, and the user has moved at least 30 meters, the location is being stored. This generates a set of location points where the amount is depending on the route distance. When the user has created the whole route by performing it, he or she will push the finish button.

Next a dialogue windows will show up, where the user can give the route a name, some useful information related to the route, and set a difficulty level of the route. The status is then set to finishing, the icon turns red, and the route is being uploaded directly to the cloud. The user is awarded points based on the distance of the route and the *route-type*. Different types of routes awards different amount of points. For instance hiking awards more points than walking the same distance as it is in general tougher. After this, the route is being drawn on the map with lines, showing exactly where the user has gone. A message is saying the route has been created successfully and x amount of points has been earned. Finally the icon turns orange, and the status is set to idle again. There are also two flag icons showing the starting point of the route and the finish line. If the route is less than 500 meters, it will not be possible to upload it as it is too short. This is shown in a dialogue box. The GPS on the device is set to be on the highest accuracy level when performing the route. This is important in order to create accurate routes that people would be able to follow.

The next tab on the menu is the *find routes*. Here the user gets a list-overview of the nearby routes. The list shows small containers representing the route profile. Each element contains an image of the *route type*, the *route name*, the *length*, *distance away* from the user, and *route difficulty*. The latter one is represented with three different colours: Red (hard), yellow (medium), and green (easy).

The last tab, *my routes* is displaying the same content as the routes. The difference is that these routes are the ones the user has made, and there is an option to delete a certain route.

Common for the whole route menu is that it is possible to sort the routes by *distance, difficulty, rating,* and *type*. Each route element is also click-able, leading to a new screen representing the *route profile* in more detail. On top of the screen there is a map where the route is drawn, and below there is information related to the route: *Name of route*, *name of the creator*, *description of the route*, *length of the route*, *difficulty of the route*, *route type*, *amount of times the route has been used* (trips) and lastly the *best time on the route*, followed by the name of the person with the best time on the current route. Below the route information, there is a rating bar. This bar is showing the amount of starts the route has gotten. It ranges from 0 to 5 stars. People who have used the current route are able to rate the route when completed. The stars are being calculated with an average.

On the bottom there is a button saying start route. This allows the user to start this route. The only criteria is that the user has to be within 200 meters of the starting point, illustrated by a green flag. If the user is within the distance, he or she can do the route by following the drawing on the map. If the user strays from the route, an alarm will sound, and a message will show, telling the user to get back on track. If the user decides not to do so, the route will not be completed and no points will be earned. There is an algorithm checking whether the user has actually completed the whole route. It looks at the GPS location points collected, and compares them to the original route. There are 5 location points spread out from the original route which works like check points. If the user does not come within circa 150 meters of 4/5 of these check points, it will be considered incomplete and the user will not earn any points. This is to prevent cheating. If the user succeed in completing the route, he or she will be awarded points based on the distance and on the route type. A new dialogue window will appear with a congratulation, and as well acknowledging if the user has made a new time record on the route. The old and the new time will then be displayed. The average speed in kilometres is also displayed. Lastly the user will be able to rate the route with stars from 0 to 5.

Social

By clicking the social tab in the right menu, the user will be taken to a new menu very similar to the one of the route. This menu is representing the social features of the app and consists of the following four fragments or screens: *Map, nearby, friends*, and *requests*. The map is showing the user, as well as the friends of the users. This feature is somewhat controversial as it allows the users to see where their friends are on the map, although this has not presented any problems to the focus group. However, in order to see friends on the map, there has to be a mutual consent of friendship, and the users would have to be online, and allow location-tracking. This feature can be switched of while still using the app normally if the user is not interested in sharing his or her location. The next tab is the *nearby* screen. It is similar to the nearby list of the routes, except that concerns people. Each element contains information such as *name, age, gender, profile image, online status, distance away*, and a button which is for sending friend requests. If the element is clicked the user will go to the persons profile, which was described earlier.

The next tab is a friend-list. It is displaying the same information as *nearby*, but in addition there are two buttons. The first button is represented by a message bubble icon. When clicked the user is taken to a message dialogue screen, where the two users can write each other text messages in private. The idea is that the users should arrange meetings and plan activities together, such as going for a hike. The second button is represented by an icon showing a stop symbol over a figure. This button is for removing a friend from the friend-list. The last tab is friend request list. It is similar to the others, except that is contains two different buttons: one check button for accepting a friend request, and one button for rejecting friend request. If the user decides to accept the users friend request, they will become friends and the user will be moved from this list to the friend list, and it will then be possible for the two users to send messages.

Common for the whole social menu is that it is possible to display the users by who is online, the gender, or simply just to show all people.

Settings

When the setting tab is clicked the user is taken to a new screen showing the different settings of the app. First there is the option of toggling location-tracking, which will result in friends being showed on the map when turned on. Next there is an option to turn on or off the activity alarm. The activity alarm is always on by default. The purpose of the activity alarm is to monitor the user's activity level. If the user is sedentary for a certain time period, an alarm is sound to prompt the user to move. A new screen is displayed showing heath facts about being active and a button to turn of the alarm. There is also some text saying that the user can get up and move a few meters to turn of the alarm and to earn points. The user will then be awarded 50 points for moving. The activity monitor algorithm is using the device's accelerometer to see whether the user is sedentary or not. If the users is sitting still with the device within approximately 1.5 meters, he or she is considered inactive and the alarm will sound after a certain time. However if the user is moving more than this, the alarm is reset and will not be triggered. The alarm is also only active when the user is in the application and between 9 in the morning and 9 in the evening local time. This is to avoid unwanted interruption.

Next in the setting screen, there is an option to set the alarm time on the following intervals: 45, 60 or 120 min. If the setting is set to e.g. 60 minutes the alarm will sound after one hour of inactivity. Below this section there is an option to select distance unit using either the imperial and the metric system, i.e. km or miles. Lastly there is a slider where the user can select the distance to find routes or people within. This is set to maximum by default, which is 100 km or 62 miles. On the very bottom there is a save settings button which does exactly that. The settings will be the same the next time the user opens the app. This data is stored on the device.

About

The *about* tab is showing a dialogue box in the main menu, where there is some information about the app.

Logout

This is the final tab in the menu. When clicked the user is being logged out and told so by a message box. The user is then taken to the login screen of the app and after which is being displayed as offline in the app.

4.4 Architecture

This section will elaborate on what kinds of technologies, and tools that have been used throughout this project, as well as how they have been implemented. The system architecture will be illustrated and the different components that are used will be explained.

4.4.1 Programming Language and Tools

The application has been developed using the programming language C# with Visual Studio 2015 Community edition, and Xamarin Studio integrated development environment (IDE). The reason behind this choice is that the project have been intended as a cross platform development project for mobile devices, and due to the fact that the tools being used, which is Microsoft Xamarin, require the developers to use this language for that purpose. The C# language is object oriented language, and is developed by Microsoft. They were aiming to combine the computing power of C++ with the programming ease of Visual Basic. In terms of syntax, C# and Java are quite similar (SearchWinDevelopment, 2016). One great benefit of C# is that it is designed to work with Microsoft's .Net platform. The .Net platform is a collection of programming support, with special consideration to web services. This is particular useful when handling databases and devices, which is done in this project.

The back-end of this project have been written in JavaScript. Most of the JavaScript back-end code has been provided by Microsoft Azure and is responsible for managing connections and database operations. The developer has the option of choosing between .Net or JavaScript back-end. Most of the functionality is the same, however the JavaScript back-end offers a simple way to monitor the data in the database through what is known as *easy tables.* By using easy tables, the developer needs only to login to Azure Portal and click the table one would want to view the data from, instead of logging in and connecting to the database via DMBS, which is a bit more cumbersome.

Moreover the application is designed as a client-server type of application. That means the client, which is the user and the user's phone, connects over the internet to a server in order to retrieve and store data. The server resides in the Azure Cloud Services hosted by Microsoft and is responsible for all the communication with the database, where the actual data is stored and retrieved from.

Listing of Technologies Used

To develop this application a series of well established tools and technologies have been utilized. These tools have taken the development from initial model and prototype, to the finished application.

<u>Software</u>

- C# as main programming language
- JavaScript on back-end
- SQL

- XML
- Visual Studio & Xamarin Studio IDE
- Andorid, Iphone/iOS, and Windows Phone Emulator.
- Xamarin Cross Platform Development (Mono)
- Windows Azure Cloud Services (Server and SQL Database)
- .Net Framework 4.5
- Google maps API & Windows Azure SDK
- Git Source Control
- Visual Studio 2015 Unit Tests
- Visual Studio 2015 DBMS SQL Server Object Explorer
- Microsoft Paint

<u>Hardware</u>

- Pc & Mac.
- Smartphone w/ Android & Connection-kit.

These tools and technologies have been used to craft the mobile application *moveFit.* They have all played an important part in the development. Some of the technologies are chosen based on the authors previous experience with them, others are completely unfamiliar and have been used in this project as a goal to learn something new and useful. Below is a simple architecture model of the system, giving an overview of the main components.

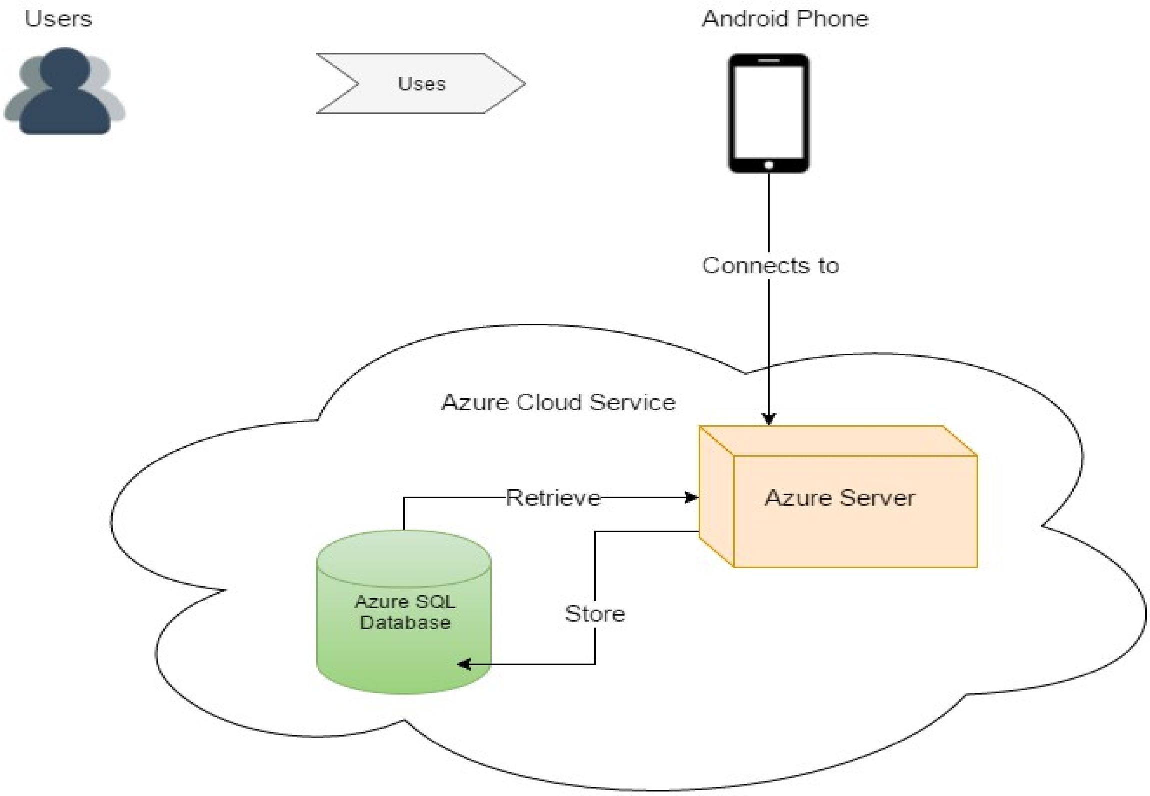


Figure 4-3: System architecture

Functional responsibility is shared between the client and the server, allowing the user device to be less resource dependent and thus more energy efficient as it won't have to do all the data processing by it self. Microsoft Azure Cloud services allows the developer to create and use different kinds of scripts in order to process data. That might for instance be validation or calculations on an insert operation, or a special sorting function before retrieving data from the database. This requires the client to be online at all times, as the client and server have a continuous communication going back and forth while the application is running. Otherwise the application will not be able to retrieve the necessary information when demanded, nor save important information. For instance the if the user is creating a route, and the internet connection is lost, the user wont be able to upload the route to the cloud when finished, resulting in zero points for the user, and no-one else will be able to use this route unless its created again. Likewise if the server has a downtime, the client won't be able to store various important information.

The following table outlines high level functions in the app, and the responsibility.

Functions	**Responsibility**
Register User using Facebook account	Client & Server
Retrieve and store User, or Route related info	Server
Get user location using GPS and cell broadcast	Client
Send user location to the server	Client
Ordered list of users in the proximity	Client & Server
Find route within the proximity	Client & Server
Creating routes	Client
Add a person to friend list	Client & Server
Remove a route, or a person from friend list	Client & Server
Tracking user real time when online with GPS	Client
Send message to another user	Client & Server
Activity alarm	Client & Server

Table 4-1: Function responsibilities

The graphical elements of the application is written in eXtensive Markup Language (XML). This is by convention when dealing with UI in Android apps, even though the same can be done programatically. Visual Studio 2015 has been used as the editor.

GitHub has been used as version control system in this project. GitHub allows users to create a repository, and upload code to this repository. The user can decide whether to make the repository public or private. In this project the repository is public and available at GitHub (2016). Git is used as a source control system, and is integrated with Visual Studio. Git keeps track of files that have been edited, and on demand it commits, and pushes these changes to the GitHub repository, which is hosted on an external server.

4.4.2 Data Storage

The back-end solution where the data is stored, is a server with a SQL database in the cloud. This is a relational database as a service (DbaaS), and as it is hosted in the Azure cloud with a server it is also software as a service (SaaS) and platform as a service (PaaS).

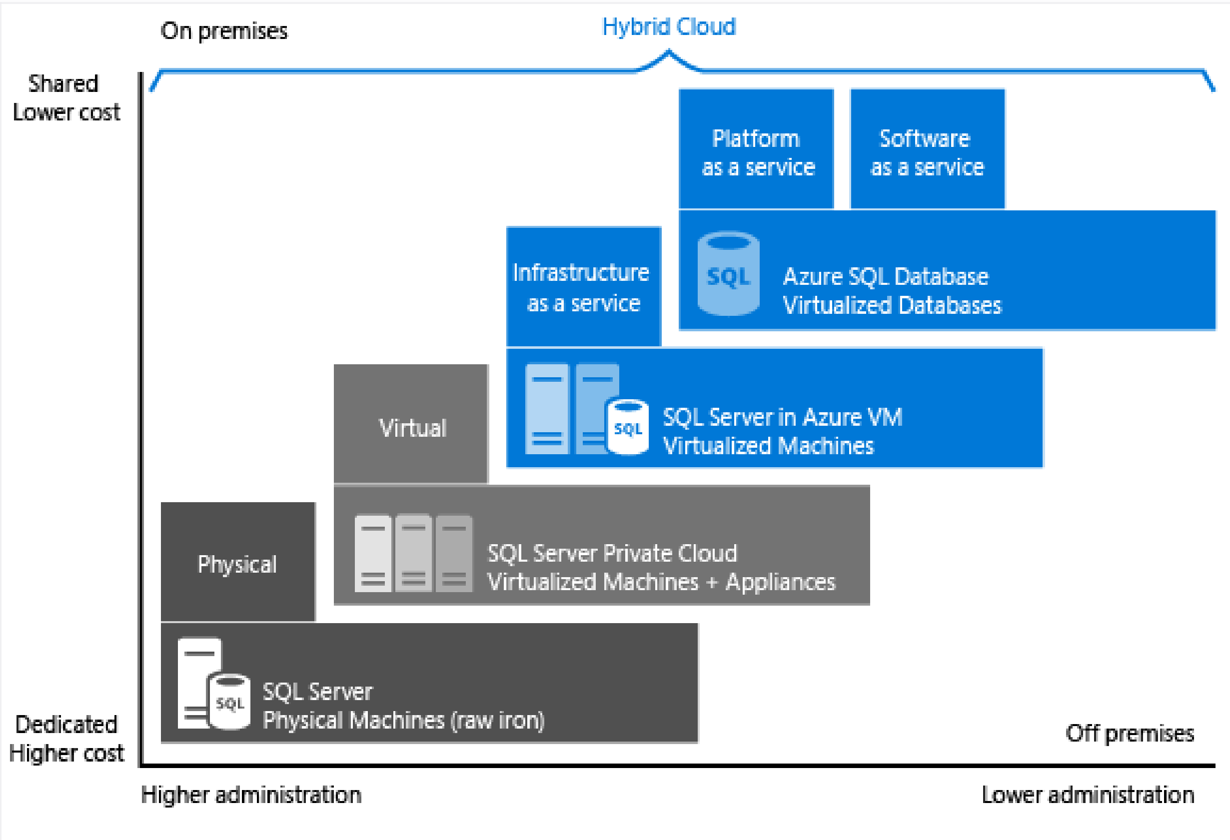


Figure 4-3: Microsoft Azure cloud architecture (Microsoft's data platform, https://docs.microsoft.com/en-us/azure/sql-database/sql-database-paas-vs-sql-server-iaas)

The database is responsible for storing about 95% of all the app-data. The relevant data is being produced on the phone by the users and then uploaded to the cloud. Later, this data is being retrieved again, when needed. In this way, the phone will not need to store large amounts of data, thus saving space for other use and at the same time being safer, as user data is not available for anyone with unauthorized access. On the other side, it is a requirement that the user is online with continuously internet access, otherwise the application wont be able to manage the crucial data it is supposed to.

Structured query language (SQL) is used to manage the data in the database. This allows for use of the CRUD operations, also known as *create*, *read*, *update*, and *delete.* These operations are essential to manage a dynamic database (Martin, 1983). SQL is being used in conjunction with .NET language – integrated query (LINQ). This allows for querying the database, simply by using C# code instead of SQL. The LINQ statements that are written in C# are being translated into SQL operations, which again are ran against the database (Msdn.microsoft.com, 2016). For instance whenever a user is created, an insert/create operation has to be executed in order to store the new user in the database table. When some information related to the user changes, e.g. the user's position, an update operation is executed. The location field in the user table is then being updated i.e. old data is replaced with new. Same goes for read i.e. retrieving specific data related to the user, or delete, which for example deletes the whole user record or instance. Visual Studio provides a integrated database management system (DBMS), making it easier to manage the database. The developer can get easy access to all the data that is stored, and can also run custom queries to retrieve certain data. Furthermore the developer can do all the CRUD operations in the database directly, such as creating tables, and adding references. This is possible as Visual Studio establishes an connection to the database, after being given the credentials. Below is an overview of the database tables in the cloud.

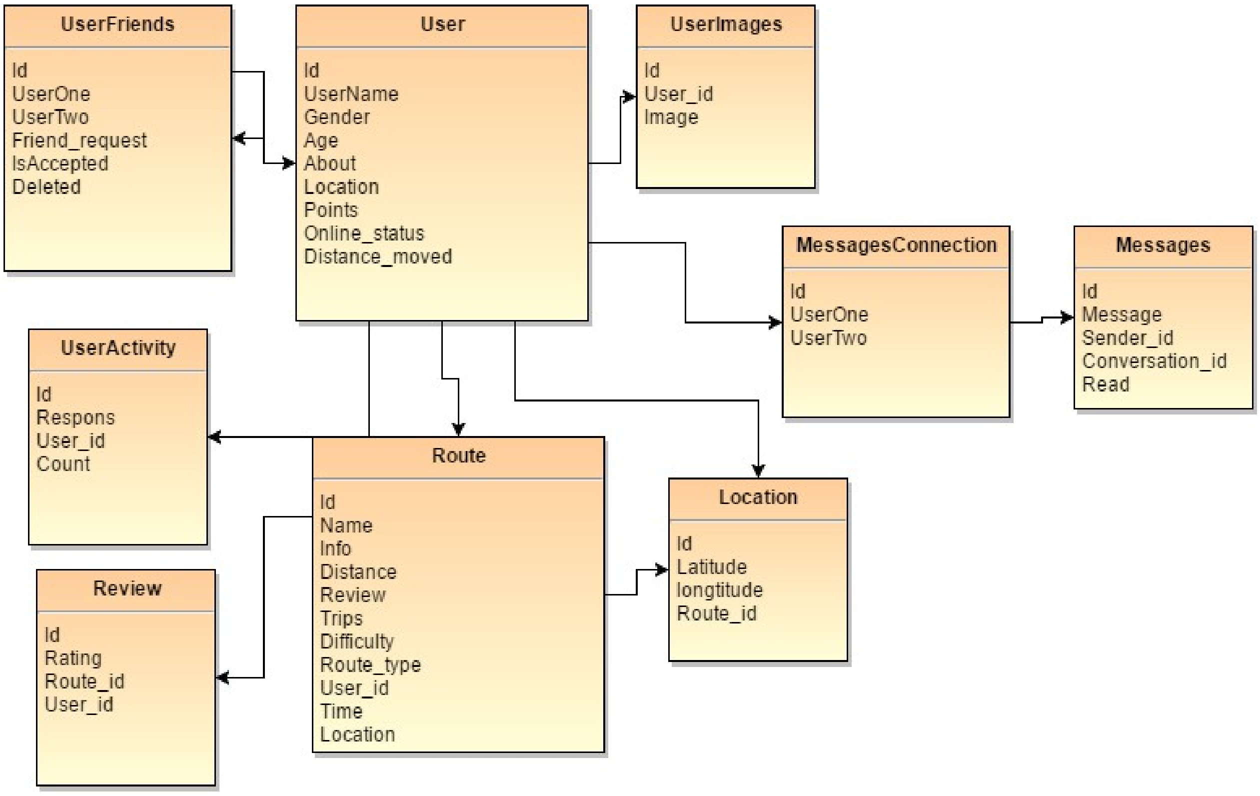


Figure 4-4: Database model

By uploading data to the database on the server, each client with a connection to the server will have the ability to acquire these data, which is a fundamental part of this application. Most data is produced and shared by the users. This allows for interaction between the users, the possibility to see each other in the app and communicate, as well as creating and sharing routes.

The data being stored in the cloud is an important part of this research project, as it is the basis of analysis that will provide valuable insight into how the application promotes an active lifestyle. Data such as the distance a user has moved, the connections the users have made e.g. forming friendships, and how the users respond to the activity alarm are important to analyse in order to get an overview of how the application has had an impact.

The app also utilizes files for storing settings related to the user, also known as *shared preferences* in Android development. This file is stored locally on the smartphone and contains basic settings data, such as display distance unit with the metric system, or the imperial system, "*search for nearby*" distance, and the interval of how often the activity alarm will sound.

4.4.3 Privacy and Security

Privacy issues are already being addressed by the host, Microsoft Azure. If for instance the user's phone is lost or stolen, the user data will be inaccessible for unauthorized users. Both data and the connection to the database is encrypted, rendering the data useless to others without authorization. A possible downside to using cloud services is if the server or service provided is down. Although if this is the case, Microsoft Azure have backup services, and guaranteed a very short potential downtime (Azure.microsoft.com, 2016).

NSD – Norsk Senter For Forskningsdata which is a national archive for scientific data, are managing privacy related issues related to storing and publishing personal data (Nsd.uib.no, 2016). For instance they will make sure that no person sensitive and identifiable data is being published. NSD has been consulted in regards to this project, considering the data that is being stored and used in this project, and they have given their approval on certain conditions. See *Appendix B* for more details.

4.5 Software Development

Android is the platform that this project have been focusing on, although it has been developed with cross platform technology. The main reason Android was prioritized is because it is the most popular platform, holding 87.6% of the global market share to current date (www.idc.com, 2016).

4.5.1 Cross platform Development

Xamarin is a cross platform developing tool, that focuses on sharing code between the different platforms i.e. Iphone, Windows phone, and Android. This allows the developers to write code once, and use the same code across all the different platforms (Developer.xamarin.com, 2016). As a result, the developer will save a lot of time as one would not have to write native code for each platform. The developer only needs to use one language as well, namely C#. This technology allows the developer to distribute the application to more users as well.

However, as it is possible to write code that is shared 100% across the platforms, it may at times be necessary or beneficial to write platform native code, e.g. for the UI. It is possible to write interoperable UI code across the platforms with Xamain.Forms (Xamarin.com, 2016), however it was found during the prototyping that it would be more beneficial to write native code for Android to handle the UI, considering the features that were to be implemented. In this project the main focus has been on the Android platform, although in the beginning of the development all the platforms were targeted. Even though the IOs and Windows phone platform were not completed in terms of UI, they still share a significant portion of the code, which can be used for future work and expansion.

4.5.2 User interface

User interface (UI) is a very important element of application development, as this is the part of the app that the user is interacting with. The purpose if the UI is to allow the user to use the applications features with ease. UI brings together concepts from interaction design, visual design, and information architecture (Usability.gov, 2016). The application in this project is built with a graphical user interface (GUI), which is written natively for Android phones. Usability.gov provides a guideline for best practice for interface design, which has been used during this development (Usability.gov, 2016).

- Keep the interface simple
- Create consistency and use common UI elements
- Be purposeful in page layout
- Strategically use colour and texture
- Use typography to create hierarchy and clarity
- Make sure the system is communicating what is happening
- Thin about the defaults

The better the UI is designed, the easier it will be for the user to use the application, which is especially important if the application is complex. Nowadays applications that are being developed have a big focus on the design. The users are more “picky” and they prefer apps that are looking good as well as easy to use. “Looks and feel” aka user interface and user experience has become one very important aspects of mobile apps (Anon, 2016). The users wants the app to be responsive, pretty, and quick at executing tasks.

A goal in this project was to make a GUI design that is responsive, intuitive to use, and up to date with the modern requirements and expectations. Moreover it is supposed to be as simplistic as possible, so that the user wouldn't have to deal with a lot of buttons, switches, and settings. Android has been on the marked for a while, and a majority of smartphone users have adopted this operation system (www.idc.com, 2016). As a result, Android users are used to a certain style, or design pattern. Android developers are encouraged to continue this trend, as the users often prefer something that they are already familiar with. This has also been taken into consideration while developing this application. In order to ensure a good use-ability, user evaluation and a focus group has been utilized, where the users have looked at and tested the apps user interface as well as functionality. This has proven to be invaluable, as the feedback could be used directly to modify, or improve the application. The next section will look more into usability testing.

4.5.3 Usability Testing

Usability testing is a method used to evaluate how easy some system is to use, and getting feedback from an external point of view. This enhances error discoveries, and deficiencies that otherwise might not be noticed by the developer(s). To run an effective usability test one would need to develop test plan, recruit participants, and finally analyse and report the findings before implementing the suggested improvements (Usability.gov, 2016). Furthermore, it is important to emphasize which aspects of the application the users should test thoroughly. Both usability and functionality has been tested in this project. The user is supposed to know easily whether the various functions are working like it should or not. In *Chapter 5* user evaluation is elaborated more in detail.

4.6 Core Features

This section presents a summary of the core features of the application. These have been implemented incrementally and iteratively through the prototype development. Once the features had been implemented, they were given to the focus group for assessment, and testing.

One of the main features of this application is the map and its available functions. The map is used extensively for the route related mechanics. For instance the routes are drawn to the map, they are also shown as icons on the map so that it is easy to find the location of a certain route. The map is also used to show the user location, and the user's friends. The map used is provided by Google, and they have an application programming interface (API) available for public use.

Another important feature is the point system which is responsible for rewarding and keeping track of the user's points. These are stored in the cloud. After a user has completed a route, he or she will be awarded a certain amount of points. This allows for a common forum where everyone can see other people's points and ideally encourage competition. A scoreboard has been implemented to show these data. The user will also be able to post his or her results to social media such as

Facebook and Twitter, after completing an activity. This is also thought to be an incentive to motivate people to be more active, by allowing the users to show how active they are.

Socializing is an important aspect of this application. There are several ways this appears. The users are able to create a profile, where they can share images, either of them selves or from one of the activities. The profile is open for others to view. Images are important is social media applications, as images are able to convey much information. Moreover, communication between the users is also an important feature, as it may be of great interest to plan routes, or other activities together. They users are able to chat live in the application via text messages. These are private.

The main goal of this project was to find a way to prompt the user to be active, preferably when the user is already inactive. To this end, the application contains a feature that monitors the users activity through the phones accelerometer. While the user's movement is under a certain threshold, for a specified amount of time, the app will alert the user of his or hers low level of activity. This is aimed at encouraging the user to move. The alarm is only sound given the criteria of inactivity, and between 9 am and 9 pm local time.

Another feature that is implemented to encourage users to move, is the route system. The users are able to create routes/activities, and earn points. The route type and distance determine the amount of points one can earn. These route are also shared among the users, which ideally would lead to a competition of creating the best or nicest routes.

4.7 Storyboard and Screen Mock-ups

In this section I will Illustrate parts of the application through storyboards. A storyboard is a graphic representation on how a system works, such as the developed application. It is illustrated with help of pictures, given in a certain sequence. This technique is used for giving a model, or a high-level overview of how the application works. It is a part of Agile software development. A mock-up is a model of some structure, which is used for either instructional purposes, or for experimental purposes (Co.Design,2016). Jake Knapp gives a demonstration of how to create a great storyboard , which I have followed to some extent (Co.Design,2016). Here the main screens of the application is illustrated. With respect to user privacy names and other user identifying attributes are censored.

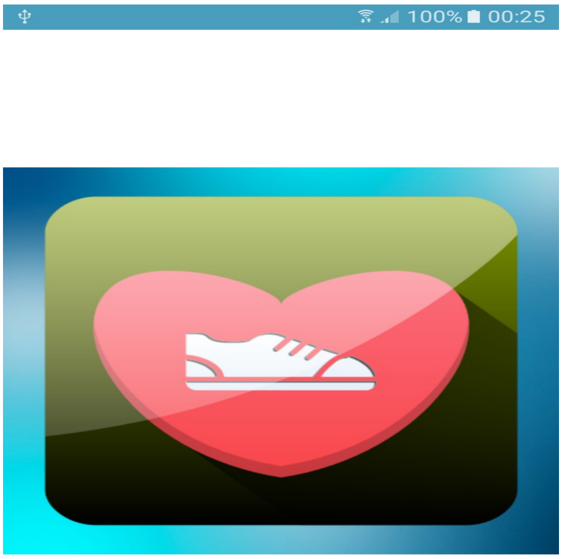


Figure 4-5: App logo

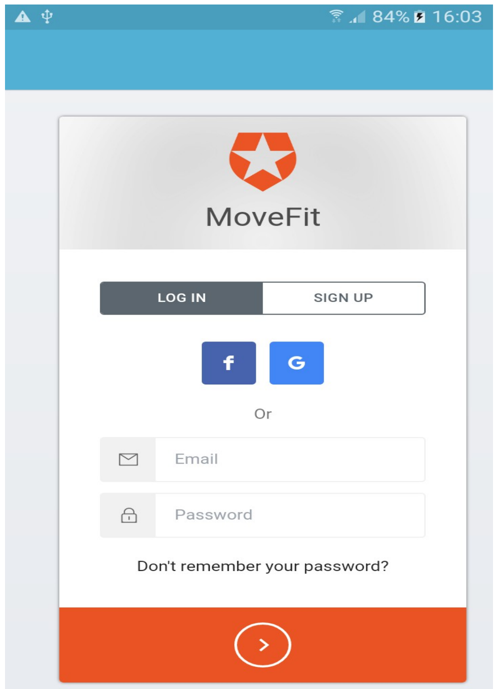


Figure 4-6: Login screen

The first screen is the welcome screen which is greeting the user and showing the App logo. The purpose is basically branding by familiarizing the user with the application logo.

The second screen shows the login screen. The user has the option of logging in ether with a google account, which all Android users must have in order to use an Android phone, or a Facebook account, which most people have nowadays. This allow the application to collect data about the users that already exists in these social networks, such as profile picture, name, email, etc. By taking advantage of existing data, the user wont have to spend extra time typing in user data, that he or she have done some many times before in other social media applications.

This application is using a login service provided by Auth0 (Auth0, 2016). This provider is useful in several way. For instance they provide a unique user identification, which is used throughout the application for identifying the different users. Furthermore, application insight data is also stored and accessible, e.g. amount of times a user has logged in, amount of users, and whether the users are real and not a bots. By using a login mechanism, the application has a security layer preventing unauthorized users intervening with others peoples account, and accessing personal data.

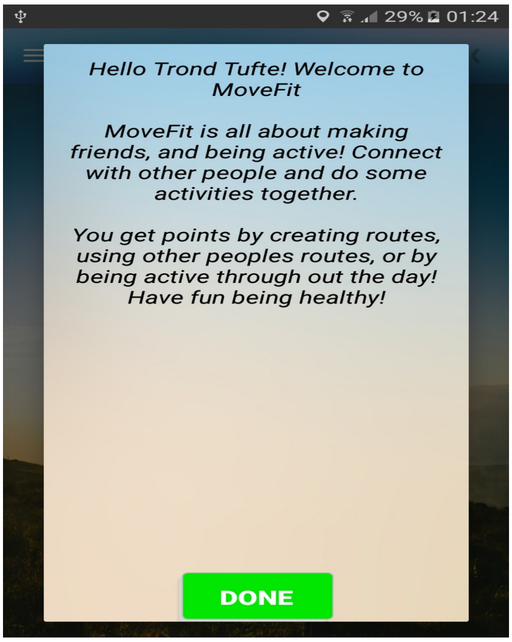


Figure 4-6: Introduction

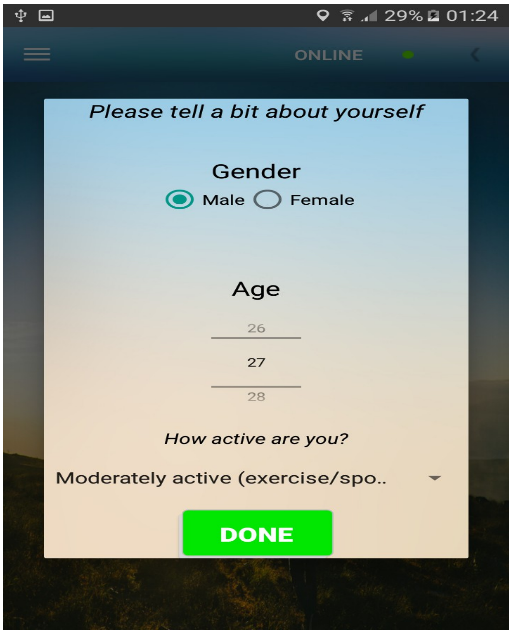


Figure: 4-7: Registration

These screens are shown to the user the first time the user logs in to the app. They are given a short introduction and are then asked to register some data as shown in *Figure 4-7.*

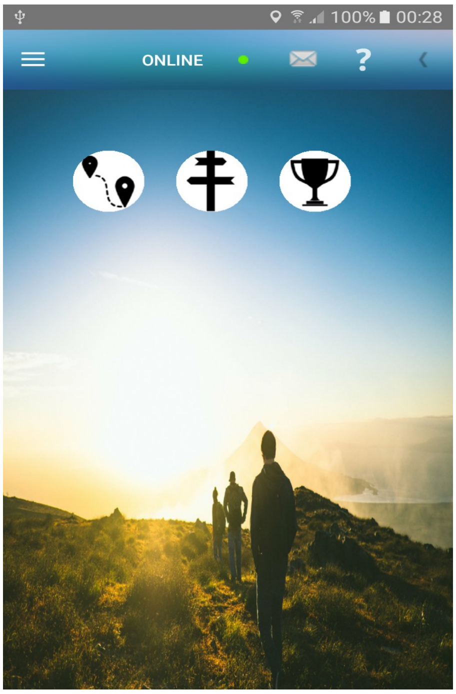


Figure 4-8: Main menu

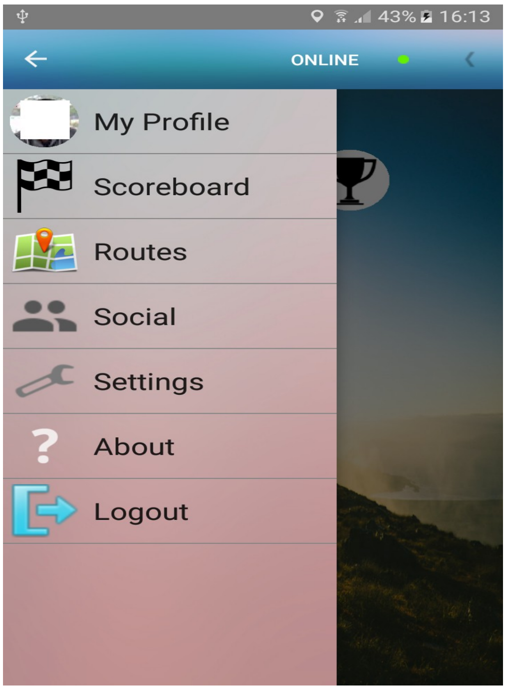


Figure: 4-9: Left menu

The first image shows the main screen i.e. the main menu. This is where the user will start after the login screen. The main screen is designed to be quite simple, so that it will not scare new users with overwhelming information and features. The background consist of a image showing nature and people who are hiking. The goal is to show that this app is about getting up and out of the chair and at the same time being able to experience beautiful places, such as this. It is thought to be inspirational. The screen also shows three white and black buttons. These are showing basic user specific information. More specifically they are showing information about available routes nearby, routes created, distance moved, and total score. This is being displayed with an animation when the user is clicking the respective buttons.

The second image from *Figure 4-9* shows the left menu. There are two menus like this. The user can drag/swipe the menu out from both right side and left side. This one from the left side is the “*main*” menu of these two. The menu consists of 7 different tabs: *My profile, Scoreboard, Routes, Social, About, Settings,* and *Logout*. Depending on the tab the users click, a new screen will pop up. For instance if the user clicks the profile tab, a screen with the users information will show up.

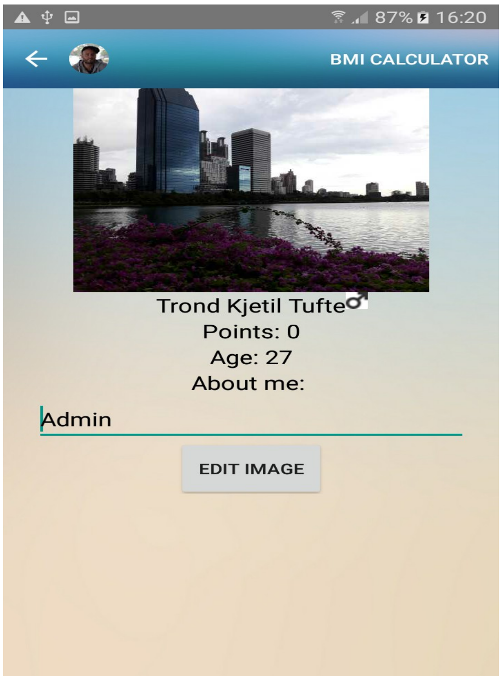


Figure 4-10: User profile

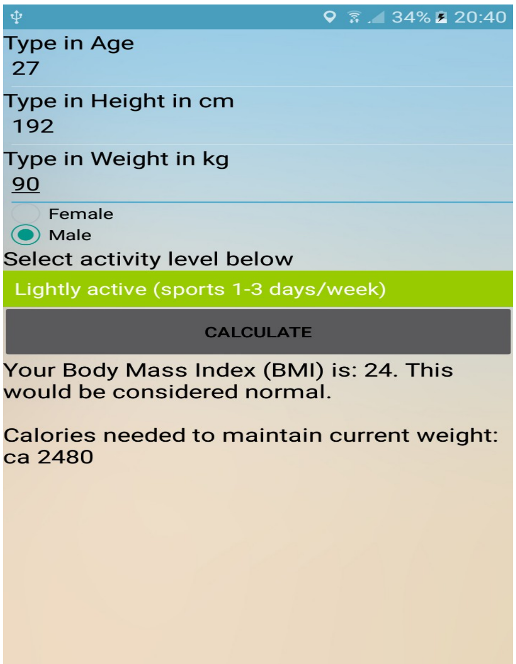


Figure 4-11: BMI calculator

Figure 4-10 shows the users profile. Here the user can upload a profile picture from the image gallery on the device and write something about him or her self. This is being uploaded to the cloud and is then available to other users who wants to view the profile. Other user information is also being displayed here, such as *name, gender, age,* and *points earned*. The top toolbar is showing a image of the user which is provided by either Facebook, or Google and a tab for BMI calculator.

If the user clicks the BMI tab a new screen appears, where the user can input his or her information, and get a estimate of body mass index (BMI) and basal metabolic rate (BMR). The purpose of BMI is to find the ideal weight when factors such as the user's *age, weight,* and *height* are considered.

The BMR is also considering activity level in addition and is telling the user how many calories he or she should consume in order to maintain current weight. This information is not stored anywhere and is not being used by the app.

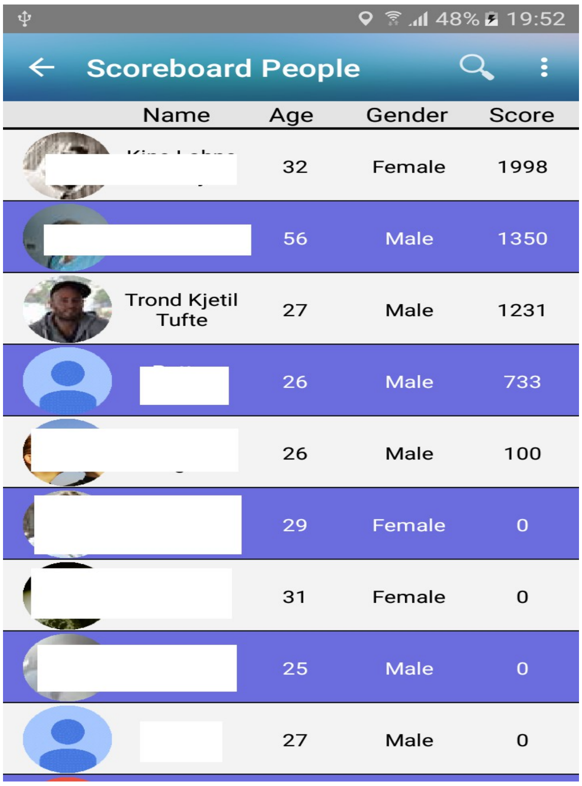


Figure 4-12: Scoreboard people

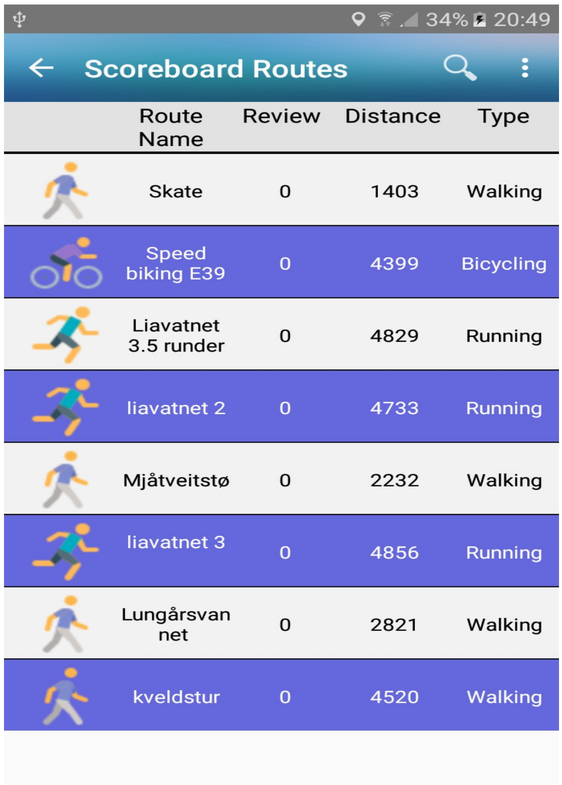
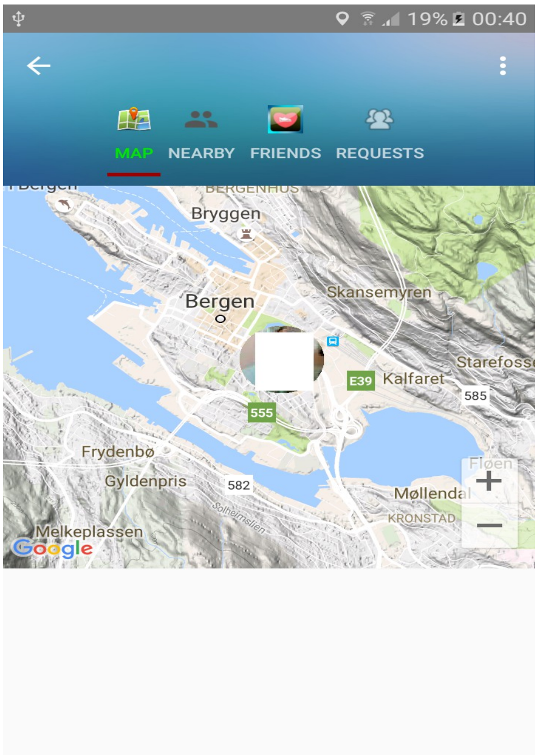


Figure 4-13: Scoreboard routes

Scoreboard people is displaying all the people within a certain radius depending on the settings. It displays information such as the user's *name, age, gender,* and *score.* The users can be sorted by the different attributes, by clicking e.g. gender in the top bar. By default the list is sorted by score. In the top right of the toolbar there is a menu indicated by three dots. This menu shows a list where the user can choose between route overview, scoreboard, and a search option. The search option allows the user to search for specific routes or people in the list.

The scoreboard route screen shows available routes nearby and is sortable like the people scoreboard. By default this list is sorted by review, which gives an indication on how popular a route is.



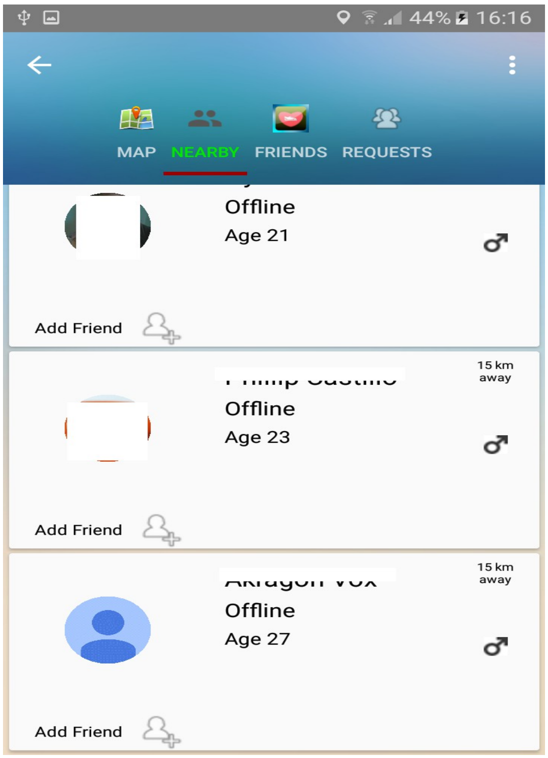


Figure 4-14: Social menu map

Figure 4-15: Social menu nearby

These screens are showing the social menu. It is a swipe menu, which means that the user can swipe through the different tabs, side-ways. The menu consists of 4 screens or fragments. The first screen is showing a map over the area where the user is located. Furthermore, the map is showing the user's friends who are also nearby. If the user clicks the image of the user, his or her profile will show up.

Figure 4-15 is showing people nearby the user. People nearby are being displayed in a list, where some some basic information is shown. The user can click the different tabs and view the users profiles, or the user can send a friend request by clicking the button down in the left corner.

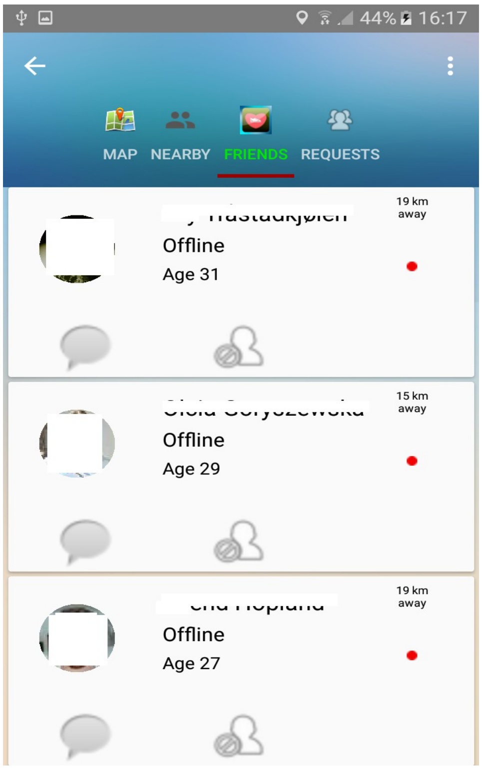


Figure 4-16: Social friends

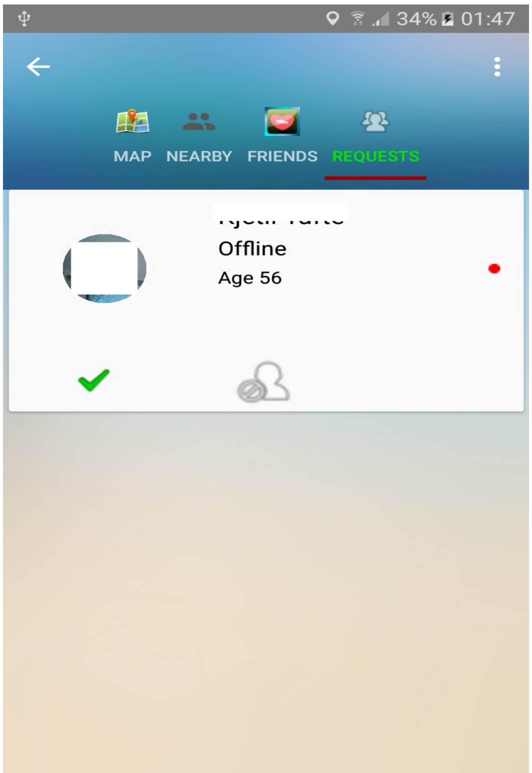
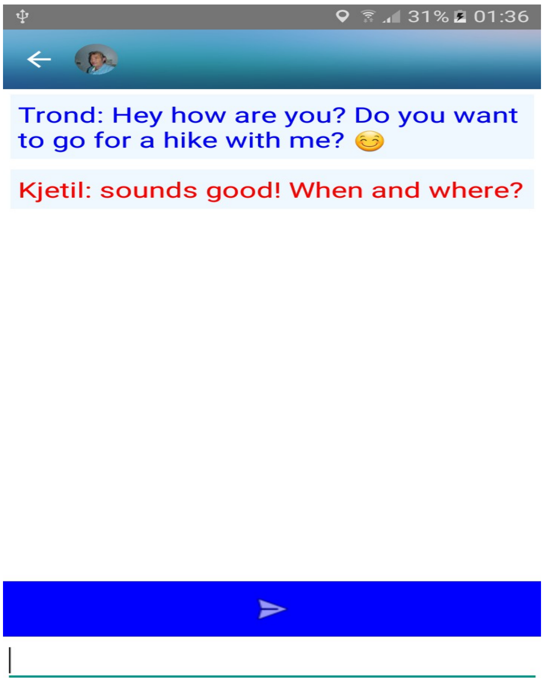


Figure 4-17: Social Requests

Figure 4-16 shows *Friends*, which is the users current friends. The difference from the other tabs is that the user now has the option of sending messages, instead of sending friend request, and deleting friend.

The last tab, “Requests” is representing friend-requests which is shown on *Figure 4-17*. Whenever a user is sending a friend request, the target user is getting an item in a list, similar to the previous lists, where the options are accept friend request, or deny it. Whenever a list is empty, a message stating that no data is found is displayed, e.g. “no friend-requests founds”.



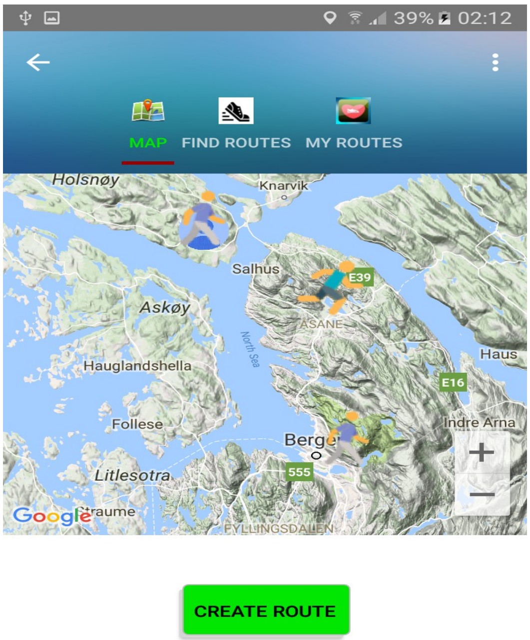


Figure 4-18: Chat dialogue

Figure 4-19: Route menu

Figure 4-18 shows the message dialogue window where the users can chat privately. The messages sent here are stored in the database and is loaded/retrieved when the user access the various chat instances.

The route menu is similar to the social menu in layout. The main difference is the content it is displaying. We can see that in the map tab there is a create route button, which enables the user to do exactly that when clicked. Furthermore the map is showing routes nearby that are available. They are represented with different icons on the map.

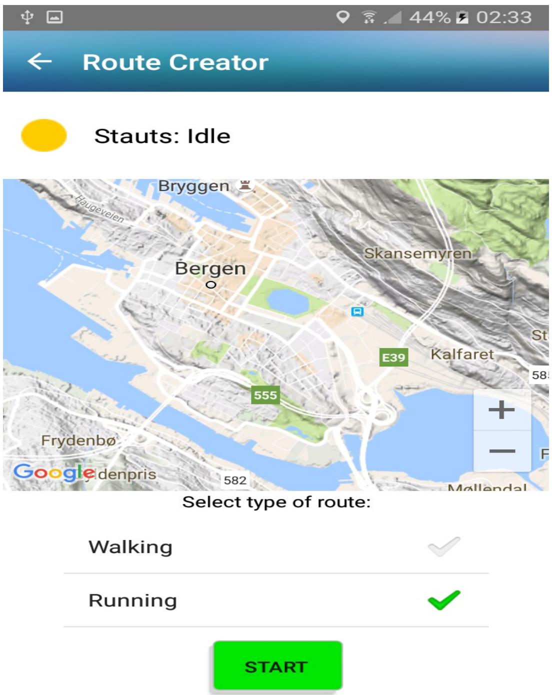


Figure 4-20: Route creator idle

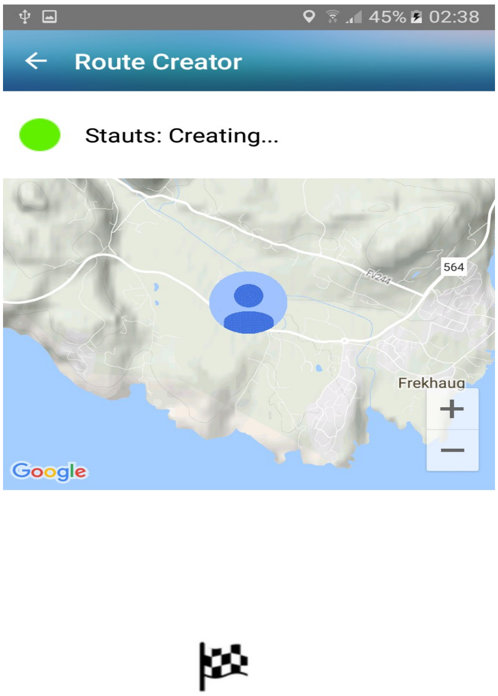
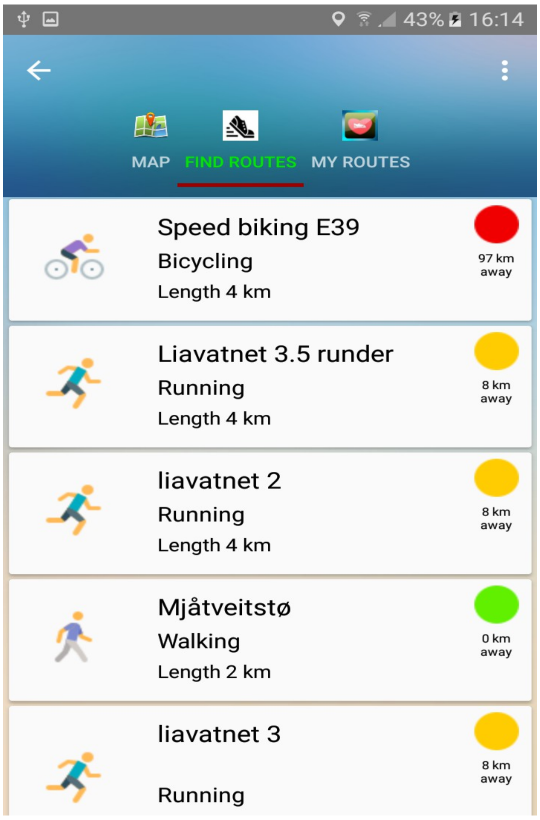


Figure 4-21: Route creator creating route

These two screens are showing the route creator which is accessed from the map tab in the route menu. The first image *Figure 4-20* is showing the route or activity possibilities in a list. When one is selected the user can click start and the route will start being created. The second screen shows a green status icon indicating that route creation is in progress and that GPS signals have been found.



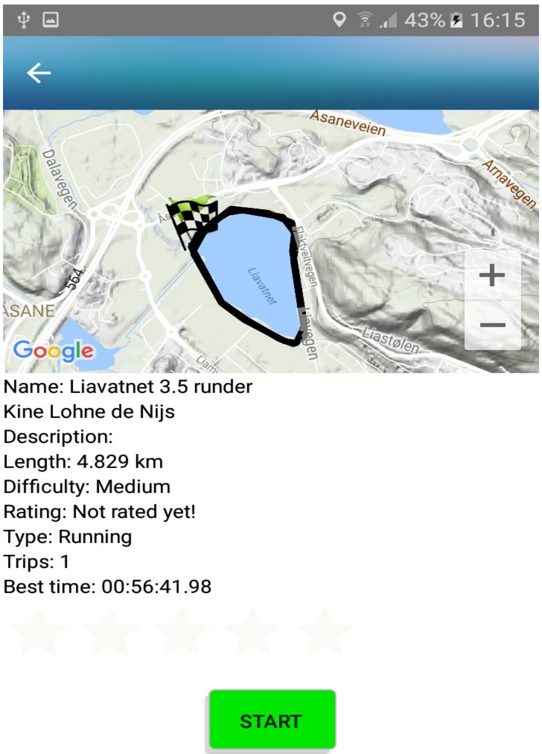
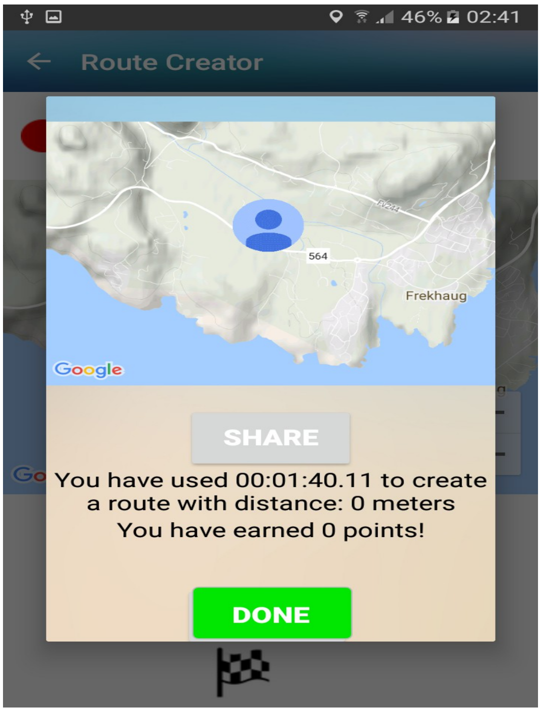


Figure 4-22: Find routes

Figure 4-23: Route

Figure 4-22 is showing the routes nearby in a list-view. When the user clicks one of these route a new screen shows up illustrated by *Figure 4-23.* Here the user can view a route with more detailed information and perform the route if desired by clicking start. One criteria is that the user has to be within approximately 250 meters from the green starting flag.



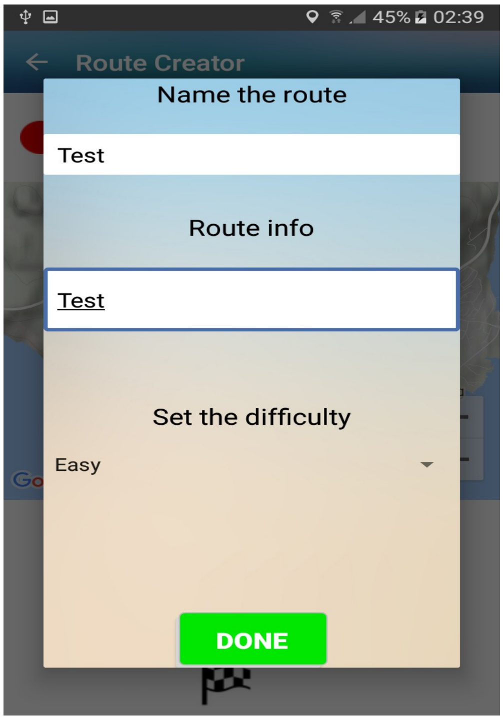


Figure 4-24: Route summary

Figure 4-25: Set route information

Figure 4-24 is showing a summary of the route performed once it has been completed. Time spent, distance moved, and points earned is displayed. The user also has the option of sharing the route on various social media. This is thought to have a motivational effect, which is supported by the social media research from *Chapter 2*.

The second screen is showing options for setting route information on the route created. The user can give the route a name, give some basic info about the route or advice, and lastly set the route difficulty.

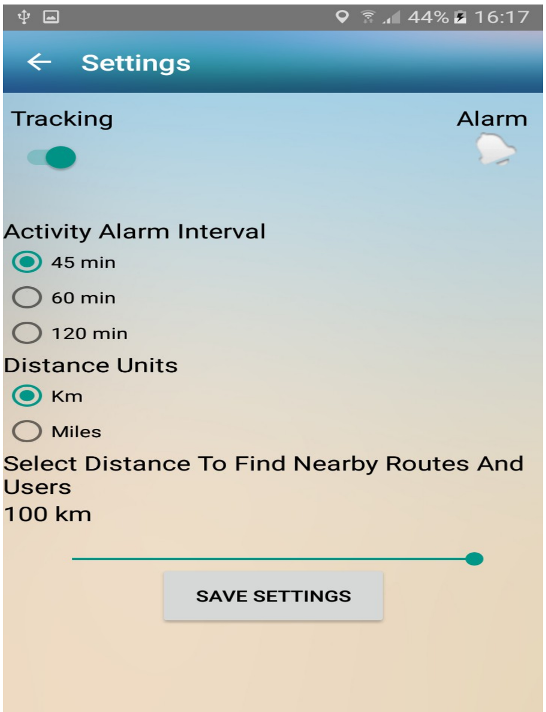


Figure 4-26: Settings

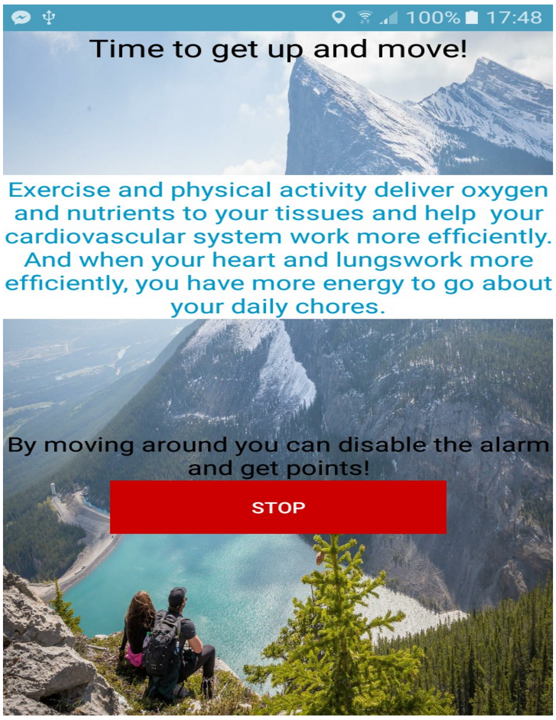


Figure 4-27: Activity alarm screen

Figure 4-26 is showing the setting tab of the application. This is found in the left menu. Here the user can disable location tracking which will result in people not seeing the user on the social map i.e. the user becomes hidden. The user can also click the alarm icon to toggle the activity alarm on and off. Furthermore the user can change the settings displayed in the figure.

The last screen is showing the activity alarm. This occurs when the user has been sedentary for a certain time period e.g. 45 minutes. When the alarm screen is shown there is an alarm sound and some text is displayed showing benefits of being active, and showing the negative effects of being sedentary. There are 10 different “motivational” excerpts being shown randomly when the alarm is triggered. The purpose is to motivate and inform the user about physical activity and health. Furthermore the user has two options of disabling the alarm: the first is to click the red stop button, the other option is to move about 5 meters. The latter option will result in 50 points being earned.

5 Evaluation, Analysis and Results

This chapter focuses on evaluation of the developed artefact. The execution of the various forms for evaluation will be discussed. The data that was collected will be analysed and presented.

5.1 Evaluation Introduction

Evaluation of some system is important, as it gives crucial feedback in terms of how the users perceive or experience the system. The developer would be able to obtain information about which things are difficult to handle and which features needs to be improved. Evaluation is method applied to see if some system meets the usability requirements (Stone et al., 2005).

This thesis have utilized a guide created by Stone et al,. (2005) on how an evaluation of a system ought to be executed. It consists of four steps:

1. **Evaluation strategy:** Describe the goal of the evaluation.
2. **Evaluation plan:** How to execute the evaluation.
3. **Data analysis:** Analyse the data gathered from testing, or survey.
4. **Data interpretation:** Find out what the different problems are in terms of usability, solve them, and present the results of the evaluation testing.

Below is a figure giving an overview of the system evaluation.

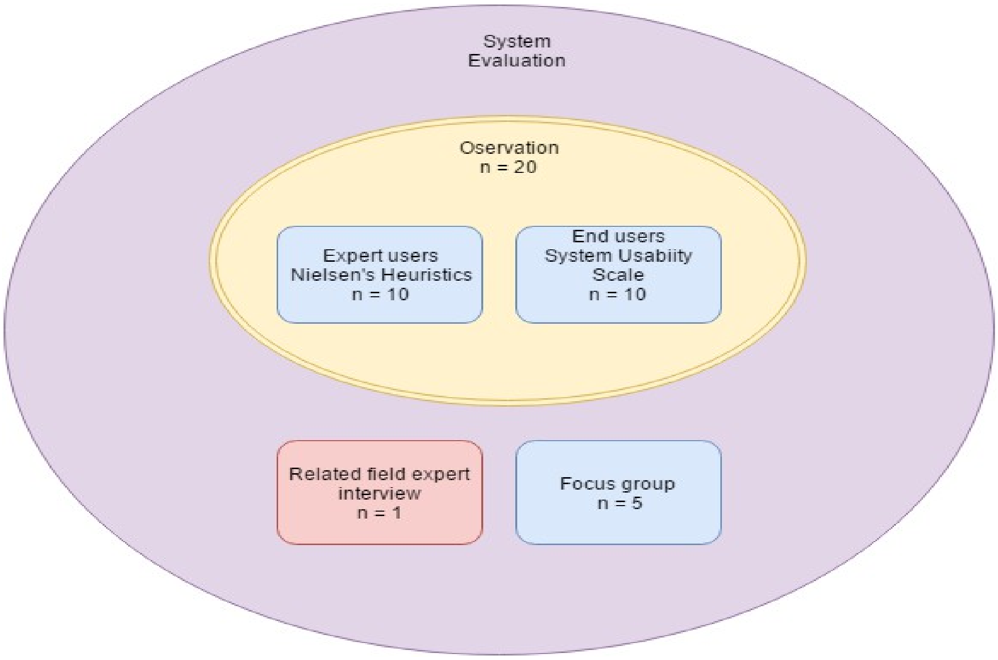


Figure 5-1: System Evaluation Overview

As we can see from the figure, there are four different approaches used to assess the system and its purpose. The artefact has been evaluated by three user groups, and one related field expert. In total 26 people have participated in the evaluation. Each group have completed their own set of evaluation. The expert user and the end users have been observed while evaluating the system. As mentioned in *Chapter 3* controlled environment observation has been used. This allows the researcher to see how the participants react while evaluating and also take notes directly as the problems occurs.

End Users and Expert Users

The first group is the end-users i.e. the average users that would use the finished application. This group have done the evaluation with *System Usability Scale* (Brooke, 1996). The second group are the “expert” users, they have experience with HCI and have a formal background in IT. This group performed a *heuristics evaluation* by Nielsen (1990). Both groups executed a set of 10 tasks that were pre-made, in order to test the functionality of the system, as well as the user-interface. These tasks performed were identical in both groups. The tasks were created with the main features or functionalities of the system in mind. Thus the main functionalities were tested by performing the following tasks:

1. Edit your profile. Add some text and add an image from "Gallery".

2. Change your settings to say Distance Unit Kilometres, and change the distance bar and then save settings.

3. Find out who is on top of the scoreboard and search for your self in the search field.

4. Send friend requests to someone nearby, accept request if anyone has sent to you.

5. Sort the nearby list or friend-list by gender.

6. Write a test message to a person.

7. Create a running route (it doesn't matter if it doesn't upload).

8. Find your own stats from the main menu buttons.

9. Disable alarm and tracking in settings.

10. *Logout*.

When the groups finished performing the tasks, they were asked to answer a survey for their respective group. The surveys were created on S*urveymonkey (*Surveymonkey, 2016) by the editing tools that they provide. The finished survey is also hosted and accessed via this web page.

Focus Group

The third group consists of 5 people who have served as a focus group. The people in this group have contributed with input from the first prototype through all the iterations the project has gone through. The participants have tested the application and given their feedback throughout the whole development process via social media (Carpenter, 2016). They have brought forth suggestions in terms of features that should be a part of the application, as well as improvements on both functionality and usability. After the application was published, they were given a semi-structured survey. The complete survey can be found in *Appendix E*.

Field Expert Interview

A professional psychologist from Helse Bergen was interviewed in order to get a better understanding of the potential a social fitness application can have on both physical and mental health. The interview was also aimed at mapping whether the governmental health institution *Helse Bergen* utilized any mHealth tools for their patients.

5.1.1 End User Evaluations

The end users in this evaluation consists of bachelor students from UiB, but also people recruited via social media. There were 10 people who participated in this evaluation. These users are non expert users, thus representing the average end users who will use the application. Considering the fact that the more testers there are, the higher the chance of detecting errors is. According to Nielsen (1994) only one evaluator would normally find about 35% of the usability errors in some system, implying it would be more meticulous to use several evaluators. The figure below shows approximately the proportion of usability problems found with “x” amount of evaluators. According to this figure the 10 evaluators would find about 87.5% of the errors in this application, which should be sufficient to identify the majority of the issues related to the app.

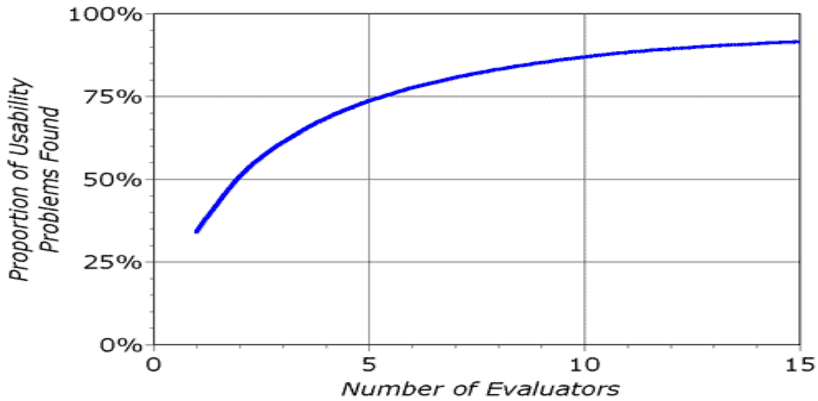


Figure 6-1: Proportion of usability problems found based on number of evaluators (Nielsen, 1994)

Method

To secure as comprehensive as possible evaluation, mixed research methods have been used. The qualitative method is the observation of the users testing and evaluating the system. They were then able to show and directly communicate their problems during the evaluation. After testing they answered a survey which was the quantitative method used in the evaluation. The System Usability Scale (SUS) survey was selected as it is simple for the end users to answer and as it is considered a "quick and dirty" method to uncover usability errors (Brooke, 1996). This survey contains 10 questions, where there are five alternatives on each questions, ranging from weak to strong. The participants were given 10 tasks to complete before answering this survey. There were three evaluation session: each one executed the same way. The observer had open dialogue with the participants and took notes at the same time. After finishing they all submitted their evaluation anonymously on Surveymonkey (Surveymonkey.com,2016).

5.1.2 Expert User Evaluation

The expert users who performed this evaluation were people with higher education than bachelor within IT. There were 10 participants for this evaluation, where all of them were master students at UiB in the Information Science program. Some had high knowledge in HCI others had good programming skills. A couple had also experience with Android application development. These users performed the same 10 tasks as the end-users while evaluating the system.

Method

This evaluation used the mixed methods. After finishing the 10 tasks they were given a survey where Nielsen's (1995) 10 heuristics were listed. There were 10 alternatives for each of the heuristics, ranging from 1 (poor) to 10 (excellent). The reason Nielsen heuristics were used is because it is a good way to find usability problems in a user interface. Similar to the previous evaluation these testers were observed and had an open dialogue with the observer. The observer took notes during the testing sessions when problems were detected.

5.1.3. Focus group

A third survey was given to the focus group users who have adopted the app from when it was just a prototype. The focus group contributed with input through the majority of the development process. Eventually after the application was published, they were given this survey. This survey was less structured to enable the users to give a more subjective opinion regarding the application and its domain. There were 5 people participating in this survey.

5.1.4 Expert Field Interview

The candidate interviewed was as mentioned in the introduction a professional psychologist working at Helse Bergen. The candidate was asked a series of questions. The interviewer was taking notes during the interview. The interviewee was given some information about the thesis before starting, as well as a demonstration of the developed application.

5.2 Results

This sections will elaborate on the results from the different data collected during the system evaluation.

5.2.1 End User Results

The results from the SUS survey can be used to calculate a SUS score. The even numbered questions are expressing negative evaluation, while the odd number questions are positive. In order to calculate the SUS score one would have to subtract one point from the odd question answer, and subtract the answer from 5 on the even questions. This is resulting in each question getting a score between 0 and 4, and the total range will be from 0 - 100 instead of 0 – 40 which it would be otherwise. Each score from all the testers are summed up and multiplied by 2.5 (Brooke,1996). The SUS scores are illustrated in the figure below.

Participants	**Q1**	**Q2**	**Q3**	**Q4**	**Q5**	**Q6**	**Q7**	**Q8**	**Q9**	**Q10**	**Score**
1	1	2	2	1	1	5	2	5	3	1	37.5
2	2	1	4	1	4	2	5	3	3	2	72.5
3	1	3	2	3	3	4	5	5	1	2	37.5
4	1	0	1	1	1	5	5	0	1	1	Incomp.
5	1	1	5	1	5	1	5	1	5	5	80
6	4	1	5	1	5	1	5	1	5	1	97.5
7	2	2	4	1	3	2	5	4	4	1	70
8	4	2	4	1	4	1	4	3	4	1	80
9	5	1	5	1	5	1	5	1	5	1	100
10	4	1	5	1	5	1	5	1	5	1	97.5

Table 6-1: System Usability Scale Scores (SUS).

As we can see from the table participant nr 4 failed two answer two questions, rendering this participant's result incomplete and therefore excluded from the final calculation.

A SUS score above 70 is considered acceptable. The higher the score the better the usability. A very good system would score 90 or more. Systems below 70 ought to be considered for change and improvement. In this case 7/9 evaluators gave a SUS score of 70 or more. The lowest score given was 37.5 which was given by two participants. The highest score given was 100 by one participant. The average score from the 9 participants is 74.7 which is considered a good score.

Furthermore another interesting pattern emerges; we can see that the score increases from participant 5 where it was significant lower on the other candidates. This might be due to the technical background of the participants, as well as different Android systems respond slightly in both use and visual representation.

Observational findings

There were discovered several errors during the evaluation. Many of these discoveries were communicated to the observer immediately after being discovered. The errors were in some cases shown directly to the observer.

Some evaluators wanted for instance more apparent button icons, which also should give some kind of feedback when interacted with. Some evaluators also suggested that the welcome screen text should be shorter and look better (format). Some evaluators also said that the background image should be cropped, rather than just auto adjusted to the screen ratio of the device. The errors revolve around the apps functionality and user-interface. Some of the critical errors found were:

- The profile image would not always be rotated properly when an image was uploaded.
- The BMI calculator would sometimes just show zero and giving a false indication of the BMI value.
- Sometimes the activity alarm would not trigger, presumably because the accelerometer sensitivity is to high resulting in an unwanted reset.
- In some cases the application would crash when requesting location service dependent

features, such as displaying the user's own image on the route map, or on the social friend ma, when the user's device GPS is turned off.

– Several text fields were allowing the users to type in as many characters as they wanted, without any restrictions.

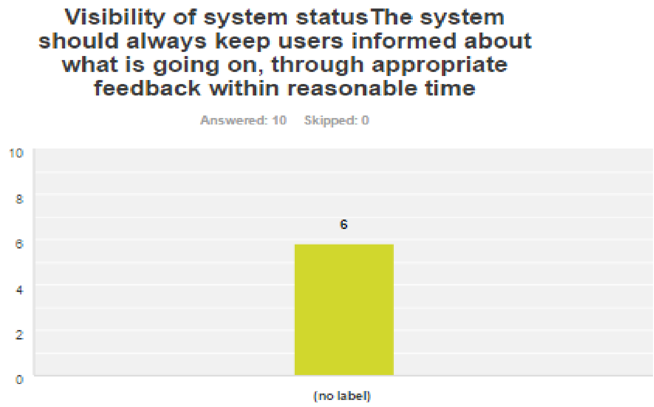
Most of the critical errors were fixed right after discovery, however several issues related to the graphical user interface remains to be addressed in future work. Creating graphical resources such as icons takes a lot of time, thus some aspects of the application have been limited to some extent.

5.2.2 Expert User Results

The results from the heuristic evaluation performed by the expert users are presented in this section. Each of the 10 heuristics will be examined. For each heuristic there is a chart and two tables with information. The chart is showing the average score of the particular heuristic. The tables shows how many people have given a certain score, as well as some basic statistics such as median and standard deviation. All the expert evaluators are familiar with the meaning of each heuristics, furthermore, each of the heuristics are described on the survey.

Visibility of System Status

This is Nielsen's (1995) first heuristic. We can see from the figure below that the average score given by the 10 expert users is 5.80. The lowest score is 3 while the highest is 9.



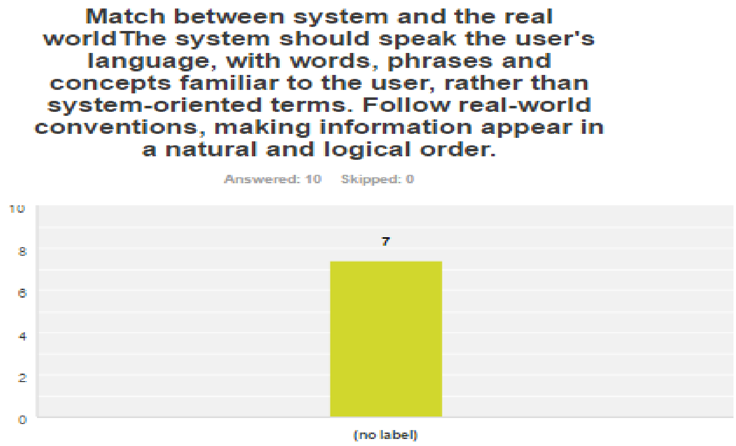
	1 (1)	2 (2)	3 (3)	4 (4)	5 (5)	6 (6)	7 (7)	8 (8)	9 (9)	10 (10)	Total	Weighted Average
(no label)	0.00% 0	0.00% 0	30.00% 3	0.00% 0	10.00% 1	20.00% 2	20.00% 2	0.00% 0	20.00% 2	0.00% 0	10	5.80

Basic Statistics				
Minimum 3.00	Maximum 9.00	Median 6.00	Mean 5.80	Standard Deviation 2.18

Figure 6-7: Visibility of system status

Match between the system and the real world

The second heuristic has got an average score of 7.40, where 4 is the lowest and 9 is the highest.



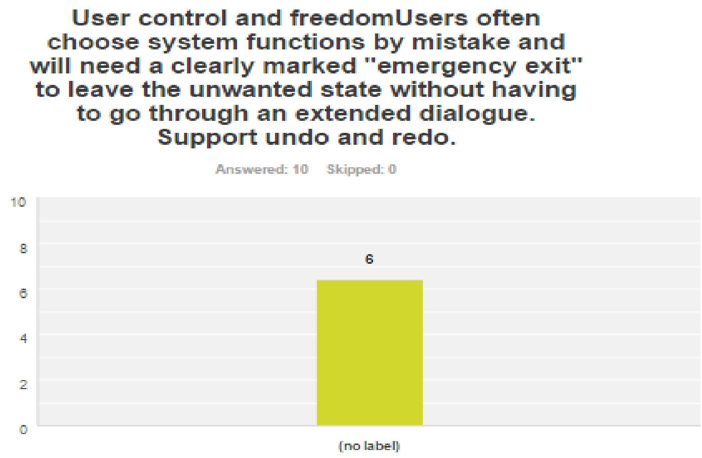
	1 (1)	2 (2)	3 (3)	4 (4)	5 (5)	6 (6)	7 (7)	8 (8)	9 (9)	10 (10)	Total	Weighted Average
(no label)	0.00% 0	0.00% 0	0.00% 0	10.00% 1	0.00% 0	0.00% 0	30.00% 3	50.00% 5	10.00% 1	0.00% 0	10	7.40

Basic Statistics				
Minimum 4.00	Maximum 9.00	Median 8.00	Mean 7.40	Standard Deviation 1.28

Figure 6-8: Match between system and the real world

User control and freedom

The third heuristic has got a score of 6.40, where 3 is the lowest, and 9 is the highest.



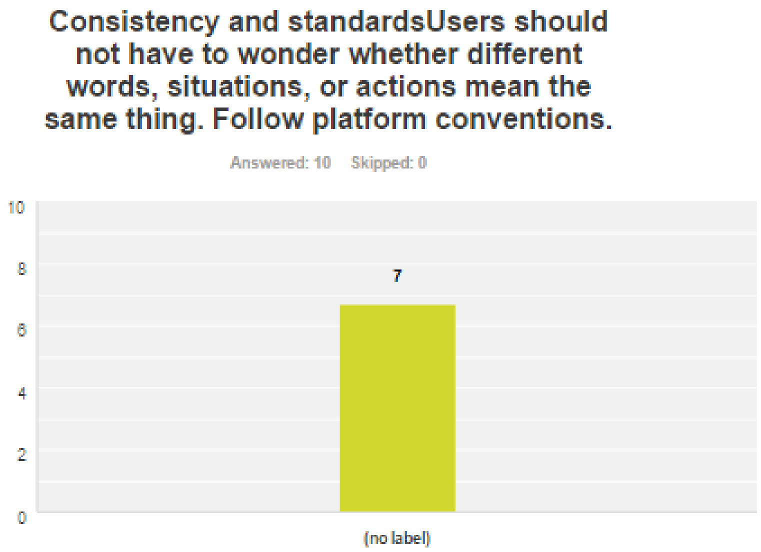
	1 (1)	2 (2)	3 (3)	4 (4)	5 (5)	6 (6)	7 (7)	8 (8)	9 (9)	10 (10)	Total	Weighted Average
(no label)	0.00% 0	0.00% 0	10.00% 1	10.00% 1	20.00% 2	10.00% 1	0.00% 0	40.00% 4	10.00% 1	0.00% 0	10	6.40

Basic Statistics

Minimum	Maximum	Median	Mean	Standard Deviation
3.00	9.00	7.00	6.40	1.96

Consistency and standards

The fourth heuristic has got an average score of 6.70, where the lowest is 4, and the highest is 8.



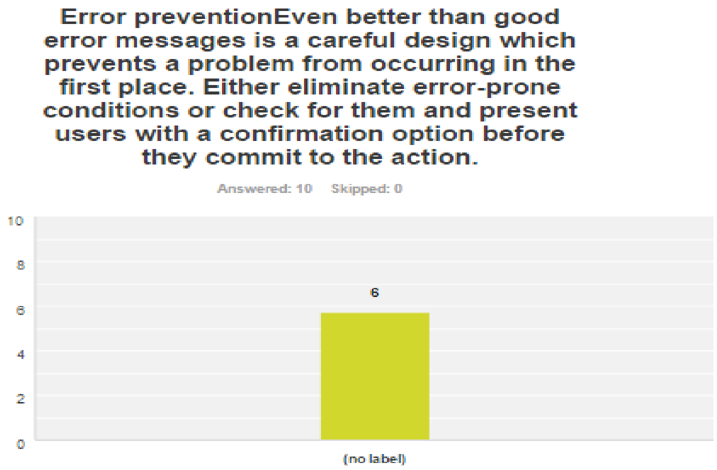
	1 (1)	2 (2)	3 (3)	4 (4)	5 (5)	6 (6)	7 (7)	8 (8)	9 (9)	10 (10)	Total	Weighted Average
(no label)	0.00% 0	0.00% 0	0.00% 0	10.00% 1	10.00% 1	20.00% 2	20.00% 2	40.00% 4	0.00% 0	0.00% 0	10	6.70

Basic Statistics				
Minimum 4.00	Maximum 8.00	Median 7.00	Mean 6.70	Standard Deviation 1.35

Figure 6-9: Consistency and standards

Error prevention

The fifth heuristic has got a average score of 6.70, where the lowest score is two and the highest is 8.



	1 (1)	2 (2)	3 (3)	4 (4)	5 (5)	6 (6)	7 (7)	8 (8)	9 (9)	10 (10)	Total	Weighted Average
(no label)	0.00% 0	10.00% 1	10.00% 1	10.00% 1	0.00% 0	20.00% 2	40.00% 4	10.00% 1	0.00% 0	0.00% 0	10	5.70

Basic Statistics				
Minimum 2.00	Maximum 8.00	Median 6.50	Mean 5.70	Standard Deviation 1.90

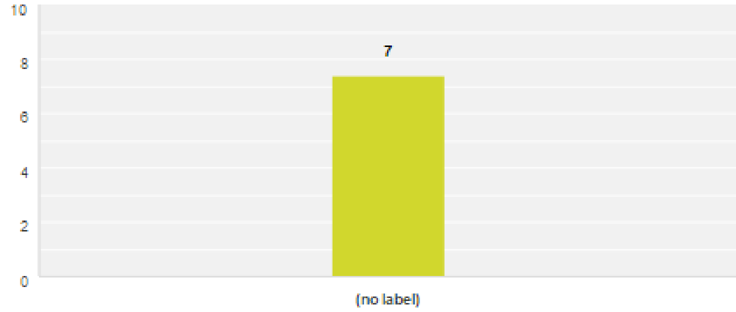
Figure 6-10: Error prevention

Recognition rather than recall

The sixth heuristic has got an average score of 7.40, where the lowest score is 4 and the highest is 9.

Recognition rather than recallMinimize the user's memory load by making objects, actions, and options visible. The user should not have to remember information from one part of the dialogue to another. Instructions for use of the system should be visible or easily retrievable whenever appropriate.

Answered: 10 Skipped: 0



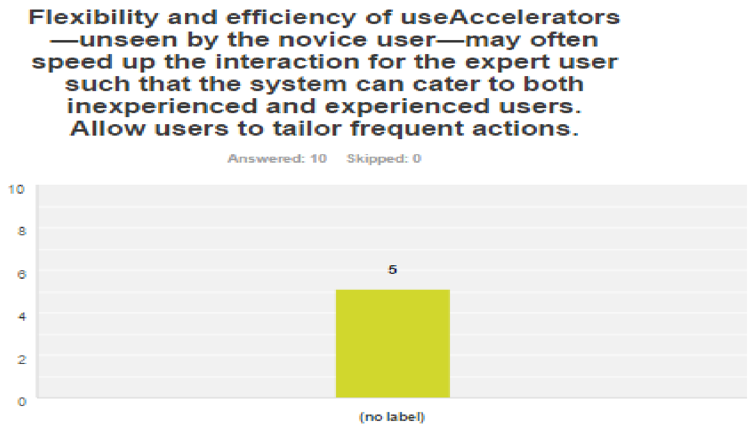
	1 (1)	2 (2)	3 (3)	4 (4)	5 (5)	6 (6)	7 (7)	8 (8)	9 (9)	10 (10)	Total	Weighted Average
(no label)	0.00% 0	0.00% 0	0.00% 0	10.00% 1	0.00% 0	0.00% 0	40.00% 4	30.00% 3	20.00% 2	0.00% 0	10	7.40

Basic Statistics

Minimum	Maximum	Median	Mean	Standard Deviation
4.00	9.00	7.50	7.40	1.36

Flexibility and efficiency of use

The seventh heuristic has got an average score of 5.10, where the lowest score is 2, and the highest is 9.



	1 (1)	2 (2)	3 (3)	4 (4)	5 (5)	6 (6)	7 (7)	8 (8)	9 (9)	10 (10)	Total	Weighted Average
(no label)	0.00% 0	10.00% 1	30.00% 3	20.00% 2	0.00% 0	0.00% 0	10.00% 1	20.00% 2	10.00% 1	0.00% 0	10	5.10

Basic Statistics				
Minimum 2.00	Maximum 9.00	Median 4.00	Mean 5.10	Standard Deviation 2.47

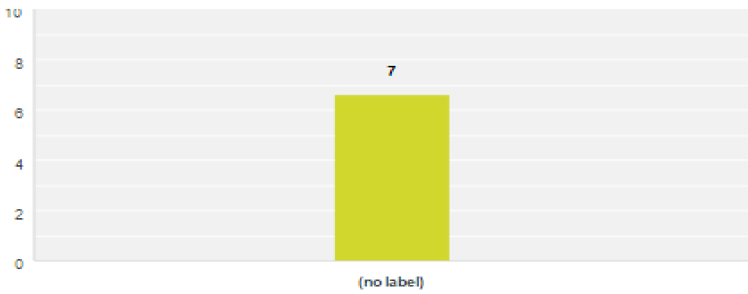
Figure 6-11: Flexibility and efficiency of use

Aesthetic and minimalist design

The eight heuristic has got an average score of 6.60, where the lowest score is 4, and the highest is 8.

Aesthetic and minimalist designDialogues should not contain information which is irrelevant or rarely needed. Every extra unit of information in a dialogue competes with the relevant units of information and diminishes their relative visibility.

Answered: 10 Skipped: 0



	1 (1)	2 (2)	3 (3)	4 (4)	5 (5)	6 (6)	7 (7)	8 (8)	9 (9)	10 (10)	Total	Weighted Average
(no label)	0.00% 0	0.00% 0	0.00% 0	10.00% 1	30.00% 3	0.00% 0	10.00% 1	50.00% 5	0.00% 0	0.00% 0	10	6.60

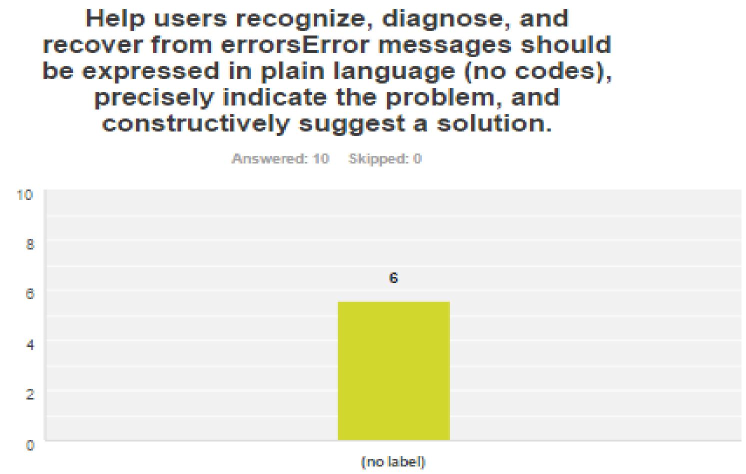
Basic Statistics

Minimum	Maximum	Median	Mean	Standard Deviation
4.00	8.00	7.50	6.60	1.56

Figure 6-12: Aesthetic and minimalist design.

Help users recognize, diagnose, and recover from errors

The ninth heuristic has got an average score of 5.60, where the lowest score is 1, and the highest is 10.



	1 (1)	2 (2)	3 (3)	4 (4)	5 (5)	6 (6)	7 (7)	8 (8)	9 (9)	10 (10)	Total	Weighted Average
(no label)	20.00% 2	10.00% 1	0.00% 0	0.00% 0	10.00% 1	10.00% 1	20.00% 2	10.00% 1	10.00% 1	10.00% 1	10	5.60

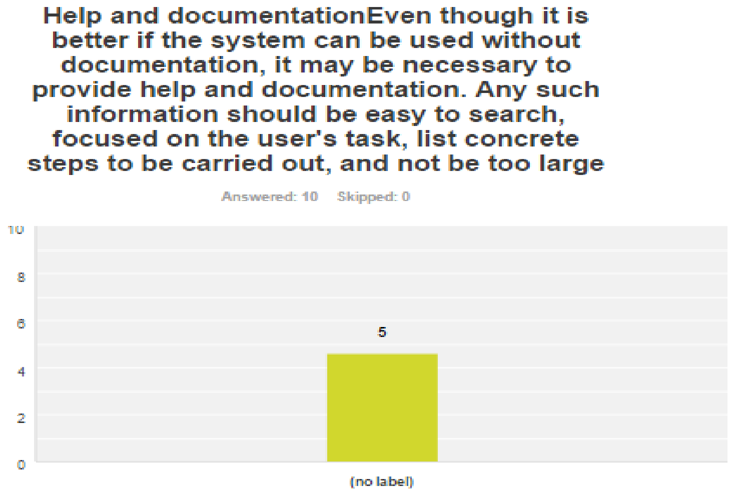
Basic Statistics

Minimum	Maximum	Median	Mean	Standard Deviation
1.00	10.00	6.50	5.60	3.10

Figure 6-13: Help users recognize, diagnose, and recover from errors.

Help and documentation

The tenth and last heuristic has got an average score of 4.60, where the lowest score is 2, and the highest is 7.



	1 (1)	2 (2)	3 (3)	4 (4)	5 (5)	6 (6)	7 (7)	8 (8)	9 (9)	10 (10)	Total	Weighted Average
(no label)	0.00% 0	10.00% 1	20.00% 2	20.00% 2	20.00% 2	10.00% 1	20.00% 2	0.00% 0	0.00% 0	0.00% 0	10	4.60

Basic Statistics

Minimum	Maximum	Median	Mean	Standard Deviation
2.00	7.00	4.50	4.60	1.62

Figure 6-14: Help and documentation.

Summary of Nielsen's scores

The scores may give some indication on how the system is perceived. Therefore it is important to take this into consideration when looking at options for improvement. One would be able to see which part of the system that is either good or bad. For instance *help and documentation* scored only 4.60 indicating this aspect of the application needs more work. The total average score is 6.1/10 which is suggesting that there is room for improvement of the application.

Observational findings

Overall the expert users discovered more usability errors than the end-users, which was expected. The issues revolved mostly around user-interface, but some functionally errors were also discovered. The expert users also provided suggestions for solutions to a greater extent than the end-user evaluators. Some of the discovered errors are as follows:

- The welcome screen and user registration is too complex and takes too long time. Several users did not even read the welcome message. On several occasions it was said that this step should be simplified.
- The three main menu buttons were not responsive enough. On some occasions they were asking what the button icons actually were supposed to be or do. When they were clicked, the information text took too long to show up on the screen.
- Some users had problems adding images to their profile, as they would not be rotated correctly.
- One user found the scoreboard to be working slow. When scrolling it would take some time before the app responded. This is suggesting that the scoreboard might be too resource intensive on some phones.
- It was also suggested that the user's own profile should be shown first on the scoreboard, followed by the users with the most points.
- When accessing the messaging dialogue from the friend-list in social, other people's message dialogue would show in addition to the intended user's message dialogue.

5.2.3 Focus Group Results

The five candidates in the focus group were asked a total of 9 questions. One question asked was *"How often, if ever, do you use heath/sport apps?"*. The chart below shows the answers.

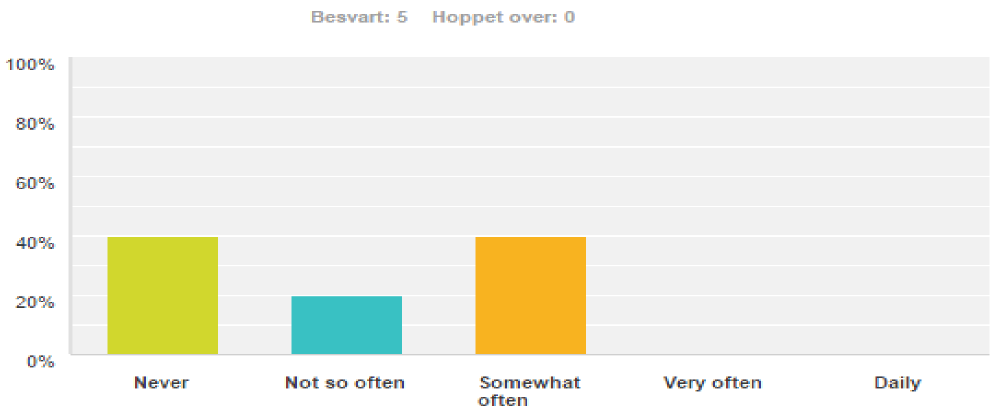


Figure 6-2: How often health apps are used

Two people responded never and two people responded somewhat often. One said not so often.

When asked how often they think they would use this app they responded more positively. The chart below shows that 3 people answered somewhat often, and two said very often.

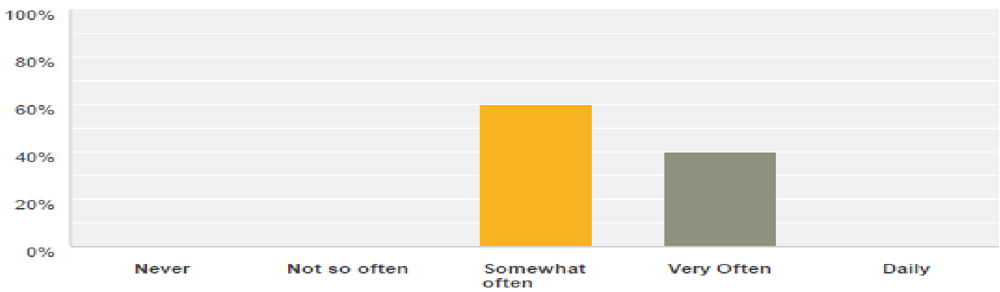


Figure 6-3: How often the app would be used

Another question from the survey was aimed at finding out which features of the app that were most appealing. The question was *"Which of the following features do you like?"*. The chart below shows the results.

Figure 6-4: How often health apps are used

Only two people said that the activity alarm was an interesting feature, whereas all of them said that the route creation feature appealed. The users were also asked how likely they think it would be for a social fitness app such as this to increase activity.

The chart below shows that the users think it is likely that such an app actually will increase activity. All of the users answered yes when they were asked if they think *"find a partner nearby"* would increase activity levels.

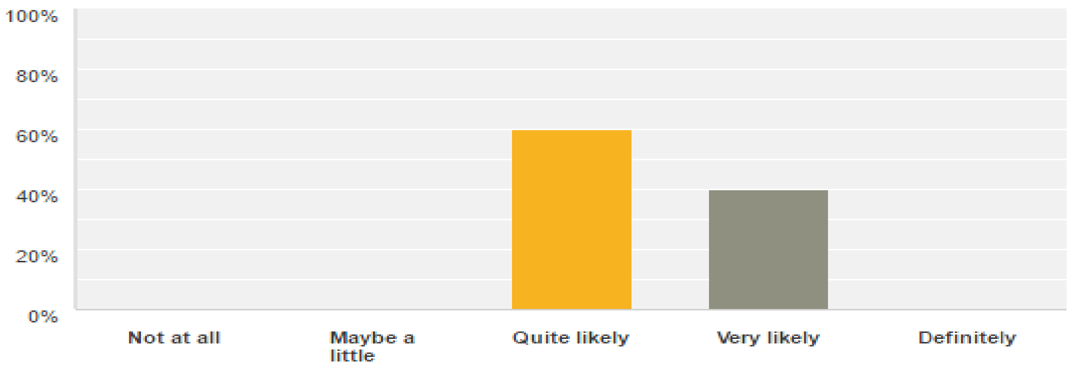


Figure 6-5: Likeliness of increasing activity by use of *MoveFit*

The users were also asked if they have been more active with *moveFit.* Four people answered *"a little bit active"* and one person said *"quite active"*.

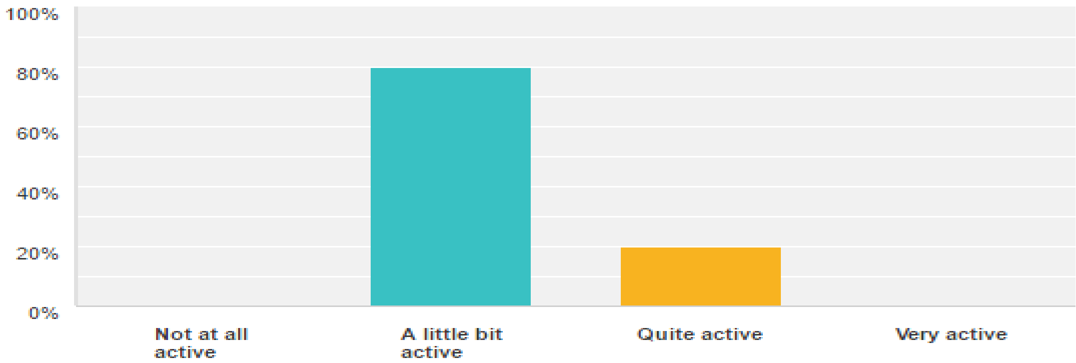


Figure 6-6: Activity level with the user of MoveFit

One of the listings on the survey was a comment section where the participants were asked to comment on which features or aspects of the application that need more improvement. Two people gave comments. Person one said: *"Social – Take the map further down"*, which is implying that the map should be bigger. This is a usability related comment. The other person wrote: "*User interface",* suggesting that overall the user interface should be better.

Lastly the participants could rate the application on a scale from 0 to 10. The average outcome was 6.6.

5.2.4 Field Expert Interview

Due to the nature of the interview being concise, the whole interview has been included in this section. The candidate wished not to publish her surname.

Candidate: Susanne 28, working at Helse Bergen with 3 years experience within mental health counselling.
Interviewer: Thesis author.

The candidate was given demo of *moveFit*, the application developed in this thesis, before the interview started. There were no difficulties during the demonstration.

Q = Interviewer asking questions.

A = Interviewee answering questions.

Q: Do you think sedentary lifestyle can directly or indirectly lead to poor mental health, and if so, how?
A: *Yes I believe so! Research is showing this. Mental wellness is increasing as a person is exercising. It becomes like a good circle. If a person exercises his mental state is affected in a good way, which makes it easier to continue to exercise, or even exercise more. People who struggle are often little active, and spend much time at home, alone with their thoughts. I have seen that those who are busy manage better.*

Q: How do you motivate patients to improve or change lifestyle?
A: *Talk therapy is often used. Giving direct advices of what to do doesn't work well, the patients tend to feel like they are getting homework. It is more important to make the patient realize the problems them selves. We use Psycho therapy techniques, for instance socratic questions and motivating interview. We know that exercising prevents depression, and we give information about these things. If a patient has diabetes we give information about the disease, and what is good and what is bad to do with that particular condition.*

Q: Do you have any particular suggestions for improving sedentary lifestyle?
A: *Staying active! Socializing is good and important, as it gets you out. We ask the patients what their previous interests are, and tell them to do something they would like to do. We do not tell them what to do.*

Q: Do you have any apps that you use or that your institution uses, if yes what kind?
A: *No! Well, I'm not quite sure. There are no apps that we have to use, but some are recommended I think. I use an app as a recommendation for my patients, where the patients register/record their thoughts and feelings in different situations (Shows the app). This app is doing the same as we would do on paper otherwise, its just easier with the app.*

Q: What do you think about hospitals or other health organizations offering health apps for their patients, in terms of countering sedentary lifestyle?

A: *I think it really depends on the condition of the person! In some cases I think it could be useful, and in others not so much. I prefer having conversations, and using apps as a supplement. That is to recommend. I think people who are for instance severely depressed wouldn't have much effect from an app alone.*

Q: Do you think this app (moveFit) would have a good effect on physical, and mental health? If so, how?

A: *Yes I do think so, as people can be social and active. But I'm in doubt that people who are very far down due to depression would use such an app. I think people who are not severely depressed would benefit more, because they would have it easier going out, and socializing.*

Follow up Q: Do you think it would be good for people with similar interests, or maybe conditions, to be able to socialize in app, and maybe meet up?

Follow up A: *Maybe, but there should be some kind of screening, so that their identity is not exposed.*

Q: Any suggestions for improvements of moveFit, in terms of functionality that could be useful for the patients?

A: *I think a way to communicate with the patient would be nice, also being able to see their progress. It could be used for motivation. For instance if a user has been active over a week, we could see that, and give them credit for being active soon after they have actually been active, like "good job". If we wait for too long, the credit we give doesn't have the same motivational effect I think. Maybe we could get some notification when the patient has been active. If we could have dialogue with the patient in the app, we could talk more than once a week which could be nice, but we would maybe spend too much time on the phone at all times then.*

Interview Summary

The interviewee shed light on several important questions. For instance the fact that sedentary lifestyle indeed does negatively affect mental health and in those cases physical activity is recommended to counter sedentary lifestyle. It was also brought forth that the health institution *Helse Bergen* does not enforce use of mobile technologies as a part of patient treatment, although there are apps that are recommended. The interviewee seemed rather unsure whether for instance hospitals ought to use mHealth apps and that it would depend on the patient and the condition. She would prefer to use dialogue instead. The interviewee was also positive when asked if moveFit could have a good effect on physical and mental health, with the exception of people who are really struggling. After being asked about any improvements, she suggested several interesting features that could be implemented. For instance a patient tracking system, where the therapist could communicate with the patient and follow up the patients progress.

6 Application Usage Data

Since the application was published, it has been collecting user data. The first version of the application was published on Google Play 28. September. 2016, however the first usable version was finished in August 2016. From August until 28th of September the application was in Alpha testing. The period from 28th of September outwards can be considered the Beta testing phase, as the application is under continuous development. It is officially released as *in production*, and the current version available is 1.5.

The application has gathered data stored in the associated database. There are 54 users registered in the database. Some users are active others not. It is worth noting that quite few of the testers most likely downloaded the app just for testing and deleted it afterwards. There are 22 females and 32 males registered in the database. The first adopters acquired the application 29th of September 2016.

When registering the first time on the app, the users are asked how active they are. There are 5 levels of activity, ranging from sedentary to extra active. There were 24 users saying they were lightly active, 6 users said they were moderately active, and 24 users said they were sedentary. The average is a split between sedentary and lightly active users. It was excepted that a good portion of the adopters would be people who are already quite active. This however shows that there are many less active people showing an interest for this type of application.

There are 13 routes or activities created by 5 different users. The biggest one is a bicycle route stretching 16.12 km for the duration of 01:18 hours. The points for the routes are calculated based on the distance and the type of route. The total distance the user has moved is also stored in the database, giving him or her an indication on how much they have moved while using the app. Another reason behind storing this data is to document the extent of usage. It seems this far that the majority of the routes are walking-routes. None of the routes have yet received any ratings from other users. This might indicate that there are too few users, and/or that users prefer making their own routes instead of using others. The figure below shows the route data in the database.

	name	info	distance	review	trips	difficulty	routeType	time	user_id
1	shopping		2446	0	1	Easy	Walking	02:18:42.00	-faceb...
2	Skate		1403	0	1	Easy	Walking	00:11:37.44	-faceb...
3	gym		980	0	1	Easy	Walking	00:14:52.51	-faceb...
4	Speed biking E39	Down h...	4399	0	1	Hard	Bicycling	00:05:17.86	-googl...
5	Liavatnet 3.5 ru...		4829	0	1	Medium	Running	00:56:41.98	-faceb...
6	Gut Leidenhaus...	Waldsp...	2385	0	1	Easy	Walking	00:21:53.61	-faceb...
7	liavatnet 2		4733	0	1	Medium	Running	00:55:24.65	-faceb...
8	Mjåtveitstø		2232	0	1	Easy	Walking	00:29:59.57	-faceb...
9	liavatnet 3		4856	0	1	Medium	Running	00:52:35.95	-faceb...
10	Lungårsvannet		2821	0	1	Easy	Walking	00:56:40.76	-faceb...
11	kveldstur		4520	0	1	Easy	Walking	00:35:50.69	-faceb...
12	kalk- porz		8735	0	1	Easy	Bicycling	00:24:07.94	-faceb...
13	City		16124	0	1	Easy	Bicycling	01:18:13.76	-faceb...

Table 6-2: Database route table.

There are 71 connections among the users, where 34 instances are established friendships, and 37 are pending friend requests waiting for acceptance. There are 62 messages that have been sent among these friendships. This might suggest that communication in such an application is indeed of some interest. The figure below is an excerpt from the userFriend table in the database. The boolean values 1 and 0 are representing true and false respectively.

	userlink1	userlink2	friendrequest	isaccepted	isdeleted
55	-googl...	-googl...	1	1	0
56	-faceb...	-googl...	1	1	0
57	-googl...	-auth0|...	1	0	0
58	-googl...	-faceb...	1	1	0
59	-googl...	-googl...	1	0	0
60	-googl...	-googl...	1	0	0
61	-googl...	-googl...	1	0	0
62	-googl...	-googl...	1	0	0
63	-googl...	-faceb...	1	1	0
64	-googl...	-faceb...	1	1	0
65	-faceb...	-faceb...	1	1	0
66	-faceb...	-googl...	1	0	0
67	-faceb...	-auth0|...	1	0	0
68	-faceb...	-faceb...	1	0	0
69	-faceb...	-faceb...	1	0	0
70	-faceb...	-faceb...	1	0	0
71	-faceb...	-googl...	1	0	0

Table 6-3: Database userFriends table

	userid	respons
28	-faceb...	1
29	-faceb...	1
30	-faceb...	1
31	-faceb...	1
32	-faceb...	0
33	-faceb...	0
34	-faceb...	0
35	-faceb...	0
36	-faceb...	1
37	-faceb...	1
38	-faceb...	1
39	-faceb...	1
40	-faceb...	1
41	-faceb...	1
42	-faceb...	1
43	-faceb...	1
44	-faceb...	1
45	-faceb...	0
46	-faceb...	0

The activity monitor has registered 46 instances where the users have been sedentary for at least 45 minutes (depending on their setting). These instances are spread over 6 users, while the remaining 48 users have not been prompted with an alarm. There might be several explanations as to why so few users have been prompted by the alarm. For instance some users have just tested the application for a shorter duration and not used it again, and therefore not waited long enough for the alarm to trigger. Some users have been active (moving around) while using the application, which would not trigger the alarm, as it will reset under activity. Another reason might be that the users have decided to disable the alarm in the settings menu.

The Table 6-4: Database userActivity table.

There are two options when the alarm sounds, either turn off the alarm by moving or by clicking the off button. In this case 16 instances are negative responses i.e. the user has clicked the stop button instead of moving. remaining 30 instances are positive responses, meaning the user has actually moved when prompted. Considering that almost twice as many instances are positive, it is possible to say that the activity alarm has had a good effect on people who have been sitting still for long.

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7 Discussion

In this chapter different aspect of the research will be discussed, such as the methods and methodologies used, the artefact, and the research questions presented in *Chapter 1*. Finally, the results according to design science research will be shortly summarized.

7.1 Methods and Methodologies

This section will reflect on the main methods that has been applied in the development of this app.

7.1.1. Focus group

Focus group was used in the initial process for gathering requirement data, however their role grew greater and they were used throughout the whole development process as they proved to be very useful. The focus group contributed with a lot of qualitative data which allowed for design and implementation improvement and provided a depth that would be hard to achieve in any other way, at least not within the scope of a master thesis. The focus group is somewhat untraditional in the sense that they functioned via social media. This has proven to be functioning well in this project, as the members are confident with the use of social media and possess great communication skills.

7.1.2. Observation

The observation gave valuable feedback regarding the interaction design and also an indication of user experiences. The observation type participant-observer suited this work, since the evaluators could ask questions along the way and communicate problems as they were discovered to the observer. Nobody seemed to be stressed, nor perform badly, due to the fact that they were being observed. For the developer this was a unique chance to get deeper into the problems that were discovered during the evaluation. One possibility would be to video-record the sessions to see what would take the most time and effort and what are the reaction of the subjects evaluating. This could also provide valuable data in terms of future development (Usabilitynet.org, 2016).

7.1.3. Development methodology

The system has been developed incrementally and iteratively by the use of several methods. Personal Kanban and prototyping have mainly been used. This has allowed for a simple model of the system to be tested early on in the development by the focus group and onward in each iteration. The focus group was then able to provide crucial feedback which was used for further improvements in the coming iterations. Furthermore, test driven development has been used to test the prototype and its core features. This has resulted in a shorter development time as less time has been spent debugging. Personal Kanban has helped giving a nice overview and structure of things that needed to be done, currently working on, and already completed. Furthermore this method allowed for more flexibility in terms of time constraints. The usage of technologies and development tools have been very useful and would be recommended for similar work.

7.1.4. Apps Content

The structure and features of the app are designed to suit a broad spectre of users and offer several means of engaging in physical activities. This app intended mainly for sedentary, yet healthy people. As of now the app is rather general in this aspect, although it could be tailor suited to target different needs such as people who are struggling with mental issues, poor diet, various chronic diseases etc. In such cases the development should include experts such as psychologist, physicians, physiotherapists, dietitians etc. as advisor and collaborators through the development.

7.2 Evaluation

The goal of the thesis was to promote an active lifestyle by use *mHealth*. The artefact that was developed is a mobile application. An evaluation has two dimensions: A more technical evaluation of the artefact, as well as its potential to promote an active lifestyle.

7.2.1 Technical Assessment

Technical assessments has been done by use of two evaluation groups: One end-user group and one expert user group. In addition a focus group has been utilized to further provide insight on the whole development process, as well as the finished product's potential to fulfil the main objective. The advantage of this is that a large group of 25 people have weighted in on the application's functionality and usability. This evaluation suggest that the application is appealing in both of these aspects. The improvements that remains to be addressed are mostly concerning user-interface, as well as adding new features. The expert group contributed with critical insight in regards to improvements, where their technical background was apparent. However end-users provided valuable insights, as well as the focus group. The focus group's role was somewhat unconventional, since they used social media as means of communication throughout the whole development process. They assisted with user requirements, testing, and suggestions in terms of new content and improvements. A focus group in conjunction with user evaluators are to recommend, as it has proven to be very instrumental. Method-wise a combination of different tools such as Nielsen and SUS evaluation has brought forth deficiencies in the application that could be handled accordingly through further development. In general the functionality and usability of the app has shown to be satisfactory.

7.2.2 Expert Elicitation

The expert elicitation brought to attention that the app could be combined with other forms of therapy. Thus making it potentially useful as a professional treatment tool. For instance people with mild depression could benefit from this tool in combination with a therapist. The expert confirmed that the developed app indeed has a good effect on both mental and physical health since it can keep people social and active. This opinion is supported by clinical studies that combine different applications with therapies for chronic diseases such as obesity, diabetes, cancer, and cardiovascular diseases (Clinicaltrials.gov, 2016). The expert has suggested several improvements such as a patient tracking system, where the therapist could monitor the patients activity, and communicate with the patient. This allows the therapist to give praise to the patient which is thought by the expert to give a great motivational effect.

7.3 Answering the research questions

Research question 1: Is it possible to develop a mobile health application that can promote an active lifestyle?

The design science approach was utilized in this research as the guiding principle to answer the question. Following the guidelines by Hevner et al. (2004) for doing design science research, was very helpful for securing the holistic structure of the research conduct. The final results of the research, following these guidelines are: a functional application (app) developed and evaluated using well defined methods. These methods regard the feasibility of the app to promote physical activity and to utilize the ways that the social medial functions. There is another social dimension: besides having a potential to improve a general well-being and health at a personal level, the society at large could benefit through reducing health costs and improving the health care outcomes. The Design Science framework enables another step and that would be testing the application in a clinically controlled manner such as a clinical trial.

In this thesis a mobile application has been developed in order to see to which extent it can influence health by encouraging the users to be more active. The goal is to counter a sedentary lifestyle. The developed app is offering different functionalities that promote activities, which was also evaluated by 25 users. The evaluation was positive and constructive in terms of promoting physical activity. Furthermore, this is appraised by the field expert. See chapter 5.2.4 for more details.

Research questions 2: Can mHealth reduce sedentary lifestyle

The data collected from the application is showing that users have been physical active. They have created/completed routes or activities, and responded to the activity alarm, indicating that the application has had an intended effect. The amount of active users is relatively low, and therefore a larger test should be conducted over a longer period, with more users, to get a definite answer to which extent physically activity is increased.

Other research has also shown that mobile health technologies have had an positive effect on physical health. Actual change in health this far is hard to determine as it has not been tested, although we know from research that physical activity leads to better health in general.

Research Question 3: Can the social network features encourage to more activity?

It is not unusual to hear criticism that social networking is leading to less social interaction (Kraut et al., 1998). This research wanted to put into good use already existing connectivity and good communication features to make people more active and at the same time interact with each-other in real life. Thus familiarity of already established social network trends, could be applied in a dedicated app to improve health and well being.

Evaluation suggests that this is indeed an attainable goal. The focus group responded very creativity by suggesting more social related content. Thus proving that this concept is of interest and that the research question is relevant.

Research Question 4: Can a social fitness application such as moveFit promote psychological health?

From the experts point of view it is indeed possible to promote psychological health with mHealth applications and more specifically with the application developed in this thesis. The main reason behind this is due to the social and activity promoting features contained in the app. Although this is the case in general, it was brought to attention by the expert that people suffering from for instance severe depression, would most likely not use these types of applications in the first place. Further more the expert expressed that the ideal situation would be to use this kind of application in conjunction with conventional therapy, such as talk therapy.

The fact that mHealth can promote psychological health is also supported by previous research. For instance Fox (1999) has shown that psychological health is positively affected by physical activity and that exercise is used as treatment on e.g. clinical depression.

8 Conclusion and Future Work

In this chapter a summary and conclusion will be given, as well as suggestions for future work and research. The finished product i.e. the app, has been published to Google Play store. The name is *MoveFit* and it can be found at Google Play (Play.google.com, 2016).

8.1 Conclusion

This research addressed a crucial problem in our society, namely sedentary lifestyle and chronic diseases caused by it. The main scientific approach that was used is Design Science methodology.

The resulting artefact is an social fitness app. It was possible to demonstrate that the app had a positive effect on the users and as well as the focus group in terms of promoting physical activity. User testing has also shown the appreciation of the various features such as social networking, and route/activity creation. The system evaluation has reached satisfactory scores in terms of functionality and usability. It has become clear from the various users, as well as the field expert, that the application could be adjusted to user groups with conditions such as depression, obesity, cardiovascular disease, diabetes, and cancer. Previous research from clinical trials devoted to assess the long term results has shown potential and promising results.

The developed app is already a product available for free download. There is enough data collected by the app to document that the various features are working according to the user requirements. User and expert evaluations have been decisive factors for releasing the app publicly. Due to the social nature of the features it could be expected that more ideas would be generated by new users and thus leading to new development iterations.

Long term effect of the app has yet to be probed in a different setting and beyond the time and scope of this thesis. That will require resources and experts of other fields to work together. Future work suggests that one way would be conducting a proper clinical trial with end points that will look deeper into the efficiency and potentials of helping selected user groups.

8.2 Future work

There are many directions this project could head next in terms of advancements. This section will look into the different possibilities in terms of both technical improvements, as well as options for further research.

8.2.1 Further Content Development

There are several suggestions for improvement given by the user evaluators, which ought to be addressed consecutively. Some of the suggested improvements are directly related to the user-interface. In terms of improving the application except for errors, there are several interesting features to implement that could possibly make the application more efficient and more attractive to the users.

One feature that seems to be of interest to various users is an interest list. This list would consist of different activity-interests the users would have e.g. top interests could be jogging, climbing, and swimming. The different users could then be matched with other users with the same interests and then do these activities together.

Another feature that seems to be popular is a challenge system. The idea is that the users would be able to send a challenge to another user e.g. “I challenge you to beat the record on this specific route”, or “I challenge you to go for run with me on this route”. The challenger or the opponent would be rewarded points for completing a challenge.

The ability to use a group chat or a chat room seems to also be a desired feature. The main benefit is that a group of people can organize and plan activities such as longer hiking trips. This could be useful for people in groups, for instance collogues at the workplace, class mates, sports teams, or just people who want to meet up with other people. The chat would be location based so that people in one area can join a certain chat group. The field expert from the interview brought forth some interesting features that could aid with mental health treatment. She proposed a feature for tracking the patients progress in terms of activity. The therapist would be able to get notifications whenever a patient has been active and then the therapist could be able to directly communicate with the patient and give praise, which according to the expert could have a great motivational effect.

Lastly, the application can be extended to the IOs and Windows Phone platforms, with relative ease, as the project is developed using Xamarin, which is a cross platform technology mentioned in *Chapter 4*. Thus some of the code used to develop this application can be used in the development on these other platforms.

8.2.2 Future Research

In terms of further research it would be interesting to expose the app to a larger user group in order to look into long term effect of the app. For instance a clinical study could be conducted, more specifically an observational study, with a testing group and a control group over a longer period of time. (Clinicaltrials.gov, 2016).

There are many examples of such studies. For instance a clinical study conducted by Safran Naimark, Madar and R.Shahar (2015) has looked at healthy population of 99 subjects over of period of 14 weeks. The study has concluded that mHealth had a positive effect on promoting healthy lifestyle. In the similar fashion it would be reasonable to assume that *moveFit* would have similar outcome, but it would be required to test it with a higher amount of users over a longer period of time. Then it would be easier to conclude the effect this application could have on health in long term.

It would be valuable to see whether health institutions would be interested in collaborating in terms of promoting this application to patients. Both physical health and mental health institutions are suitable for this application. According to White (2016) 66% of the largest 100 hospitals in USA are providing health apps for their patients, suggesting that it is useful for health institutions to provide this type of service. It would be of interest to go in a dialogue with one of the major health institution in Norway to see how it could be possible to utilize *moveFit* to promote a healthy lifestyle and prevent chronic diseases.

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10 Appendices

Appendix A: System Usability Scale (Brooke, 1999)

System Usability Scale

	Strongly disagree				Strongly agree
1. I think that I would like to use this system frequently	1	2	3	4	5
2. I found the system unnecessarily complex	1	2	3	4	5
3. I thought the system was easy to use	1	2	3	4	5
4. I think that I would need the support of a technical person to be able to use this system	1	2	3	4	5
5. I found the various functions in this system were well integrated	1	2	3	4	5
6. I thought there was too much inconsistency in this system	1	2	3	4	5
7. I would imagine that most people would learn to use this system very quickly	1	2	3	4	5
8. I found the system very cumbersome to use	1	2	3	4	5
9. I felt very confident using the system	1	2	3	4	5
10. I needed to learn a lot of things before I could get going with this system	1	2	3	4	5

Appendix B: Notification Form

Ankica Babic
Institutt for informasjons- og medievitenskap Universitetet i Bergen
Fosswinckelsgate 6
5007 BERGEN

Vår dato: 31.10.2016   Vår ref: 50460 / 3 / AH   Deres dato: Deres ref:

TILBAKEMELDING PÅ MELDING OM BEHANDLING AV PERSONOPPLYSNINGER

Vi viser til melding om behandling av personopplysninger, mottatt 08.10.2016. Meldingen gjelder prosjektet:

50460	*Design and development of mobile health tools*
Behandlingsansvarlig	*Universitetet i Bergen, ved institusjonens øverste leder*
Daglig ansvarlig	*Ankica Babic*
Student	*Trond Tufte*

Personvernombudet har vurdert prosjektet og finner at behandlingen av personopplysninger er meldepliktig i henhold til personopplysningsloven § 31. Behandlingen tilfredsstiller kravene i personopplysningsloven.

Personvernombudets vurdering forutsetter at prosjektet gjennomføres i tråd med opplysningene gitt i meldeskjemaet, korrespondanse med ombudet, ombudets kommentarer samt personopplysningsloven og helseregisterloven med forskrifter. Behandlingen av personopplysninger kan settes i gang.

Det gjøres oppmerksom på at det skal gis ny melding dersom behandlingen endres i forhold til de opplysninger som ligger til grunn for personvernombudets vurdering. Endringsmeldinger gis via et eget skjema, http://www.nsd.uib.no/personvern/meldeplikt/skjema.html. Det skal også gis melding etter tre år dersom prosjektet fortsatt pågår. Meldinger skal skje skriftlig til ombudet.

Personvernombudet har lagt ut opplysninger om prosjektet i en offentlig database, http://pvo.nsd.no/prosjekt.

Personvernombudet vil ved prosjektets avslutning, 20.11.2016, rette en henvendelse angående status for behandlingen av personopplysninger.

Vennlig hilsen

Kjersti Haugstvedt

Åsne Halskau

Kontaktperson: Åsne Halskau tlf: 55 58 21 88
Vedlegg: Prosjektvurdering

Dokumentet er elektronisk produsert og godkjent ved NSDs rutiner for elektronisk godkjenning.

Personvernombudet for forskning

Prosjektvurdering - Kommentar

Prosjektnr: 50460

I henhold til opplysninger i meldeskjemet skal prosjektet gjennomføre en brukertest på en helseapp. Data vil samles inn via spørreskjema (både papir og elektronisk), samt intervjuer. Utvalget er brukere av app'en 16 år eller eldre.

Personvernombudet forstår det slik at rekruttering foregår som følger: Utvalget rekkrutters ved at det ligger et spørreskjema i app'en, samt at studenter ved UiB forespørres om å delta. Personvernombudet legger til grunn at frivilligheten understrekes ved rekruttering, samt at alle som forespørres får informasjon om prosjektet som helhet før de eventuelt takker ja til deltakelse (se krav til informasjon nedenfor). Ifølge prosjektmeldingen skal utvalget informeres muntlig om prosjektet og samtykke til deltakelse. Dersom noen av deltakeren i prosjektet kun skal besvare spøøreskjemaet som ligger i app'en legger personverombudet til grunn at de får informasjon om prosjektet før de samtykker. Vi anbefaler da at informasjonen skriftliggjøres og legges inn i spørreskjemaet som genereres i app'en.

For å tilfredsstille kravet om et informert samtykke etter loven, må utvalget informeres om følgende:

- hvilken institusjon som er ansvarlig (UiB)
- prosjektets formål/problemstilling
- hvilke metoder som skal benyttes for datainnsamling
- hvilke typer opplysninger som samles inn
- at opplysningene behandles konfidensielt og hvem som vil ha tilgang
- at det er frivillig å delta og at man kan trekke seg når som helst uten begrunnelse
- dato for forventet prosjektslutt (20.11.2016)
- at data anonymiseres ved prosjektslutt (20.11.2016)
- hvorvidt enkeltpersoner vil kunne gjenkjennes i den ferdige oppgaven
- kontaktopplysninger til forsker, eller student/veileder.

Personvernombudet legger til grunn at forsker etterfølger Universitetet i Bergen sine interne rutiner for datasikkerhet. Dersom personopplysninger skal lagres på mobile enheter, bør opplysningene krypteres tilstrekkelig.

Survey Monkey er databehandler for prosjektet. Universitetet i Bergen skal inngå skriftlig avtale med Survey Monkey om hvordan personopplysninger skal behandles, jf. personopplysningsloven § 15. For råd om hva databehandleravtalen bør inneholde, se Datatilsynets veileder: http://www.datatilsynet.no/Sikkerhet-internkontroll/Databehandleravtale/.

Forventet prosjektslutt er 20.11.2016. Ifølge prosjektmeldingen skal innsamlede opplysninger da anonymiseres. Anonymisering innebærer å bearbeide datamaterialet slik at ingen enkeltpersoner kan gjenkjennes. Det gjøres

ved å:
- slette direkte personopplysninger (som navn/koblingsnøkkel)
- slette/omskrive indirekte personopplysninger (identifiserende sammenstilling av bakgrunnsopplysninger som f.eks. bosted/arbeidssted, alder og kjønn)
- slette/anonymisere eventuelle lydopptak

Vi gjør oppmerksom på at også databehandler (Survey Monkey) må slette personopplysninger tilknyttet prosjektet i sine systemer. Dette inkluderer eventuelle logger og koblinger mellom IP-/epostadresser og besvarelser.

MELDESKJEMA

Meldeskjema (versjon 1.4) for forsknings- og studentprosjekt som medfører meldeplikt eller konsesjonsplikt
(jf. personopplysningsloven og helseregisterloven med forskrifter).

1. Intro		
Samles det inn direkte personidentifiserende opplysninger?	Ja ● Nei ○	En person vil være direkte identifiserbar via navn, personnummer, eller andre personentydige kjennetegn. Les mer om hva personopplysninger. NB! Selv om opplysningene skal anonymiseres i oppgave/rapport, må det krysses av dersom det skal innhentes/registreres personidentifiserende opplysninger i forbindelse med prosjektet.
Hvis ja, hvilke?	■ Navn □ 11-sifret fødselsnummer □ Adresse ■ E-post □ Telefonnummer □ Annet	
Annet, spesifiser hvilke		
Skal direkte personidentifiserende opplysninger kobles til datamaterialet (koblingsnøkkel)?	Ja ○ Nei ●	Merk at meldeplikten utløses selv om du ikke får tilgang til koblingsnøkkel, slik fremgangsmåten ofte er når man benytter en databehandler
Samles det inn bakgrunnsopplysninger som kan identifisere enkeltpersoner (indirekte personidentifiserende opplysninger)?	Ja ○ Nei ●	En person vil være indirekte identifiserbar dersom det er mulig å identifisere vedkommende gjennom bakgrunnsopplysninger som for eksempel bostedskommune eller arbeidsplass/skole kombinert med opplysninger som alder, kjønn, yrke, diagnose, etc. NB! For at stemme skal regnes som personidentifiserende, må denne bli registrert i kombinasjon med andre opplysninger, slik at personer kan gjenkjennes.
Hvis ja, hvilke		
Skal det registreres personopplysninger (direkte/indirekte/via IP-/epost adresse, etc) ved hjelp av nettbaserte spørreskjema?	Ja ○ Nei ●	Les mer om nettbaserte spørreskjema.
Blir det registrert personopplysninger på digitale bilde- eller videoopptak?	Ja ○ Nei ●	Bilde/videoopptak av ansikter vil regnes som personidentifiserende.
Søkes det vurdering fra REK om hvorvidt prosjektet er omfattet av helseforskningsloven?	Ja ○ Nei ●	NB! Dersom REK (Regional Komité for medisinsk og helsefaglig forskningsetikk) har vurdert prosjektet som helseforskning, er det ikke nødvendig å sende inn meldeskjema til personvernombudet (NB! Gjelder ikke prosjekter som skal benytte data fra pseudonyme helseregistre). Dersom tilbakemelding fra REK ikke foreligger, anbefaler vi at du avventer videre utfylling til svar fra REK foreligger.
2. Prosjekttittel		
Prosjektittel	Design and development of mobile health tools	Oppgi prosjektets tittel. NB! Dette kan ikke være «Masteroppgave» eller liknende, navnet må beskrive prosjektets innhold.
3. Behandlingsansvarlig institusjon		
Institusjon	Universitetet i Bergen	Velg den institusjonen du er tilknyttet. Alle nivå må oppgis. Ved studentprosjekt er det studentens tilknytning som er avgjørende. Dersom institusjonen ikke finnes på listen, har den ikke avtale med NSD som personvernombud. Vennligst ta kontakt med institusjonen.
Avdeling/Fakultet	Det samfunnsvitenskapelige fakultet	
Institutt	Institutt for informasjons- og medievitenskap	
4. Daglig ansvarlig (forsker, veileder, stipendiat)		

Fornavn	Ankica	Før opp navnet på den som har det daglige ansvaret for prosjektet. Veileder er vanligvis daglig ansvarlig ved studentprosjekt. Daglig ansvarlig og student må i utgangspunktet være tilknyttet samme institusjon. Dersom studenten har ekstern veileder, kanbiveileder eller fagansvarlig ved studiestedet stå som daglig ansvarlig. Arbeidssted må være tilknyttet behandlingsansvarlig institusjon, f.eks. underavdeling, institutt etc. NB! Det er viktig at du oppgir en e-postadresse som brukes aktivt. Vennligst gi oss beskjed dersom den endres.
Etternavn	Babic	
Stilling	Associate Professor	
Telefon	480 91 876	
Mobil		
E-post	Ankica.Babic@uib.no	
Alternativ e-post	ankica.babic@infomedia.uib.no	
Arbeidssted	UiB, Bergen	
Adresse (arb.)	Fosswinckels gate 6	
Postnr./sted (arb.sted)	5007 Bergen	
5. Student (master, bachelor)		
Studentprosjekt	Ja ● Nei ○	Dersom det er flere studenter som samarbeider om et prosjekt, skal det velges en kontaktperson som føres opp her. Øvrige studenter kan føres opp under pkt 10.
Fornavn	Trond	
Etternavn	Tufte	
Telefon	96179361	
Mobil	451468226	
E-post	trondtufte89@gmail.com	
Alternativ e-post	trondtufte89@gmail.com	
Privatadresse	Rosslandsveien 336	
Postnr./sted (privatadr.)	5918 Frekhaug	
Type oppgave	● Masteroppgave ○ Bacheloroppgave ○ Semesteroppgave ○ Annet	
6. Formålet med prosjektet		
Formål	I dette prosjektet har jeg utviklet en social fitness app. Hensiktenn med denne apper er å promotere en aktiv livsstil. Målet er å finne ut hvordan mobil teknologi (mHealth) kan påvrike god helse. Folk registrerer seg via facebook, og navn blir lagret på server Ifm dette har jeg tenkt å gjøre en bruker test / undersøkelse om hvordan appen fungerer, og hva folk syntes om den. I appen finnes det en survey, men denne er anonym (via survey monkey). Videre skal jeg lage brukertest, hvor brukere svarer på spørsmål ang funksjonaliteten til appen, anonymt. Ingen personopplysninger vil bli publisert. Målet er å sitte igjen med oversikt over hvor effektiv appen har vært ift fysisk aktivitet, og hvordan brukeropplevelsen har vært ift design.	Redegjør kort for prosjektets formål, problemstilling, forskningsspørsmål e.l.
7. Hvilke personer skal det innhentes personopplysninger om (utvalg)?		
Kryss av for utvalg	□ Barnehagebarn □ Skoleelever □ Pasienter □ Brukere/klienter/kunder □ Ansatte □ Barnevernsbarn □ Lærere □ Helsepersonell □ Asylsøkere ■ Andre	

Beskriv utvalg/deltakere	Android Appen er ikke tilpasset en spesifikk målgruppe. Dermed er hvermansen aktuell, ettersom hvem som helst kan laste den ned og svare på brukerundersøkelse. Videre er studenter på samme institusjon aktuell å bruke for brukertesting. Appen har en aldersgrense på 12 år.	Med utvalg menes dem som deltar i undersøkelsen eller dem det innhentes opplysninger om.
Rekruttering/trekking	Det er en anonym survey in en android applikasjon som er blitt utviklet for dette prosjektet. Hvem som helst over 12 år kan laste den ned og bruke den. Videre skal studenter på samme institusjon bli tildelt en survey som de skal svare på.	Beskriv hvordan utvalget trekkes eller rekrutteres og oppgi hvem som foretar den. Et utvalg kan trekkes fra registre som f.eks. Folkeregisteret, SSB-registre, pasientregistre, eller det kan rekrutteres gjennom f.eks. en bedrift, skole, idrettsmiljø eller eget nettverk.
Førstegangskontakt	Gjennom Veileder.	Beskriv hvordan kontakt med utvalget blir opprettet og av hvem. Les mer om dette på temasidene.
Alder på utvalget	□ Barn (0-15 år) ■ Ungdom (16-17 år) ■ Voksne (over 18 år)	Les om forskning som involverer barn på våre nettsider.
Omtrentlig antall personer som inngår i utvalget	20	
Samles det inn sensitive personopplysninger?	Ja ○ Nei ●	Les mer om sensitive opplysninger.
Hvis ja, hvilke?	□ Rasemessig eller etnisk bakgrunn, eller politisk, filosofisk eller religiøs oppfatning □ At en person har vært mistenkt, siktet, tiltalt eller dømt for en straffbar handling □ Helseforhold □ Seksuelle forhold □ Medlemskap i fagforeninger	
Inkluderes det myndige personer med redusert eller manglende samtykkekompetanse?	Ja ○ Nei ●	Les mer om pasienter, brukere og personer med redusert eller manglende samtykkekompetanse.
Samles det inn personopplysninger om personer som selv ikke deltar (tredjepersoner)?	Ja ○ Nei ●	Med opplysninger om tredjeperson menes opplysninger som kan spores tilbake til personer som ikke inngår i utvalget. Eksempler på tredjeperson er kollega, elev, klient, familiemedlem.
8. Metode for innsamling av personopplysninger		
Kryss av for hvilke datainnsamlingsmetoder og datakilder som vil benyttes	■ Papirbasert spørreskjema ■ Elektronisk spørreskjema ■ Personlig intervju □ Gruppeintervju □ Observasjon □ Deltakende observasjon □ Blogg/sosiale medier/internett □ Psykologiske/pedagogiske tester □ Medisinske undersøkelser/tester □ Journaldata (medisinske journaler)	Personopplysninger kan innhentes direkte fra den registrerte f.eks. gjennom spørreskjema,intervju, tester, og/eller ulike journaler (f.eks. elevmapper, NAV, PPT, sykehus) og/eller registre (f.eks.Statistisk sentralbyrå, sentrale helseregistre). NB! Dersom personopplysninger innhentes fra forskjellige personer (utvalg) og med forskjellige metoder, må dette spesifiseres i kommentar-boksen. Husk også å legge ved relevante vedlegg til alle utvalgs-gruppene og metodene som skal benyttes. Les mer om registerstudier her. Dersom du skal anvende registerdata, må variabelliste lastes opp under pkt. 15
	□ Registerdata	
	□ Annen innsamlingsmetode	
Tilleggsopplysninger	Survey monkey brukes som elektronisk spørreskjema.	
9. Informasjon og samtykke		
Oppgi hvordan utvalget/deltakerne informeres	□ Skriftlig ■ Muntlig □ Informeres ikke	Dersom utvalget ikke skal informeres om behandlingen av personopplysninger må det begrunnes. Les mer her. Vennligst send inn mal for skriftlig eller muntlig informasjon til deltakerne sammen med meldeskjema. Last ned en veiledende mal her. NB! Vedlegg lastes opp til sist i meldeskjemaet, se punkt 15 Vedlegg.

Samtykker utvalget til deltakelse?	● Ja ○ Nei ○ Flere utvalg, ikke samtykke fra alle	For at et samtykke til deltakelse i forskning skal være gyldig, må det være frivillig, uttrykkelig og informert. Samtykke kan gis skriftlig, muntlig eller gjennom en aktiv handling. For eksempel vil et besvart spørreskjema være å regne som et aktivt samtykke. Dersom det ikke skal innhentes samtykke, må det begrunnes.
Innhentes det samtykke fra foreldre for ungdom mellom 16 og 17 år?	Ja ○ Nei ●	Les mer om forskning som involverer barn og samtykke fra unge.
Hvis nei, begrunn	I appen som er utviklet er det lagt inn aldersgrense på 12 år av tjeneste tilbyderen, Google (google play). Dermed er det mulig at ungdom mellom 16-17 år laster ned appen og svarer på spørsmål ang deres inntrykk av appen. Det skal også sies at denne undersøkelsen er fullstendig anonym	

10. Informasjonssikkerhet

Spesifiser	Navn og Email lagres digital på kryptert sql server, tilbudt av Microsoft Azure (Cloud services). Spørreundersøkelseskjema destrueres etter bruk. Videre er disse spørreundersøkelsene anonym. Navn og email er kun tilgjengelig gjennom appen (bruker ene oppgir dette selv) Disse dataene publiseres ikke, og er ikke tilknyttet noe spørreundersøkelse.	NB! Som hovedregel bør ikke direkte personidentifiserende opplysninger registreres sammen med det øvrige datamaterialet.
Hvordan registreres og oppbevares personopplysningene?	■ På server i virksomhetens nettverk □ Fysisk isolert PC tilhørende virksomheten (dvs. ingen tilknytning til andre datamaskiner eller nettverk, interne eller eksterne) □ Datamaskin i nettverkssystem tilknyttet Internett tilhørende virksomheten □ Privat datamaskin □ Videoopptak/fotografi □ Lydopptak □ Notater/papir ■ Mobile lagringsenheter (bærbar datamaskin, minnepenn, minnekort, cd, ekstern harddisk, mobiltelefon) □ Annen registreringsmetode	Merk av for hvilke hjelpemidler som benyttes for registrering og analyse av opplysninger. Sett flere kryss dersom opplysningene registreres på flere måter. Med «virksomhet» menes her behandlingsansvarlig institusjon. NB! Som hovedregel bør data som inneholder personopplysninger lagres på behandlingsansvarlig sin forskningsserver. Lagring på andre medier - som privat pc, mobiltelefon, minnepinne, server på annet arbeidssted - er mindre sikkert, og må derfor begrunnes. Slik lagring må avklares med behandlingsansvarlig institusjon, og personopplysningene bør krypteres.
Annen registreringsmetode beskriv		
Hvordan er datamaterialet beskyttet mot at uvedkommende får innsyn?	Data med personopplysninger er lagret på kryptert database server, hos tredjepart Microsoft Azure(Cloud services)	Er f.eks. datamaskintilgangen beskyttet med brukernavn og passord, står datamaskinen i et låsbart rom, og hvordan sikres bærbare enheter, utskrifter og opptak?
Samles opplysningene inn/behandles av en databehandler (ekstern aktør)?	Ja ○ Nei ●	Dersom det benyttes eksterne til helt eller delvis å behandle personopplysninger, f.eks. Questback, transkriberingsassistent eller tolk, er dette å betrakte som en databehandler. Slike oppdrag må kontraktsreguleres.
Hvis ja, hvilken		
Overføres personopplysninger ved hjelp av e-post/Internett?	Ja ○ Nei ●	F.eks. ved overføring av data til samarbeidspartner, databehandler mm. Dersom personopplysninger skal sendes via internett, bør de krypteres tilstrekkelig. Vi anbefaler for ikke lagring av personopplysninger på nettskytjenester. Dersom nettskytjeneste benyttes, skal det inngås skriftlig databehandleravtale med leverandøren av tjenesten.
Hvis ja, beskriv?		
Skal andre personer enn daglig ansvarlig/student ha tilgang til datamaterialet med personopplysninger?	Ja ○ Nei ●	
Hvis ja, hvem (oppgi navn og arbeidssted)?		
Utleveres/deles personopplysninger med andre institusjoner eller land?	● Nei ○ Andre institusjoner ○ Institusjoner i andre land	F.eks. ved nasjonale samarbeidsprosjekter der personopplysninger utveksles eller ved internasjonale samarbeidsprosjekter der personopplysninger utveksles.

11. Vurdering/godkjenning fra andre instanser

Søkes det om dispensasjon fra taushetsplikten for å få tilgang til data?	Ja ○ Nei ●	For å få tilgang til taushetsbelagte opplysninger fra f.eks. NAV, PPT, sykehus, må det søkes om dispensasjon fra taushetsplikten. Dispensasjon søkes vanligvis fra aktuelt departement.
Hvis ja, hvilke		
Søkes det godkjenning fra andre instanser?	Ja ○ Nei ●	F.eks. søke registereier om tilgang til data, en ledelse om tilgang til forskning i virksomhet, skole.
Hvis ja, hvilken		
12. Periode for behandling av personopplysninger		
Prosjektstart Planlagt dato for prosjektslutt	06.10.2016 20.11.2016	Prosjektstart Vennligst oppgi tidspunktet for når kontakt med utvalget skal gjøres/datainnsamlingen starter. Prosjektslutt: Vennligst oppgi tidspunktet for når datamaterialet enten skalanonymiseres/slettes, eller arkiveres i påvente av oppfølgingsstudier eller annet.
Skal personopplysninger publiseres (direkte eller indirekte)?	□ Ja, direkte (navn e.l.) □ Ja, indirekte (bakgrunnsopplysninger) ■ Nei, publiseres anonymt	NB! Dersom personopplysninger skal publiseres, må det vanligvis innhentes eksplisitt samtykke til dette fra den enkelte, og deltakere bør gis anledning til å lese gjennom og godkjenne sitater.
Hva skal skje med datamaterialet ved prosjektslutt?	■ Datamaterialet anonymiseres □ Datamaterialet oppbevares med personidentifikasjon	NB! Her menes datamaterialet, ikke publikasjon. Selv om data publiseres med personidentifikasjon skal som regel øvrig data anonymiseres.Med anonymisering menes at datamaterialet bearbeides slik at det ikke lenger er mulig å føre opplysningene tilbake til enkeltpersoner. Les mer om anonymisering.
13. Finansiering		
Hvordan finansieres prosjektet?	Finansieres av instituttet.	
14. Tilleggsopplysninger		
Tilleggsopplysninger	Ingen	

Appendix C: Nielsen's Heuristics Survey

Heuristic Evaluation

11. **Visibility of system status**

The system should always keep users informed about what is going on, through appropriate feedback within reasonable time

1	2	3	4	5	6	7	8	9	10
○	○	○	○	○	○	○	○	○	○

12. **Match between system and the real world**

The system should speak the user's language, with words, phrases and concepts familiar to the user, rather than system-oriented terms. Follow real-world conventions, making information appear in a natural and logical order.

1	2	3	4	5	6	7	8	9	10
○	○	○	○	○	○	○	○	○	○

13. **User control and freedom**

Users often choose system functions by mistake and will need a clearly marked "emergency exit" to leave the unwanted state without having to go through an extended dialogue. Support undo and redo.

1	2	3	4	5	6	7	8	9	10
○	○	○	○	○	○	○	○	○	○

14. **Consistency and standards**

Users should not have to wonder whether different words, situations, or actions mean the same thing. Follow platform conventions.

1	2	3	4	5	6	7	8	9	10
○	○	○	○	○	○	○	○	○	○

15. **Error prevention**

Even better than good error messages is a careful design which prevents a problem from occurring in the first place. Either eliminate error-prone conditions or check for them and present users with a confirmation option before they commit to the action.

1	2	3	4	5	6	7	8	9	10
○	○	○	○	○	○	○	○	○	○

Appendix D: Focus Group Survey

1. How active are you now?

Sedentary (little/no exercise)	Lightly active (sports/activity 1-3 days/week)	Moderately active (exercise/sports 3-6 days/week)	Very active (exercise every day, or being active every day)	Extra active (exercise 2 or more times per day)
○	○	○	○	○

2. How often, if ever, do you use health/sport apps?

- ○ Never
- ○ Not so often
- ○ Somewhat often
- ○ Very often
- ○ Daily

3. How often do you think you will be using moveFit in the future?

- ○ Never
- ○ Not so often
- ○ Somewhat often
- ○ Very Often
- ○ Daily

Finish

4. Which of the following features do you like?

- [ ] Point system allowing for competition
- [ ] Route creation
- [ ] Social features
- [ ] Activity reminder

5. How likely do you think a social fitness app such as moveFit will increase activity?

- ◯ Not at all
- ◯ Maybe a little
- ◯ Quite likely
- ◯ Very likely
- ◯ Definitely

6. Do you think the "find a partner nearby" feature will increase activity?

Yes	No
◯	◯

7. Have you been more active with moveFit?

- ◯ Not at all active
- ◯ A little bit active
- ◯ Quite active
- ◯ Very active

8. Which things do you think need to be improoved, or maybe added?

9. Please rate moveFit

☆ ☆ ☆ ☆ ☆ ☆ ☆ ☆ ☆ ☆

Finish

Appendix E: System Usability Scale (SUS) Survey

System Usability Scale

1. I think I would like to use this system frequently

Strongly Disagree ○ ○ ○ ○ ○ Strongly Agree

2. I found the system unnecessarily complex

Strongly Disagree ○ ○ ○ ○ ○ Strongly Agree

3. I thought the system was easy to use

Strongly Disagree ○ ○ ○ ○ ○ Strongly Agree

4. I think that I would need the support of a technical person to be able to use this system

Strongly Disagree ○ ○ ○ ○ ○ Strongly Agree

5. I found the various functions in this system were well integrated

Strongly Disagree ○ ○ ○ ○ ○ Strongly Agree

6. I thought there was too much inconsistency in this system

Strongly Disagree ○ ○ ○ ○ ○ Strongly Agree

7. I would imagine that most people would learn to use this system very quickly

Strongly Disagree ○ ○ ○ ○ ○ Strongly Agree

8. I found the system very cumbersome to use

Strongly Disagree ○ ○ ○ ○ ○ Strongly Agree

9. I felt very confident using the system

Strongly Disagree				Strongly Agree
○	○	○	○	○

10. I needed to learn a lot of things before I could get going with this system

Strongly Disagree				Strongly Agree
○	○	○	○	○