Current Challenges and Methods in Adherence with mHealth Applications Used for Alcohol Use Monitoring and Reduction

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Tuomas Liimatta
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Abstract

Smartphones have become ubiquitous in the modern world; with them business of mobile applications (apps) has risen. Included in these applications are mobile health (mHealth), also referred as electronic health (eHealth), apps that are designed to aid people suffering from a variety of health issues. In this thesis the focus is on apps that aid people with alcohol related issues. Goal for this thesis was to study the current field of existing mobile applications that, deal in people suffering from substance use issues, mainly excessive drinking. Specific focus is on the adherence of those apps and how they plan to maintain it. Using this existing expertise and utilizing a Design Science Research (DSR) approach, MyLimits, a design prototype of mHealth application was designed. MyLimits aims at aiding young adults to self-manage their drinking amounts and habits better, with the purpose of designing an app that is would be able to maintain adherence among its users. Two new features were innovated for MyLimits to improve its adherence and these new features were an unnoticeable mode for widget feature and regular check-up meetings with a chatbot. MyLimits and its new features were evaluated in interview sessions with members of the target age group, along with gathering experiences and thoughts on adherence in behaviour change apps.

The research found that existing alcohol related mHealth apps apply a variety of tools for their users. Personal monitoring tools such as self-reporting and goals settings a popular among many others. Social features are also common allowing users to connect with other users, health professionals or people who have experience in reducing their drinking. Gamification and rewarding systems are on the forefront of upcoming apps, but their actual affects still require studying. Findings on adherence show that mHealth app's adherence benefits from segmenting the progress as behaviour change requires a long-term process. Visits and communication with a health counsellor were a great predictor for adherence. Other key aspect to adherence were tailoring to allow the user to personalize their mHealth tool and reminders have been shown to increase adherence and effectiveness of the interventions.

The small number of interviewees was a limitation for this thesis, with five interviewees being interviewed. This was greatly affected by the COVID-19 situation affecting the world during the fall of 2020. Therefore, the interviews were done online, by use of audio call and screen sharing. This removed the possibility for testing the app in a real-world scenario. The interviewees did not have self-reported issues with drinking, and this could affect how sensitively they see the topic. Measuring adherence requires a longer period of monitoring and testing, greatly limiting the potential of evaluating the adherence of MyLimits.

Keywords
Alcohol use, mobile application, adherence, mHealth

Supervisors
Ph.D., University lecturer, Tonja Molin-Juustila
Ph.D., Postdoctoral researcher, Pasi Karppinen

Foreword

First off, I would like to thank everybody that helped me make this thesis and develop MyLimits. These include my supervisors Tonja Molin-Juustila and Pasi Karppinen who provided me with an interesting topic to work on, all the way from the project course in 2018. On that note I would want to thank my team members from the project Johannes Riekki and Lauri Laitinen, for developing the project prototype as a team. I want to thank Liisa Kuonanoja as well for working as the reviewer for this thesis and providing valuable feedback on the study. I was not particularly familiar with the topic, beforehand, but it turned out to be a highly engaging topic to work with. Personally, I feel that there were interesting ideas and findings made along the way and I do hope they get to be used in some way for the benefit of mankind.

Anyway, this was great experience to dip my toes in the vast ocean of scientific literature. Let's rock 'n roll on with it.

Tuomas Liimatta

Oulu, February 2nd, 2021

Contents

1. Introduction

This thesis studies the existing technological solutions used in mobile applications to support people who wish to monitor or reduce their alcohol consumption. The thesis is carried out as a Design Science Research (DSR), with a design prototype, MyLimits, a proposed mobile application, that is based on the background literature, is delivered as the research artefact. This thesis continues the work started in a project course at the Oulu University where a project prototype of the application was produced along with studying into the existing applications, literature, and techniques in the field.

This thesis utilizes the master's thesis on Behaviour change techniques in alcohol reduction by Johannes Riekki, who was a team member on the preceding project course at Oulu University. In his thesis Riekki identified requirements for a mobile behaviour change applications that focused on alcohol reduction and intervention. In his thesis, Riekki (2020) also identified the impact of retaining user engagement and adherence over a longer period of time to reach most sufficient behaviour change. This also a finding by Hur, Cousins & Stahl, 2019, who noted that only the use of behaviour change techniques was not enough to create permanent change in behaviour.

Alcohol is the oldest and most widely used drug in the world, having estimated by WHO (World Health Organization) that there are two billion alcohol users in the world. Alcohol introduces critical health and social risks when excessively used and causes alcoholism and alcohol use disorder (AUD) that has been characterized as a chronic, relapsing disease (Meredith, Petry & Alessi, 2015). However, there are reports on the health benefits of alcohol when consumed in moderation. These conscious alcohol drinkers who enjoy alcoholic beverages without consuming them excessively are a key group for this study as it would be important to develop a way for excessive alcohol drinkers to monitor and settle their consumption levels to a conscious level. The target age group for this study is young adults, who are inexperienced in their limits and capability to handle and monitor alcohol consumption. Data from 2015 shows that in developed countries traffic accidents are the leading cause of death in age group of 15-24-year-olds. Being under the influence of alcohol is a major contributor to these deaths with 25% of fatal accidents in Europe 2012, being contributed to it. (Seco, Gaspar, Magrinho & Castelo-Branco, 2018).

The widespread use of mobile phones has led to the creation of mobile and electronic health (mHealth and eHealth) applications or apps. In the existing literature the terms of eHealth and mHealth have been used interchangeably. In this thesis the focus is on mHealth technologies, but in the cases that eHealth is discussed the context is relating to mobile technologies. The meaning of mHealth has varied in existing literature. For the purposes the of this thesis the definition of Akter and Ray (2010), will be used, where mHealth is "defined as a personalized and interactive service whose main goal is to provide ubiquitous and universal access to medical advice and information to any users at any time over mobile platform". This definition was selected on the basis that it covers a wide variety of apps, unlike some definitions that focus on specific groups of health workers or patients. These health apps have become widely used with a paper from 2019 showing 325.000 health apps being available in app stores and approximately 60% of smartphone users to have at least one health app on their mobile phone (Messner, Probst, O'Rourke, Stoyanov & Baumeister, 2019). The remarkable production pace of alcohol reduction apps emphasises the need to review and evaluate the apps that are available (Meredith et al., 2015). These mHealth apps provide the beneficial tool for in-situ data collection by the user, that is not a possibility at a clinic. The mobility of eHealth and

mHealth apps empowers users by offering them the possibility to actively engage in and self-manage their own condition, regardless of their geographical location (Rabbi et al, 2017; McCurdie et al, 2012; Messner et al, 2019; Spring, Gotsis, Paiva & Spruijt-Metz, 2013; Wright, Dietze & Lim, 2017a). Despite this, mHealth apps heavily rely on the data collected and in many cases sensor technologies have made data collection effortless, unfortunately this does not adapt well to use to substance abuse applications, especially drinking. In substance abuse cases e.g., alcohol usage needs to be manually recorded and collected. This created a heavy focus on the user engagement and adherence of the app to keep the user engaged enough to manually record their habits for long periods of time almost daily (Rabbi et al., 2017). The term “adherence" in this study follows the definition by Sieverink, Kelders & Gemert-Pijnen, 2017 as “the extent to which individuals should experience the content to derive maximum benefit from the intervention, as defined or implied by its creators”. Studies have shown that adherence and engagement are a real issue with Mccurdie et al. (2012) stating that a quarter of the apps are used only once, failing to engage the user for further use. Hur et al. (2019) states that engaged users are active and willing to participate in activities to improve their health and in interacting with health care professionals. An article by Farango (2012) showed that health and fitness apps have only a 47% retention rate after a 30-day period of use and this is backed by Messner et al. (2019) who found the reasons to be the burden of high data entry, loss of interest and hidden costs. This is another challenge faced by an alcohol monitoring and reduction apps as they require lengthy period of use to be effective. To resolve the retention rates, motivation and persuasion methods are studied and implemented in the design prototype to try and solve this issue (McCurdie et al., 2012).

DSR was chosen as the method for this study, due to the possibility to focus in depth on the relationship between with the user and technology. Implementation of a design prototype provides a possibility to test the previously supposed guidelines i.e., Riekki 2020 in actual technical environment, in this scenario mobile phone. The possibility to reveal these possible issues was one of the major reasons in choosing DSR as the method, where development of the design prototype would define clearly the situation to these methods and strategies.

To explore what makes for an effective mHealth app the following research question is formed, with the supplementing sub research questions:

1. What kind of features should a mHealth application for monitoring and reducing alcohol consumption include?
    a. What approaches and tools the existing health applications provide for people who want to reduce and/or monitor their alcohol consumption?
    b. How can mHealth apps plan for adherence in their development?

The supplementing questions help answer issues such as what existing tools and approaches in alcohol related mHealth applications and how deal with the issue of adherence.

Chapter 2 presents background studies into existing mHealth solutions and apps, along with the issues they face, especially the challenge of adherence is explored. In chapter 3 the research method for this thesis is detailed along with the development of the design prototype and the interviews. In chapter 4 the development and implementation of the design prototype application is documented. Chapter 5 includes the results and evaluation of the design prototype from the interview sessions. Chapter 6 presents the findings and discussion on the results of the study. Chapter 7 provides a conclusion to the thesis, with limitations and discussion on the future implications.

2. Background

In this chapter the current most popular tools and methods used to support behaviour change with alcohol use issues are explored, along with existing eHealth and mHealth solutions that are available to help individuals dealing with drinking issues. Engagement and adherence strategies are studied on how mobile applications, especially health application, retain user adherence for maximum effectiveness. The initial search results were achieved from IEEE and ACM Library by using search words “Substance abuse”, “Mobile application”, “Drinking” and “Alcohol reduction”. These search words were also mixed and simplified to get additional results by searching only key words “application” and “alcohol”, as an example. These searches provided several valuable research articles, however, it was deemed that for scientific accuracy, more background material needed to be assembled, to acquire a scientifically valuable amount. An additional review was conducted to gather more background. JMIR - Journal of Medical Internet Research was used as the additional source for this review. Same combination of search words was used, with the addition of time limitation with articles published since 2017 being included. After, this the abstract was reviewed, to make sure the article matched the topic, if they did not, they were discarded. Additional material for the study was gathered by pearl diving articles, by looking at previous works of authors of the papers resulting from the previous searches, along with articles referenced in those articles. Additional material was included from authors previous project course, that functions as the basis of this thesis, as well as other university research studies that contained scientific articles relating to the topic.

Structure of the Background chapter is presented in Figure 1. First chapter (2.1) discusses behaviour change techniques and what is their current role in the field of mHealth. As behaviour change is the goal of all substance abuse solutions, all the following chapters should be viewed through a lens of behaviour change.

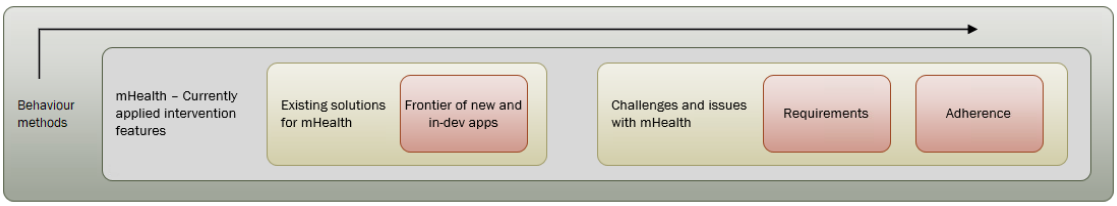


Figure 1. Background chapter progression line.

Second chapter (2.2) focuses on mHealth apps and the features used in existing interventions for substance abuse. The chapter also discusses the existing mHealth solutions to drinking issues, that have been researched in the existing literature, with an additional look into the frontier of mHealth apps with new and in-development apps being discussed and presented. Third chapter (2.3) discusses the challenges and issues that mHealth and development of mHealth face. A look into the development requirements for mHealth apps is also done, with the chapter finishing on the current methods used to deal with adherence in mHealth apps.

2.1 Use of behaviour change techniques

Apps in the mHealth market utilize a variety of behaviour change techniques (BCT) and theories as a basis for their features of intervention and this has been found to be useful

and more effective than apps that have no basis in theory (Spring et al., 2013). McKay, Wright, Shill, Stephens & Uccellini, 2019 performed an extensive study on the currently available field of available mHealth apps. Findings from that study showed that most common behaviour change techniques were related to practise, rehearsal, instruction, self-monitoring behaviour, customizing features and reminders.

Milne-Ives, Lam, De Cock, Van Velthoven & Meinert, (2020) noted that an issue with mHealth apps is that they generally do not report if the app is based on a behavior change technique. The study also discovered that four BCTs were used in more than half of the apps they studied, they were goal setting, feedback on behavior, self-monitoring and instructions of how to perform the behavior.

In his thesis Riekki, (2020) identified requirements for alcohol reduction mobile applications. The thesis finds that "a successful mobile application for reducing or abstaining from alcohol use should utilize suitable behavior change techniques such as self-monitoring, coping skills, social support and comparison, boosting self-efficacy and motivation, goal setting and reviews, giving out rewards, action-planning and cognitive bias retraining". A list of example behavior change techniques in Table 1.

Table 1. Riekki, 2020 Example behavior change techniques.

Behavior change technique	**Example technique**
Self-monitoring	Having a diary where the user can maintain a log of all the alcohol servings they have consumed during the day.
Coping skills	The application provides a list of fun activities the user can do on weekends instead of drinking.
Social support and comparison	Having a chat feature where sponsors can provide support to users.
Boosting self-efficacy/motivation	Sending motivational messages and images to the user.
Goal setting and review	The user can set a goal successfully partaking in sober October.
Giving out rewards for success	When achieving a successful goal, the user is sent a link to a relaxing video.
Action-planning	Providing a list of polite ways, the user can decline to accept an offered drink.
Cognitive bias retraining	Showing the user data about negative effects of alcohol use.
Providing additional support	Asking if the user would like to receive text messages with beneficial information.
Identity change	Sending the user recipes for healthy non-alcoholic drinks and beverages.
Links to written material	Providing links to publicly available scientific papers that discuss substance abuse.
Tailoring	Being able to change the applications language and turn off unwanted features.
Providing information about alcohol use and reduction	Providing a link to national guidelines about normal alcohol consumption.
Providing feedback	Providing an e-mail address where the user can send suggestions and report bugs.

Additionally, Riekki found that it is imperative for the app to maintain user engagement. To achieve this the thesis suggests use of user retention strategies such as, ease-of-use, professional design, providing personalization options and being transparent about the application and matters relating to it.

2.2 Methods and features utilized in existing mHealth applications

Mobile health or mHealth apps utilize a great variety of features and systems to deliver their health intervention or goal. This chapter presents the features and systems that

existing drinking reduction mHealth apps deploy in attempts to support the user reach their conscious drinking levels.

A common feature in drinking reduction apps is scheduled notifications. In behaviour change apps scheduled notifications can be supportive and motivate the user. These notifications can support the user by reminding of them their process or supplying the user with motivational content, like "you are doing, great" or "you have been sober for X number of days, good job" (Bock et al., 2014). These scheduled notifications can help users to remember their goals and to motivate them to keep up their change. However, there are people who do not find these notifications effective or pleasant. Scheduled notes at fixed times can be cumbersome or even annoying to some users. An issue with scheduled notifications is that they can be socially awkward, with Attwood, Parke, Larsen & Morton, 2017 finding that users are concerned what other people think if they see a drinking app notification or icon pop-up in their mobile device. To avoid this frustration scheduled notifications, should be optional in mobile health applications, so the users who do not want to utilize them, may turn them off easily (Bock et al, 2014; Kelders, Kok, Ossebaard & Gemert-Pijnen, 2012).

Self-monitoring or self-reporting is a popular tool in mHealth apps and is often required by behaviour change methods deployed in them. Self-monitoring requires the user to keep record of their behaviour in activities like, eating, activity, or substance use. The traditional issue with self-monitoring has been how burdensome it is. Study from Attwood et al. (2017) found that most users engaged with an mHealth app enter their data in one session, usually at the start or end of day. The recent developments in technology, especially in mobile devices have relieved this burden and made it easier on the users. With the introduction of wearable devices and other accessory technologies this can become even easier in the future (Attwood et al, 2017; Spring et al, 2013).

Goal setting is widely used to support intervention in mHealth solutions and was a prominently mentioned feature in many of the studied mHealth apps (*Saying When*, *A-CHESS*, *Daybreak*). Goal setting specifies the target behaviours needed to achieve the valued health outcome. Goal setting has been shown to be an effective component in delivering intervention. Goal setting is valuable in supporting the user's confidence or self-efficacy, that has been shown to be important in behaviour change efforts (Attwood et al, 2017; Glanz & Bishop, 2010). Glanz & Bishop (2010) list three strategies that can be used with goals to boost self-efficacy "(a) setting small, incremental and achievable goals; (b) using formalized behavioural contracting to establish goals and specify rewards; and (c) monitoring and reinforcement, including patient self-monitoring by keeping records". This is supported by findings from Attwood et al. (2017), with some users wanting to set their own goals and others wanting the app to adjust the goals to their personal progress. The users also wanted the goal setting to be simple, with majority of users wanting one goal rather than multiple.

In a study by Wright et al. (2017b), they workshopped and developed an alcohol-related risk-reduction brief intervention delivered by SMS to young adults during drinking events. Brief interventions have been known to be effective in reducing alcohol consumption by young people. In their development Wright et al. (2017a) deployed the FRAMES (Feedback, Responsibility, Advice, Menu Options, Empathy, and Self-Efficacy) model suggesting:" provision of personally relevant "feedback," discussions relating to "responsibility," non-judgmental "advice" for changing behaviour, suggesting a "menu" of options to support change, expression of "empathy," and encouraging "self-efficacy".". In the workshops young people advocated for the following motivational strategies: open-ended questions, affirmations, reflective statements and summary

statements. These strategies were seen as they were non-judgemental and emphasised on personal motivation. Another finding from the workshops was that short and actionable messages are well suited for the mobile platform, especially for in-moment intervention, while maintaining a clear and encouraging tone.

Social networking and connecting was prevalent topic and theme in form of exchanging messages directly with other users. Direct messaging other users or user groups can be used to draw support and strength from other users when the process of behaviour change is at its hardest. Bock et al. (2014) received strong support for this in their study, with smokers wanting to quit smoking. One of their focus group participants responded with "If there was like a group, someone like in your group you could text and be like, I really need a friggin' cigarette right now.", emphasising the moment of possible relapse, when the users of the health app may provide support and comfort that the digital application may not. Direct messaging in health applications provides the possibility for users of the application directly support each other in their behaviour change, especially in the most challenging portions of the change, i.e., moments of relapse or other struggles. Some studies and health applications have experimented with a "buddy" system, where a fellow program user is appointed as a contact person to contact in cases when they struggle with the process. Study by Bock et al. (2014) indicated that people are hesitant to utilize this kind of tool as they do not want to "bother" other users that they do not know directly. People also seem to prefer communicating to larger groups of users, especially when it is possible to remain anonymous while doing so.

Rabbi, Klasnja, Choudhury, Tewari & Murphy, 2019 name two valuable features to successful intervention, in personalization and contextualization. Personalization is a process of matching the user's individual preferences and lifestyle to the intervention. This may be achieved by having the solution responding to physical activity with notifications like "You walked 10 times in the last week near your office. Don't forget to take small walks near your office today". Similar personalization suggestions have been shown to lower barriers for acting on the suggestion. This was supported by a study from Attwood et al. (2017) where personalization or tailoring was desired in relation to goal setting. The study also evaluates that social and emotional triggers are more proficient starting points for personalizing an app rather than geographical locations. Rabbi et al. (2019) state that contextualization pushes a step further than personalization delivering interventions at a moment of need or possible relapse or at a moment when the intervention is easy to follow. Following the previous example, the notification could be delivered when the user enters the office, or in a case of need, if the user enters some input to signal, they need support the application may provide encouraging or motivating notifications immediately to help relieve the issue.

In their development of a texting program to help people who want to quit smoking Bock et al. (2014). discovered major themes from their focus group research. Theme of social connections or networking was a prevalent theme. Many participants hoped for a social networking functions, hoping for a "Facebook of smokers" style of platform with more user control, allowing sharing of feelings and issues relating to the process of quitting. Although, in the article many participants pointed out that the topic was too personal for them to share with other users. Another issue that was apparent in some of the existing apps was that these features are abandoned, and they become, more of a deterrent and create the illusion that the community and app itself are not used. This was demonstrated in Tofighi, Chemi, Ruiz-Valcarcel, Hein & Hu, 2019 paper where many apps had discussion forums for users, that had not been active for over a year.

Changing the tone of an eHealth application has been tested, if it would yield greater engagement and satisfaction from the app. McCurdie et al. (2012) tested varying tones for their Asthma self-management app. Interestingly their test subjects reacted strongly against a “fun” tone that they were testing, reasoning for this was “that the fun content or language belied the seriousness of their chronic disease condition “.

A major issue for the users and potential users of eHealth and mHealth apps has been that the apps do not provide scientific basis on the functioning of the intervention. Garnett et al. (2018) reported that in their review of the existing studies, half of the studies did not make any reference to theory at all. However, their study found no correlation between the effectiveness of the intervention and the fact if it shares its scientific basis or not. Regardless of this, it would be reasonable for the apps to provide a theory or reasoning for the basis how the app is intended to work. This would offer more information for the users who are looking for an app to help with their issues. With these characteristics used in mHealth the following chapter will discuss the exact characteristics that have been identified in existing studies.

2.2.1 Characteristics of Existing mHealth solutions for reducing alcohol consumption

There already exists a great number of apps available to the consumers with a study from 2019 showing 325.000 health apps being available in app stores (Messner et al., 2019). Despite the vast number of apps, they have been a subject to a limited amount of scientific studies, with that limited amount being inconsistent in results (Choo and Burton, 2018). A major challenge with the lack of scientific research is that there has been little standards or measurement of their success in treating the patient’s issue. Tofighi et al. (2019) studied and attempted to evaluate the existing low-cost apps on their functionality, aesthetics and quality of information. They utilized Mobile App Rating Scale (MARS) and critical content analysis to analyse and rate the existing apps. The MARS is the first metric created by clinicians and technology experts to measure the app quality of functionality, aesthetics and quality of information. Tofighi et al. 2019 also utilized a critical context analysis on the apps from their listed app stores. Their paper narrowed the field of apps to 74 by applying two rounds of quality reviews and eliminated apps that were deemed harmful, not in English, required payment (over one US dollar), duplicates or apps that promoted harmful behaviour. The results from the 5-point MARS scale revealed that apps relating to alcohol use were rated relatively low with a general mean of 2.82 and only one app rated over a grade of 4, with *SoberWorx* at 4.20. The applications scored especially low in information (2.81), engagement (2.75) and satisfaction (1.75).

The highly rated apps from Tofighi et al. (2019) paper were analysed closer for design features, that could attribute to their higher score. Features found were tracking of substance use and related consequences (e.g., cost and calorie intake), remote and near peer support based on geospatial positioning and allowing family members to locate treatment programs and mental health services. The *Saying When* app was developed by The Canadian Centre for Addiction and Mental Health, with the aim to aid users in reaching abstinence or in reducing their drinking amount. As the basis of the app, a manual on cognitive and behavioural strategies was used. The app utilized features such as baseline assessment of drinking patterns, setting personal goals, tracking drinks and urges to drink, links to treatment services and offering advice to success. App called *Alcohol Tracker* applied the Alcohol Use Disorders Identification Test and Functional Analysis of Addictive Behaviours to alert users if they exceeded the alcohol consumption based on the National Institute for Health and Care Excellence UK Guidelines. Several

apps provided users with tools to socially interact with their peer users. Most prevalent of these was *Sober Grid*, an app developed by a team of academics and developers, with the goal to link users together and provide a platform for users to share their experiences and challenges. Other social features applied was video conferencing calls to other users in recovery provided by the app *Pocket Rehab*. The app also provided a possibility to chat with an experienced peer, in case previous peer-to-peer contact had not been helpful. *SoberWorx* provided users with links to treatment centres, addiction counselling and even sober living homes, along with sharing educational recovery videos from YouTube.

Lowly rated apps from the study by Tofighi et al. (2019) shared common themes of being limited to only 1 or 2 basic functions, while claiming to utilize complex design features to support recovery. The features in these applications included supportive quotes, some from religious texts, timers, blood alcohol calculators, logging in substance use and playing relaxing music that were claimed to stimulate desires to quit. In addition, many of the low rated apps used deceptive descriptions to attract users. Many of the apps included pop-up advertisements when used, with some requiring paying for a *full-version* to remove the advertisements. On top of these features the apps promoted harmful behaviour and use of substances. An app named *Drive After: Alcohol calculator* provided strategies on how to appear sober and how to hide the smell of alcohol. Another instance was with *Best Alcohol Test* app that offered games to test the user's reflexes to demonstrate how drunk the user was.

A study done by Meredith et al. (2015) studied two research databases for evaluations on smartphone apps designed to reduce alcohol consumption. Their study resulted in six apps, two of which were deemed to require more testing before any conclusion could be made, two that failed to promote self-reported reduction and two promoting successful self-reported reduction from alcohol use, these apps were *A-CHESS* and *LBMI-A*. *A-CHESS* is based on the self-determination theory, which suggests that motivation and well-being are enhanced when psychological needs of competence, autonomy and relatedness are met. The app is also informed by a cognitive-behavioural approach to prevent relapses, by focusing on identifying and preventing high-risk relapse situations. *A-CHESS* supports these by implementing features such as a GPS based positioning system that warns the user when they are near a high-risk location, offering information on the subject, anonymous discussion forums, motivational reminders on goals and milestones, surveys to assess amount of use and cravings, and panic button feature where a message is sent to preapproved friends and family when the person is close to relapse. *A-CHESS* was tested on a trial for people recovering from alcohol dependence and the trial showed clear benefit from using the app compared to recovery without. The trial measured "risky drinking days in the past 30 days (more than four standard drinks for men or more than three standard drinks for women in a 2-hour period)", patients with *A-CHESS* reported 1.39 risky days over a 12-month period whereas patients without the app recorded 2.75 risky days. Further studies of *A-CHESS* have shown good sensitivity and specificity in predicting risks of relapse and informing the patient and their support people about the risk. Another version of *A-CHESS*, called *ACHESS* was designed to provide support for adolescent alcohol and substance abusers (Meredith et al., 2015). *ACHESS* has been tested and the results have shown it to be an effective tool to be integrated into care models (Hussey and Flynn, 2019).

LBMI-A is a smartphone app designed to provide alcohol use disorder or AUD patients with recovery support. The app is based on several theoretical perspectives including relapse prevention, community reinforcement and motivational enhancement. The app works on a series of psychoeducational modules of motivational enhancement, identification of high-risk areas, social support networks, carving management, problem

solving, alternatives to drinking and practising refusal of drinks. After reviewing a module from text or video, a related feature of the app becomes available to the user. In a pilot study, done with patients suffering from AUD, *LBMI-A* produced significant decreases in self-reported heavy drinking days and drinks per week. Additionally, *LBMI-A* produced a clear increase in self-reported percent days abstinent. Usage of the app did decline over the 6-week study, but 71% of the patients did access all seven modules, suggesting *LBMI-A* is a feasible and efficacious app for promoting abstinence. It is worth noting that the commercial version of *LBMI-A*, called *Step Away*, was recently released and has not been evaluated in the peer-reviewed literature (Meredith et al., 2015).

Paper from Meredith et al. (2015) reports of a study done in Sweden to evaluate two Swedish smartphone apps designed to estimate blood alcohol concentration (BAC): *Promillekoll* and *PartyPlanner*. *Promillekoll* is developed by the Swedish government and the app provides the user with an estimate of their BAC based on manually entered beverages. The app then provides strategies on how to maintain the user's consumption at a rate that would prevent them from reaching dangerous BAC levels. *PartyPlanner* was developed by Gajecki, Berman, Sinadinovic, Rosendahl & Andersson, 2014 and functions similar to *Promillekoll*, by providing the user with estimates of their BAC. Both *Promillekoll* and *PartyPlanner* were tested in a study on 1,932 university students, who had been identified as hazardous drinkers. The test used past 7-day self-reported drinking amount as a baseline and that was compared to a 7-week study when using the apps. The tests showed no significant decreases in the self-reported measures of alcohol consumption, additionally only 41% of *PartyPlanner* participants used the app, and even up to 74% of *Promillekoll* participants used it, signalling that the apps failed to engage the intended users in the study.

Laurens et al. (2020) worked on developing a mHealth app called *Breindebaas*. The app was designed to retrain the user's tendency bias by using training sessions which presented 100 images to the user, of which half were images of alcohol beverages and the other half non-alcoholic beverage images. This relies on the cognitive bias modification (CBM) with the user having to swipe away from them on the mobile device, when the image is an alcohol beverage, and swipe towards them on a non-alcohol beverage image. This process is based on the previous study by Wiers, Eberl, Becker & Lindenmeyer, 2011 and aiming to move the methods of that study into mHealth platform. *Breindebaas* is aimed at the general audience. The study identified a significant reduction in alcohol consumption over both short-term tests (3 weeks) and long-term tests (3 month). The simple concept of the app received also praise for its simplicity and user-friendly design. Nearly half of the study participants also reported having gained more control over their personal alcohol use.

Study by Tait, Paz Castro, Kirkman, Moore & Schaub, 2019 evaluated the *Daybreak* app that was developed to support high-drinking individuals to change their relationship with alcohol. This is facilitated by encouraging users to set goals for their intervention (like abstinence or reduction), reflecting on mood and peer support. *Daybreak* deployed four mechanisms to achieve behaviour change and they included weekly check-ins, peer support, behavioural experiments, and health coaching. Weekly check-ins included questionnaires to encourage the participants to self-reflect and explore their motivation for the behaviour change. Peer support was enabled by a blog feature, where users could connect with other users. Behavioural experiments were implemented in two components, self-guided experiment and associated learnings. Health coaches operated online by using a real-time chat and they partnered with users to aid them in setting personal goals and assisting in reaching those goals. The study resulted that *Daybreak* significantly improved outcomes for measures in alcohol consumption, user mental health and quality of life. In

addition, the study showed that *Daybreak* was most effective with non-risky drinkers, whereas with risky drinkers it was suggested to add face-to-face support to accompany the app. This result highlighted the importance of a determined baseline for the user.

Study by Attwood et al. (2017) evaluated the publicly available *Drinkaware* alcohol reduction app. *Drinkaware* offers four features to its users: in the form of 1) alcohol calculator, 2) feedback on drinking patterns and drinking's impact on health, 3) goals for drinking reduction with supportive messages when specific goals are met, 4) risky geographical zones, like regular bar or supermarket, where user might need additional support to resist or regulate alcohol consumption. The study found that users who intended to reduce their alcohol consumption or users who reported high levels of alcohol prior to download had the highest engagement with the app. Users in the study also expressed that the app had helped them raise awareness of their consumed alcohol levels prompting changes in their drinking behaviour.

Ashford et al. (2019) studied the publicly available recovery support service *Sober Grid*. *Sober Grid* was also closely reviewed in the existing expertise report for the project course preceding this thesis. *Sober Grid* utilizes social features to support users in their alcohol reduction. The tools utilized are "text-based and photo-based status sharing, user check-ins, a geolocation "grid" that allows users to find others in recovery near their location, user to user connections (unilateral or bilateral), alumni group pages, and a "burning desire" feature that allows users to immediately reach out for help to others in the community". The study focused the recovery outcomes of the users of *Sober Grid*, especially on the sobriety length and number of relapses. The findings indicated that *Sober Grid* is used by a diverse group of individuals engaging in all the available features. Results on length of sobriety showed that on average *Sober Grid* was used for less than a year, indicating that the app is most engaging in the early parts of recovery. Findings from relapses show that relapses from check-ins were lower than relapses deriving from sobriety date changes, which could suggest that user's willingness to report relapses may be affected by various reasons, such as shame or stigma.

2.2.2 Frontier of development in mHealth interventions

The frontier field of mHealth applications and the research for them is rapidly expanding, with new apps being developed containing new features and solutions to alcohol issues. This chapter presents the most recent ongoing research in alcohol related mHealth apps, presenting the direction where the field is growing as well as presenting the newest tools and features being tested and developed. Currently, there is plenty of interest in mHealth with numerous studies into the existing and in-development applications and in-use behaviour change methods. Sawares, Shen, Xue, Abi-Jaoude & Wiljer, 2017 are working on a large-scale systematic review of the existing mHealth solutions. In Sweden, a large-scale study by Bendtsen et al. (2020), is studying and developing mHealth apps for a large variety of topics (alcohol, nutrition, physical activity, and smoking) and subject groups (like pregnant women, children, students and clinical care).

Chimpshop is a mobile app that attempts to reduce alcohol consumption in its users by applying gamification. The app is a gamified version of the Alcohol Attention-Control Training Program, which is a computerized intervention that operates by reducing user's alcohol conception by overcoming their alcohol attention bias. In the app, players earn points by selecting healthy product, while trying to avoid alcohol products in a virtual supermarket. This process is believed to reduce the user's alcohol attention bias towards alcohol-related stimuli. Preliminary pilot studies are suggesting that playing *Chimpshop*,

just 30 minutes per week, is associated with reduction in self-reported alcohol consumption. This is only a preliminary study, and the app is undergoing further testing to prove its efficacy (Meredith et al., 2015).

Rabbi et al. (2017) proposed Substance Abuse Research Assistant or *SARA*, a novel app to help adolescent users (14-24-year-olds) in engaging to track their substance intake. Focus of their development is to gain user engagement by using different methods like financial incentive, motivation, and persuasion, especially Rabbit et al. (2017) highlights their multitude of rewards systems to increase novelty and hopefully increase engagement. *SARA* operates by implementing a daily survey, that monitors users' daily emotions and by two active daily tasks. The tasks collect data and test the user's spatial memory, gait, problem solving skills etc. The centrepiece of *SARA's* engagement is a growing *aquarium* that gains additional rewards in forms of decorations and fishes as the user completes daily tasks. Completing daily tasks also earns the user badges, that also provide the user with a small financial incentives. To prevent repetitiveness in the reward system *SARA* also provides additional rewards in memes, funny gifs and life-insights. To maintain adherence the app has daily times notifications to remind the user to perform their tasks along with a daily inspirational quote.

In a study Haug et al. (2020) tested the effects of mobile phone-delivered, just-in-time planning interventions to reduce alcohol use in adolescents who have reported recent binge drinking. The study found that planning interventions were effective to reduce the average drinking amount of young people on typical drinking days by about one standard drink. Study by Wright et al. (2017a) supports these results as their pilot study on an ecological momentary intervention (EMI) based brief mobile intervention produced reduced results in the mean amount of drinks consumed during heavy drinking occasions.

Satre, Ly, Wamsley, Curtis & Satterfield, 2017 studied converting the well-known theoretical behaviour change model of theory of planned behaviour (TPB) into a mHealth app. The development and pilot testing of the app focused on screening, brief intervention, and referral to treatment (SBIRT), that has been highly promoted for identifying and treating individuals at risk of alcohol or drug problems. The goal of the app was to provide a tool to promote translation of substance screening and intervention skills from classroom to clinical setting in nursing students. The tested app utilizes three primary functions to deliver the SBIRT: (1) review skills (i.e., address knowledge and beliefs about SBIRT), (2) apply skills with patients (i.e., build confidence and perceived behavioural control), and (3) report performance data (i.e., increase accountability and social norms and/or influence). The app showed great promise in the pilot tests and has moved into further testing.

2.3 Challenges and issues with development of mHealth apps

Due to being a relatively new phenomenon, mHealth has some challenges and issues related to it. A major issue and challenge with development of mHealth apps is their top-down approach headed by developers and programmers, leaving the intended users out from the development process (Bock et al, 2014; Velsen et al, 2013). This mismatch with technology and user requirements has caused a difficulty to judge eHealth apps on their effectiveness. McCurdie et al. (2012) state that this easily leads to systems possibly lacking key features. Bock et al. (2014) also believes that to have an impact on health behaviour, the app must be both useful and desirable to the user. The application needs to be designed the way that the user wants to use the application and to be consistent with the way individuals use technology.

Previous studies show that existing alcohol apps do not present any evidence of efficacy in addition, the apps did not provide any evidence of sustained use. For instance, apps promising peer support had forums that were not moderated, nor was there any clinicians to offer any evidence-based information. Clarity on how the underlying intervention mechanics are supposed to work are not available to the users in the app store or within the app itself. Not even basic measures, such as duration or intensity of app use, were not available. This lack of available information forces potential users to rely on user ratings and comments to evaluate an apps potential benefit (Leonard et al, 2017; Tofighi et al, 2019; Weaver et al, 2013).

An issue with mHealth apps that aim to promote healthy behaviour or general wellbeing is when they are categorized with apps that promote opposite behaviour. In a study by Weaver et al. (2013) found that half of alcohol related apps in Android's Google Play and Apple's iTunes stores were entertainment apps that promoted drinking. These apps included drink recipes, drinking games and bar finders among other types of apps. The study also found that these entertainment apps were the only health apps used by the participants, concluding that young people are more likely to download apps that encourage drinking instead of apps designed to reduce it. This causes issues to researchers and potential users of alcohol reduction apps. Challenge with researchers is that when two groups of apps with contradictory goals are grouped under the same term of eHealth, it becomes hard to evaluate and analyse the apps under that term. For users, these two extreme ends of possible solutions can be hard to comprehend when trying to select an app to use. It might be hard to see the value and legitimacy of an app if the app store presents it among entertainment purposed apps. This can be especially challenging for people with severe alcohol issues, when they are looking for an app to help them, they might encounter a risk of relapse when confronted by apps that promote drinking. (Weaver et al., 2013).

2.3.1 Development requirements for mHealth apps

The development of requirements for mobile health applications and eHealth in general has been lacking in the past. This is a crucial detriment as requirements are the foundation that technology is developed on, describing what the system should do at any point of use and what kind of user experience it should provide. Requirements define the activities the applications need to fulfil, being highly important to the developers creating the application. Inclusion of end users in the development of requirements has shown great promise in the past, especially in improving usability. Inclusion of the end user helps identify bad development designs and unneeded features of the application, which helps in saving money on development. Requirements are a highly valued tool in designing an eHealth system, for a multitude of reasons. Requirements allow to estimate the cost of technology, preventing programmers from making their own requirements. Requirements also helps prevent brain drain, in case of a project member leaving the project. (Velsen et al., 2013).

Literature on eHealth development requirements has been scarce, however study by Velsen et al., (2013) has helped set guidelines for designing requirements for mHealth apps. With this, requirements have been studied that to fully use the potential of eHealth technology, the technology needs to be developed by a multi-disciplinary team who can apply a human-centred approach to the development. Even the World Health Organization (2010) has recognized the issue of mismatch between context and technology, going as far as stating it as a main reason why up to three quarters of new medical devices fail. According to the study these issues can be resolved by developing

requirements properly. Using human-centred design has been suggested and it has had success in the past. Developing eHealth applications differs from other domains where the target users are very easily definable. In most cases eHealth application is developed to people suffering from a disease or health issue, e.g., patients with Arthritis or people wanting to quit smoking. Some applications are also developed for people aiding patients in these health issues. Due to this the end user should be well defined and detailed, by the developers so they can develop the system to aid the users the best. eHealth applications are designed also differently from other domains, with the applications being free to use in many cases or they are they purchased by a medical organization (e.g., hospital) then offered by medical professionals to potential users to help with their issue, often free of charge. Due to the eHealth technologies being part of treatment or prevention of health issues, their requirements need to provide more than a list of functions and features. The requirements should also entail how they are to be embedded to the process and context of recovery. (Velsen et al., 2013).

Velsen et al. (2013) proposed a modified version of the CeHRes roadmap that puts extra emphasis on the requirements that address designated context of use. Their roadmap creates a set of documented requirements that work as the basis for a design document. The documents contain everything needed to program the technology including technology goals and requirements along with a prototype version of the designed eHealth system. These documents may also serve as a proof of concept for the stakeholders and as a basis for a business plan for the system.

2.3.2 Adherence methods and challenges for mHealth apps

Services and systems provided by eHealth and mHealth can be effective in promoting good health and healthy behaviour, but a common challenge they face is that of adherence. Studies have shown that eHealth systems have an average adherence of 50%, which translates to half of users, that quit using the solution before reaching their goal. Regarding adherence the user also plays an active role in the process of achieving the benefits that the mHealth system aims to achieve. The role of adherence with mHealth systems has been widely studied in the past, but the focus has been on explaining variations in adherence, while the role of technology has been overlooked (Hur et al, 2019; Kelders et al, 2012). Despite this, there is evidence from studies that mHealth apps improve on the overall treatment adherence, especially in chronic and stigmatized disease management. This is attributed to the features that embed the intervention to everyday life, by the use of reminders, pushes and notifications (Akter and Ray, 2010; Messner et al, 2019).

A major challenge with adherence is determining when a user is adherent, how to measure it and how it relates to intended usage of an intervention. Milne-Ives et al. (2020) reported of the issue in their study over how to evaluate adherence and how tests evaluate adherence in apps. In their systematic review Sieverink et al. (2017) found that over half of the apps dealt with adherence with the attitude of “the more use, the better” and less than half specified a threshold for intended usage. In a study by Laurens et al. (2020) when developing and testing a mHealth app called *Breindebaas*, they advised their test subjects to complete at least six training sessions, yet in reporting the results, they considered completion of four sessions as successfully adherent. Based on their definition of adherence Sieverink et al. (2017) suggested three elements necessary for determining adherence in eHealth technology: “(1) the ability to measure the usage behaviour of individuals; (2) an operationalization of intended use; and (3) an empirical, theoretical, or rational justification of the intended use”. Messner et al, (2019) found that “half of the

individuals who use a mHealth app stop using it after a while. Reasons to stop using mHealth apps are high data entry burden, loss of interest and hidden costs".

Adherence is highly vital for the long-term survival of an eHealth or mHealth system and for it to apply its benefits onto the users. Studies have shown that lifestyle interventions, with long-term goals, might benefit from including segments with stricter format and shorter durations. Mental health interventions usually aim at long-term goals like relapse prevention and might apply a less strict of a format. Being less strict might increase the lack of adherence to the system. Studies have shown evidence that existing mHealth interventions can improve adherence and they should be planned on when planning the system. Methods like increased amount of engagement from the user has great impact on adherence. (Kelders et al., 2012).

Kelders et al. (2012) studied to gain insight into the factors that affect adherence in eHealth interventions, specializing in web-based solutions for chronic conditions, lifestyle, and mental health interventions. According to Kelders et al. (2012) a typical web-based intervention is "meant to be used once a week, is modular in setup, is updated once a week, lasts for 10 weeks, includes interaction with the system, a counsellor, and peers on the web, includes some persuasive technology elements, and results in about 50% of the participants adhering to the intervention". They also found out that lifestyle interventions are longer and less strict, than the ones for mental health and chronic conditions, but require less frequent usage and thus have a lower adherence.

Study by Kelders et al. (2012) looked at effects of specific persuasive technologies in eHealth systems. They found out that primary task support elements are widely used in interventions for both chronic conditions and lifestyle changes. Tailoring is also a very widely used feature and it widely recognized as being important in health communication. Reminders are the most utilized element in eHealth solutions. Studies have shown the importance of reminders as a tool in increasing adherence and effectiveness of the intervention. Suggestions were the second most used element, especially used in interventions for chronic conditions. Crucial finding was the seldom use of praise and reward elements especially in relation to health interventions. In recent studies gamification with rewarding systems have shown great promise in increasing the adherence and appeal of the eHealth solution. McCurdie et al. (2012) found great success in an application for young children suffering from diabetes, by rewarding free songs from iTunes to the children. At the end of the study, they received high satisfaction rates and 88% of the subjects would continue using their app. Frequent intended usage was also found to have a positive impact of adherence. This seems little counterintuitive, but it might mean the users are more actively engaged when they are expected to be active at using the system.

Social features such as social support, social learning and social comparison had mixed and unclear results in the study by Kelders et al. (2012). Social support, though widely regarded as an important strategy in behaviour change, was unclear if it had any effect on the adherence of the eHealth system. Similarly, challenges were encountered with social learning and social comparisons, so their effect on adherence remains unclear and a subject to further research.

Frequent visits and communication with a health counsellor were a significant predictor for adherence. Regular face-to-face sessions paired with eHealth solutions produced the best results in adherence. This finding is supported by a wide range of studies with clinical support of a counsellor is related to longer exposure and engagement with eHealth solutions. This clearly solidifies the importance of some form of support to the user in

maintaining adherence. Clinical counsellors have a much greater effect over just peer support, which could be related to the highly personal subject that eHealth systems deal with. (Kelders et al., 2012).

3. Research Method

This chapter discusses the Design Science Research methodology (DSR) used in carrying out this thesis. Chapter 3.1 includes the utilization of DSR in this thesis, and how it was deployed in development of the design prototype. Chapter 3.2 describes the process and steps taken in the development of the design prototype, from its conception in the project course at University of Oulu to its finish with this thesis, with the conducted interviews and user reviews described in detail.

3.1 Design Science Research

DSR was selected for this thesis as the aim is to construct a design prototype of a mobile application to support people aiming to reduce or monitor their alcohol consumption. According to Hevner et al. (2004) design science is used in solving problems by deploying design-science with behavioural science research paradigms. This combination of behavioural science working with the interaction between people and technology along with DSR is used to create innovative artefacts to solve identified problems. DSR aims at the creation of innovative artefacts such as constructs, models and methods.

In design science, IT artefacts are created and evaluated in an effort to solve organizational problems. According Hevner et al. (2004) these artefacts are represented, "in a structured form that may vary from software, formal logic, and rigorous mathematics to informal natural language descriptions". These artefacts can also include new innovations relating to social, information or technical aspects or any designed object with an embedded solution to an existing research problem (Peffers et al., 2006, 2008). In the scope of this thesis, the problem is whether mobile apps can be used to reduce/monitor a person's alcohol consumption and how can the apps maintain adherence with the user to achieve the goals of reduction. This organizational problem is solved by utilizing the preceding course work as the basis to develop a visual presentation of a mobile application to help users reduce their alcohol consumption, with adherence of the application and its features as point of focus.

This research follows the DSR cycles that set by Hevner et al. (2007) as the research framework (DSR cycles presented in Figure 2). The model presents three cycles of *relevance cycle, design cycle* and *rigor cycle*. *Relevance cycle* operates as the starting point to the DSR process. Identification and defining of central requirements and acceptance criteria can be formed during this cycle. During this cycle testing of the research artefact and its relevancy to the target concept should be evaluated. *Design cycle* is the essential part of the three cycles. Here the iterations between design, implementation and evaluation runs fastest and the loop is run until a satisfying conclusion is reached e.g., requirements for the artefact are reached or customer is satisfied with the artefact. *Rigor cycle* serves two crucial purposes: first the literature search and research into existing issues and problems, and secondly the rigorous studying of the existing solutions and designs. It is highly valuable for researcher to explore existing designs for innovation and therefore return to the design cycle (Hevner et al., 2007).

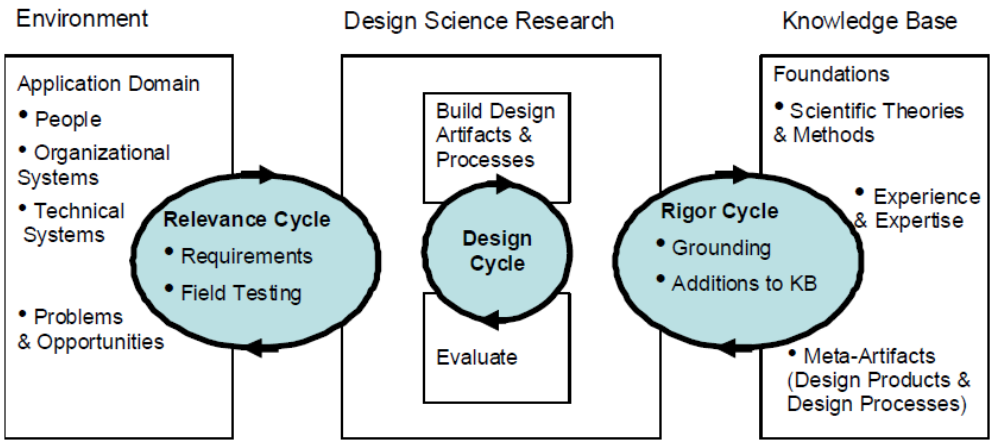


Figure 2. Design Science Research Cycles (Hevner et al., 2007).

Hevner et al. (2007) cycles for DSR are applied in this thesis to create the design prototype. The university project work followed a very similar structure and will work as the *relevance cycle* for the thesis. The project prototype developed during the project also works as the basis to explore the *rigor cycle* by studying the existing studies into the field. The *rigor cycle* is also engaged with exploring the study by Riekki (2020) and by this thesis, with its background studies and development of the design prototype. With this completion of the *rigor cycle*, the thesis can move to *relevance cycle* to redefine the requirements for the DSR artefact. These requirements are then tested and evaluated in the *design cycle* with interviews on potential users as was done with the project prototype in the project interviews.

3.2 Development steps of the design prototype

In this chapter the development progress of the design prototype is presented. Starting with the project work done at the Oulu University, including the early concepts of the project prototype. Project interviews reviewing these concepts are also included in this chapter. The development steps done to the design prototype after the background studies, with target audience interviews are also discussed.

3.2.1 University project prototype and project interviews

The development of the design prototype conducted in the autumn of 2018 and finished in December of that year, with the Research and Development Project course for the University of Oulu. Following preliminary discussions between the clients of the project, very broad guidelines were set where the team would study existing solutions utilizing mobile platforms, social platforms, and gamification.

The original concept of the project course was very broad with the goal to innovate a solution to help people suffering from alcohol abuse. During the preliminary discussions and the study into existing solutions the concept was solidified into a mobile application that aims at supporting people who wish to reduce or quit drinking. The mobile app would feature social platforms and other features found in the study of existing solutions. Target audience was young adults between ages of 18-25 as they are the most inexperienced drinkers and might not understand their own limits and the impact of their drinking. However, the project prototype was developed to be usable by people of all ages.

This solidified early project prototype was developed into paper prototype that was accepted by the customers. Using this paper prototype three semi-structured qualitative project interview sessions were held to evaluate the prototype and to gain information and insight, on the quality and usability of the prototype from potential users. The project interviews were qualitative in nature and performed as semi-structured, including both specific and open-ended questions. This was to give the interviewer the possibility to explore possible new ideas or information that the interviewee might present during the project interview. The interviews performed during the project course were performed in three sections. The first section was about general information about the interviewee, second was more focused on the drinking habits and experiences of the interviewee and third section was a set of questions about the presented images of the project prototype. The project interviews were held over a two-week period at a workspace assigned for the project team at the University of Oulu, with the interviewee's students at the University.

The project interviews were analyzed, and improvement suggestions were made to the project prototype. These improvements were presented to the customers and with their feedback implemented for the final project prototype. Improvements to the prototype were made with the final version of the project prototype being delivered to the customers along with an introduction video describing the functions and use of the project prototype. One of the team members continued to their own thesis with the study by Riekki (2020), which is utilized in this thesis too. From there on the development of the design prototype for this thesis begun, which is explained in the next chapter.

3.2.2 Development of the design prototype MyLimits

Work on the design prototype commenced in the summer of 2020, with the exploration into the background studies. The work continuing from the project prototype, described in the previous chapter, continued shortly after that with new ideas being implemented to the project prototype. During the background study the topic of adherence with mHealth apps surfaced and was chosen to be focused on with the development of the design prototype.

In the fall of 2020, the development of the design prototype begun with reconstruction of the desired features from the project prototype. It was deemed that recreating the whole project prototype in detail would be too much work. Instead, focusing on the newly innovated features, along with studying on how to best achieve adherence, would be the focus in the development of the design prototype. The development phase along with the new features are described in more detail in chapter 4.

During the development of the design prototype, it was decided to include an avatar to the app. Following this decision, the topic of avatars was also included in the interview topics. In reviews of the in-development design prototype it was noted that different avatars significantly affected the authority and general feel of the app. A doctor avatar would give the app a more serious authoritative feel and a robot avatar would present the app as more of a tool for the user. Three different avatars were included for testing in the interview sessions with target audience, to gain more insight into their affect.

Proto.io was used as the program to create the MyLimits. Originally a different tool was intended to use in the development, but it was changed in early December to Proto.io. The original tool was decided on the basis it that it would offer an interactive prototype of MyLimits to use in interviews, but due to the difficult COVID-19 situation in December of 2020 the testing of MyLimits was decided to be performed online, by using

video calls. Due to this change the feature, interactiveness was not needed anymore, so the tool was changed. Proto.io was already a familiar tool from the project course and provided clear and easy tools for creating images of MyLimits to demonstrate during the online video calls.

3.2.3 Interviews sessions

In this chapter the methods and procedures used for interviews and evaluations for analysis are described. In total 5 number of interviews were held and analysed.

MyLimits was subjected to testing with target audience interviews in December of 2020 with 5 number of interviews being performed with young adults. As per the cycles by Hevner et al. (2007), the interviews were intended to be performed in the field to simulate potential instances of use, using it the city streets or at a bar or café. This was retracted due to the COVID-19 pandemic situation at the time of testing, so the tests were performed online with audio calls and screen sharing. Due to this change of plan, purposeful sampling was performed on the writer's personal Discord channels, which included multiple members of the target audience. This was to allow fast turnouts for the interviews, within the matter of hours from the initial open invitation to the interviews. This was due to the fast-paced schedule towards the end of December 2020 to perform all the interview by the end of the year. The interviews were recorded using OBS Studios, from audio calls using Discord. During the interview screen share was used to present the MyLimits design prototype to the interviewee, but this was not recorded visually. The images shown in the interview are presented in chapter 4.2. The interviews were done, cleaned, and transcribed in Finnish and during analysis converted to English.

The interviewees were recruited from the writer's personal Discord channel by an open invitation to the members of the Discord server group. Subjected interested in the interview were provided with data protection form (see Appendix B) and the general topic of these interview and the estimated length of the interviews. If the subjected was still interested in participating a time for the interview was agreed on within the next 24 hours. The interview process was formal, yet friendly. All the interviewees were already familiar with the interviewer, but the discussion remained on the subject of the interview. Despite the familiarity with the interviewees, it was recognized that topic of drinking and alcohol use could be delicate subject to the interviewees. To accommodate for this the questions were presented with care and the interviewees were made aware that they did not have to answer if they so chose to. At the end of the interview the interviewer asked the interviewee if the topic had been handled properly.

The interviews were semi-structured to ensure all points of discussion were reached, while maintaining the possibility for the interviewer to focus on different themes with different interviewees. This was valuable as the interviewees has very different backgrounds to the topics, so the areas where they had experience and ideas, could be focused more thoroughly. Some of the interviewees had no experience with behaviour change apps, so in cases like these the topic could be passed with general questions as the interviewees had very little in-depth answers to give.

The interview procedure was spread to five sections (see Appendix A). First section contained approval of privacy notice, delivered to the interviewee when they accepted the invitation to the interview. In addition, the first section contained discussion about the interviewee's personal relation habits with drinking. Experiences with behaviour change apps, were also discussed, with heavy focus on the adherence of these previous

experiences with apps. Second section contained presentation of MyLimits, here the interviewer presented the design prototype, with the interviewee having the possibility to stop the presentation and ask additional questions. Third section contained the topic of widget feature along with the innovated unnoticeable mode ideas. Fourth section included the check-up meetings with bots. Fifth and final section of the interviews focused on the avatars and how the interviewee perceived them. The interviewees were asked to name their favourite avatar. Following this, they were asked to imagine that they were in charge of developing and releasing the app, and which avatar they would choose for MyLimits and why they chose it. With these interview sessions, the next chapter describes how the interview data was analysed.

3.2.4 Analysis methods

The interviews were analysed by transcribing the audio file into text form. The transcribing was not full transcription of every word from the interview. This was to save time and workload; additionally, large parts of the interviews were the interviewer explaining the functioning and purpose behind MyLimits and all its features. Therefore, the transcribing focused on the more active parts of the discussion, especially on the presented questions and the answers to them. The transcribing was done in Finnish with the speech cleaned up by removing filler words and sounds. This transcription was then translated into English and used in analysis tables.

Table 2. Table of the profile name of the interviewees and the lengths of the interviews.

Number	1	2	3	4	5
File name	Haastattelu1.flv	Haastattelu2.flv	Haastattelu3.flv	Haastattelu4.flv	Haastattelu5.flv
Gender	Female	Male	Male	Male	Male
Age	25-29 years	25-29 years	20-24 years	25-29 years	25-29 years
Profiling name	**Non-Drinker**	**Ex Heavy Drinker**	**Experimenter Drinker**	**Social Drinker**	**Casual Drinker**
Length of interview	38.55	35.41	36.26	34.04	33.59
Drinking history	Does not drink	Six years sober, used to drink heavily	Does not regularly drink, has been drunk twice	Socially drinking once every two months. Sometimes sauna drinks	Considers normal, drinks socially and to relax

In the analysis the five interviewees were profiled based on their drinking behaviour into a table (see Table 2). Their interview answers from all the major points of discussion were then formed to a table for clear comparison and analysis. Using the tables to compare the answers from the interviewees and to reflect it on the existing solutions the analysis was done. This concludes the research methods of this thesis with the development of the design prototype, MyLimits, being presented in the next chapter.

4. Development of the project prototype and of MyLimits

This chapter describes the development of the design prototype, MyLimits. Chapter 4.1 describes the work done during the 2018 project course at Oulu University, including original project prototype designs, along with the final project prototype based on feedback from interviews. Chapter 4.2 describes the implementation of the final version of MyLimits, including changes based on the interviews and the innovation of the new features.

4.1 Development of the project app during the project course

The development of the project prototype conducted in the autumn of 2018 and finished in December of that year, with the Research and Development Project course for the University of Oulu. This chapter describes the processes that created the project prototype, which was later used as the basis for the design prototype of this thesis. This project work has not been reported earlier so it is presented here as the basis for the design prototype. The project team included three members, each of them masters level students at Oulu University: Tuomas Liimatta, Johannes Riekki and Lauri Laitinen. Tuomas Liimatta acted as the Project Manager during the project, while the development tasks were split equally among the members. The customers for this project were Tonja Molin-Juustila and Pasi Karppinen.

During the project course the goal was to develop a prototype for a solution to help users reduce their alcohol consumption. Guidelines for the project were very broad and the team could innovate freely based on the studies of existing substance reduction solutions available. Based on the background studies the team settled on a few different ideas for further testing. The ideas were a mobile alcohol use diary, a social support forum, an application for self-monitoring alcohol intake or a tool that utilized gamification and storytelling to help deliver the intervention.

The existing project prototype was tested and analysed for potential intervention types and settled on creating a single paper prototype that included elements from all these interventions. The project prototype could receive the user's manual entries and present data based on the entries. The prototype deployed tailoring and customizability to allow the user to personalize their user experience by choosing a customizable avatar to deliver information and by selecting the tools for reduction. The project prototype also included goal setting and notifications to promote engagement and adherence. The project prototype was tested by the members of the team and then tested further with interviews for user evaluation. The interviews were done as semi structured interviews with students at the Oulu University Faculty of Information Technology and Electrical Engineering. Twelve students were approached to participate in the interview, with four agreeing to be interviewed and three being interviewed in the end.

The interviews showed promising results for several elements of the project prototype. However, many of the tools and features needed to be streamlined or changed to achieve better usability and adherence. Streamlining the whole project prototype was a key outcome of the interviews, with a need to make the use of the app as effortless as possible, for this a widget tool was added to ease the manual data entry into the alcohol diary. Presentation of data to the user was also improved, by giving the user tools to customize

the presented data and graphs. These changes were refined and implemented to the final digital visual representation, with a video presentation that presented all the features of the project prototype. The final project prototype, the video and all the research material were collected into a portfolio and then delivered to the customers for evaluation. The customers were satisfied with the results and deemed that further research and development was worth exploring.

Figure 3 presents the early project prototype and its features and elements. These features and elements were the results from the project team's internal research, testing and analysis. These prototypes were printed onto paper and presented during the project interview sessions.

Figure 3. Project prototype example of baseline and goal setting, notification and information delivery with an avatar.

Figure 3 shows the use of goal setting on the left most image. With it, the baseline of consumption is set by the user, followed by the desired reduction goals, along with the timeline the goals are aimed to be reached. This gives the user something to strive towards and also allows for a point of reference to follow the development. Middle screen in Figure 3 shows the app sending the user a notification. In this example the notification is a congratulatory message to the user for achieving a goal they previously set for themselves. Notifications and reminders are important for the longevity and adherence of a mHealth app. The rightmost screen depicts the use of an avatar (in this project prototype a doctor figure) presenting the user's progression towards their goals, with their goal and current progress presented side-by-side. The avatar can be used to deliver various kinds of information and positive messages to boost the user's motivation and engagement.

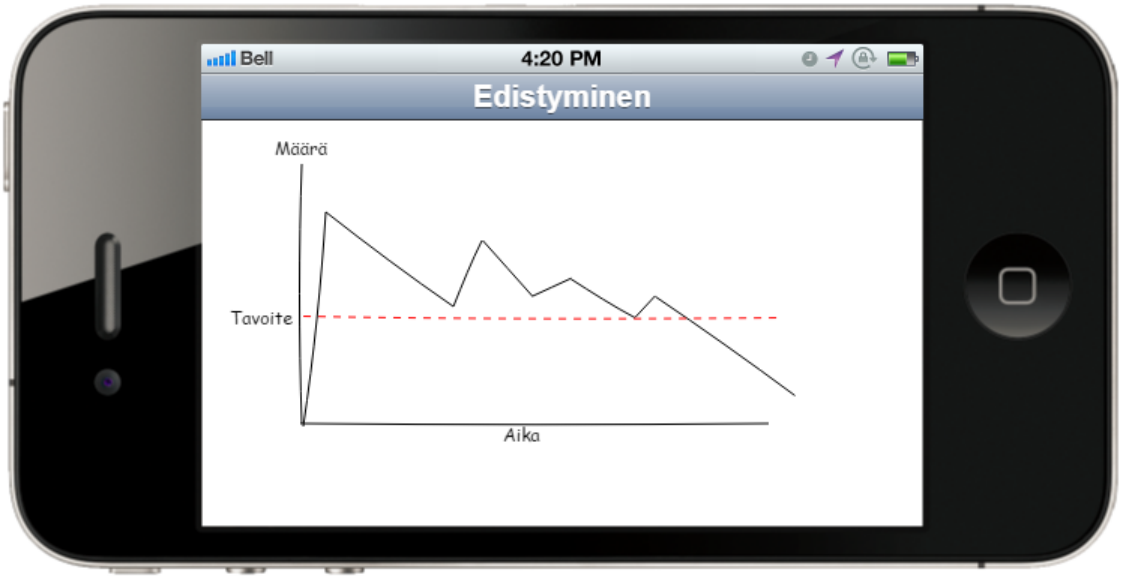


Figure 4. Example graph from the project prototype depicting progress of the user from their self-monitoring data.

Figure 4 shows the graphical presentation of the data gathered by self-monitoring from the user. The project prototype included various styles of graphs and charts depicting the progress of the user. This example depicts a line graph with progression of time on the x-axis and alcohol consumption on the y-axis. The red line represents the goal number of consumption the user set in goal setting. This was the first version of the project prototype, which was tested in interview sessions. Based on the feedback from the interview sessions, the final project prototype was created, and it is presented in the next chapter.

4.1.1 Final version of the project prototype

The final project prototype was developed based on the project interview feedback from the earlier project prototype version. The final project prototype is presented in this chapter along with its new and improved features. The project prototype was created with Proto.io online app designing tool. Full use of Proto.io requires purchasing the program, but a 15-day free trial period was used to create the final version.

Figure 5 presents the updated versions of goal setting and progress update. The project prototype includes some small adjustments to improve on the first project prototype. Along with having been adapted to the new interface and look of the app.

Figure 5. Revised versions of goal setting (on the left) and a progress update from an avatar (on the right).

Figure 5 shows, on the left, an image depicting the revised goal setting feature. The image shows options to what the user wants to set as their goal for the alcohol reduction. The goal setting options allow the user to set a baseline for their desired alcohol consumption level and a time span for achieving this. On the right side of the figure is the progress screen where the current consumption is compared to the set goal, with an avatar providing motivational messages in the middle.

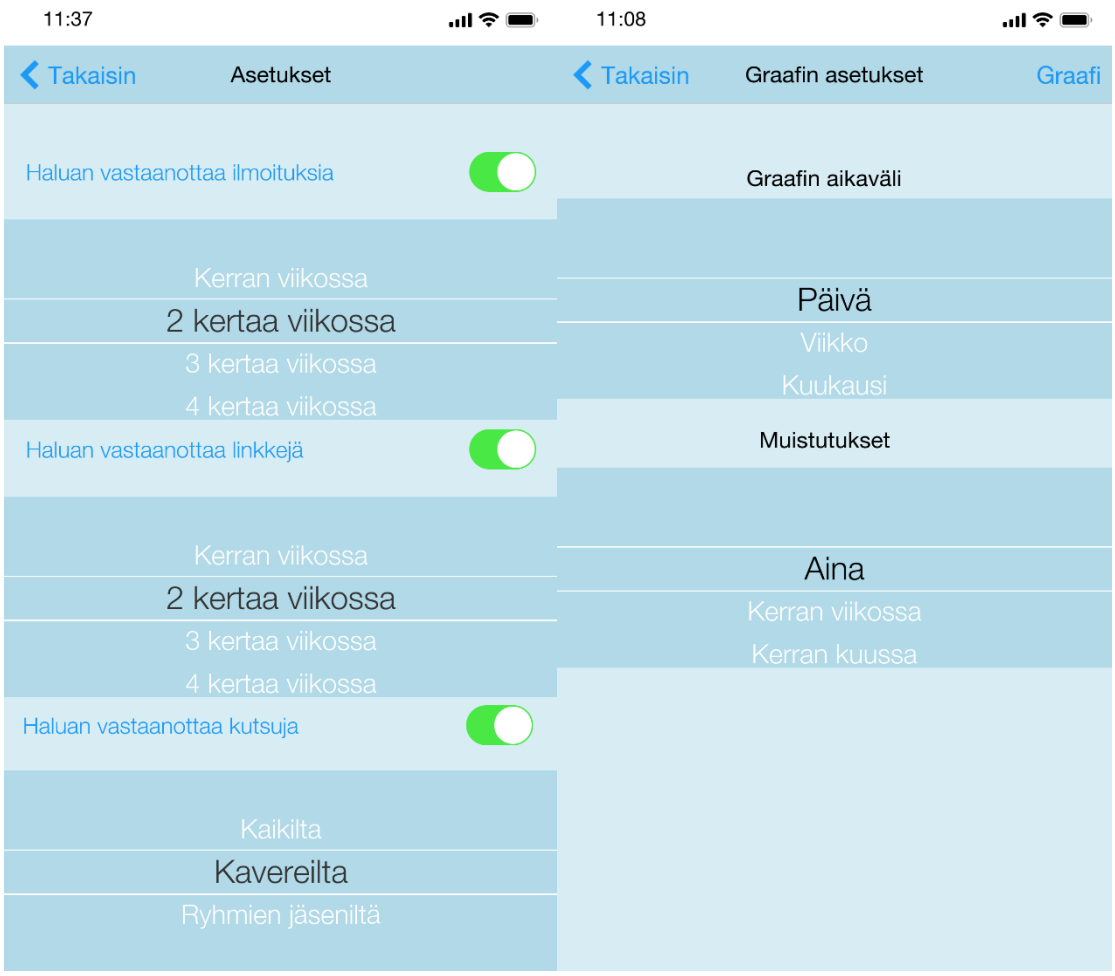


Figure 6. Added customization options with options to set schedules for notifications (on the left) and the graph creations options (on the right).

Figure 6 depicts, on the left, the new personalization options to the notifications. The green buttons offer the option to turn notifications off entirely, while the blue lines provide an option to choose how often they wish to receive notifications, informative links and social invitations. During the project interviews the value of reminders and notifications was appreciated, but the need for personalization options was also pointed out. The right side of the image presents the options for creating a personalized graph of consumed drinks. Options for the graph include timeframe (days, weeks, months) and how often the user would like to receive these graphs from the app. Graphically displayed data was also highly appreciated in the project interviews, but as with the reminders, the option to personalize them and generate own graphs was wished for and therefore added to the project prototype.

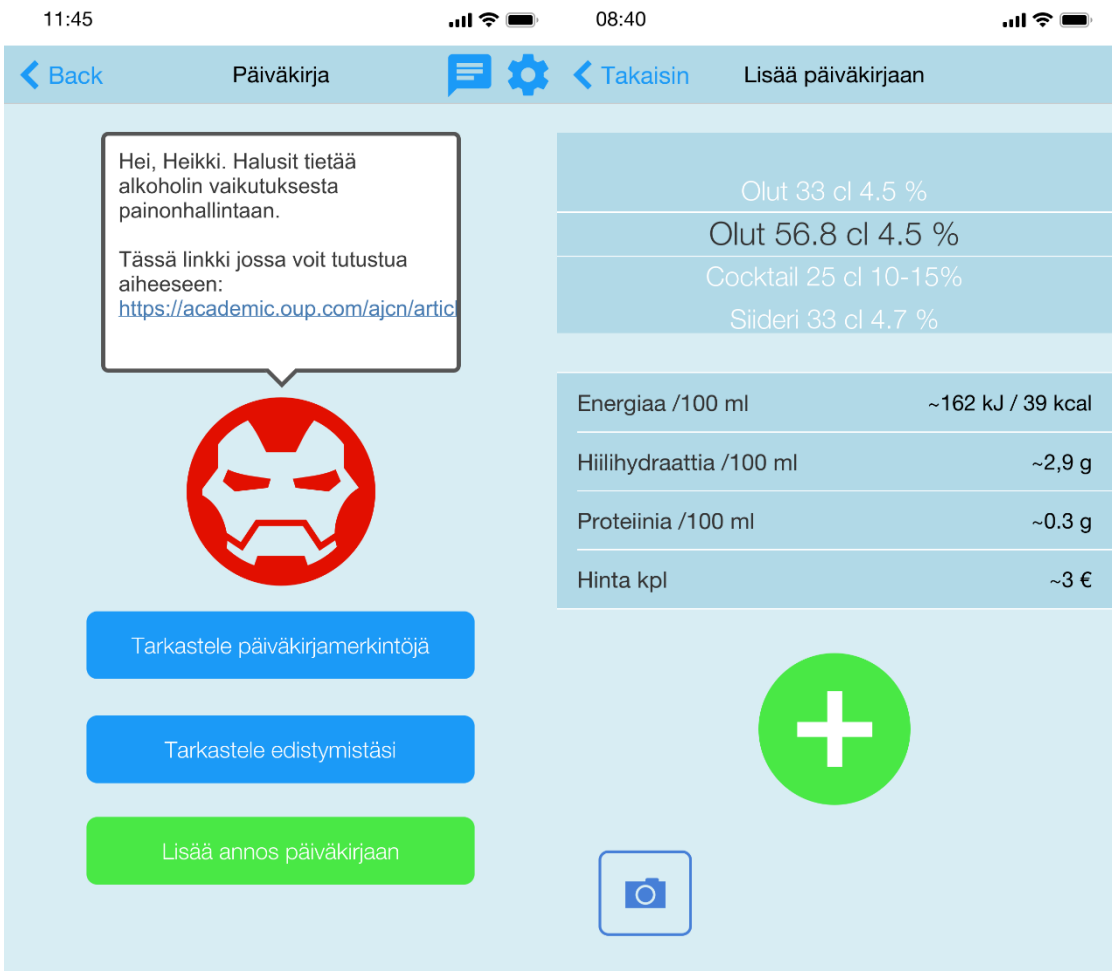


Figure 7. Diary feature with main screen (on the left) and screen for adding drinks (on the right).

Figure 7 depicts, on the left, the main screen of the diary feature. The main screen has the avatar greeting the user and offering some information and links to scientific material related to reducing drinking. Below that are buttons for viewing the diary and the progress information and a button for adding an occasion of drinking to the diary. Figure 7 shows on the right adding of a drinking occasion to the diary, with the top part of the screen suggesting "favourite" or commonly consumed drinks. The middle part includes information about the drink, with energy, hydrocarbon, protein, and price information. The big green button near the bottom adds the chosen drink to the diary. There is also an option to add a picture of the occasion of drinking with the camera button at the bottom.

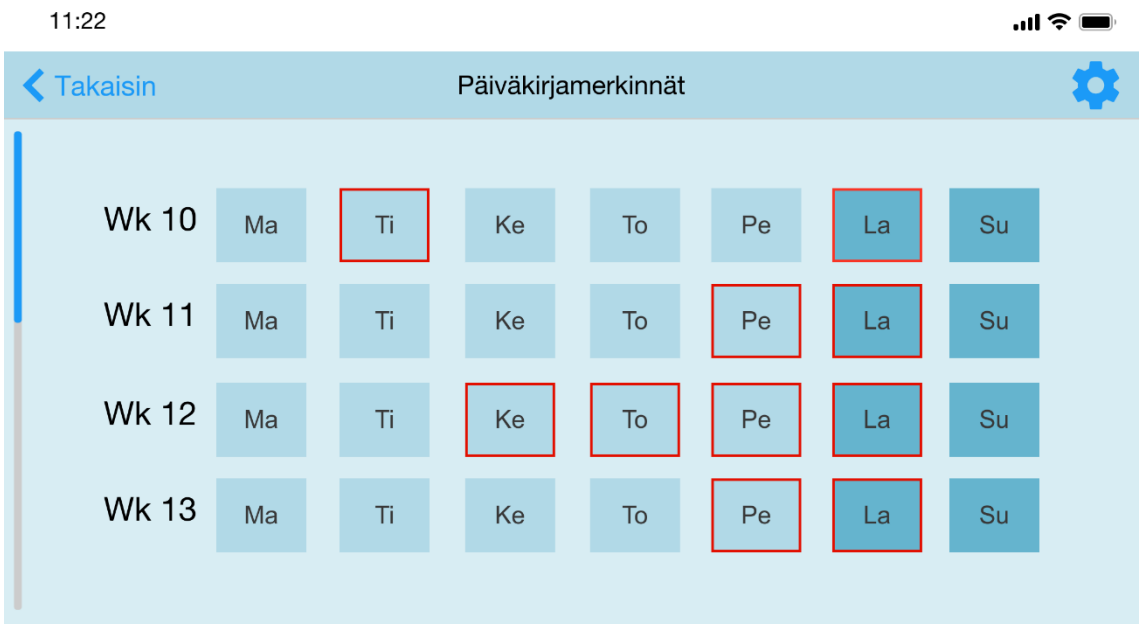


Figure 8. Calendar view of the diary feature, the highlighted dates include self-reported drinking occasions.

In Figure 8 the calendar view of the diary is visualized. In the calendar the current month is shown, with the dates of self-reported drinking highlighted. By clicking the dates, the user may view the drinks consumed on the highlighted dates or add occasions to dates retroactively.

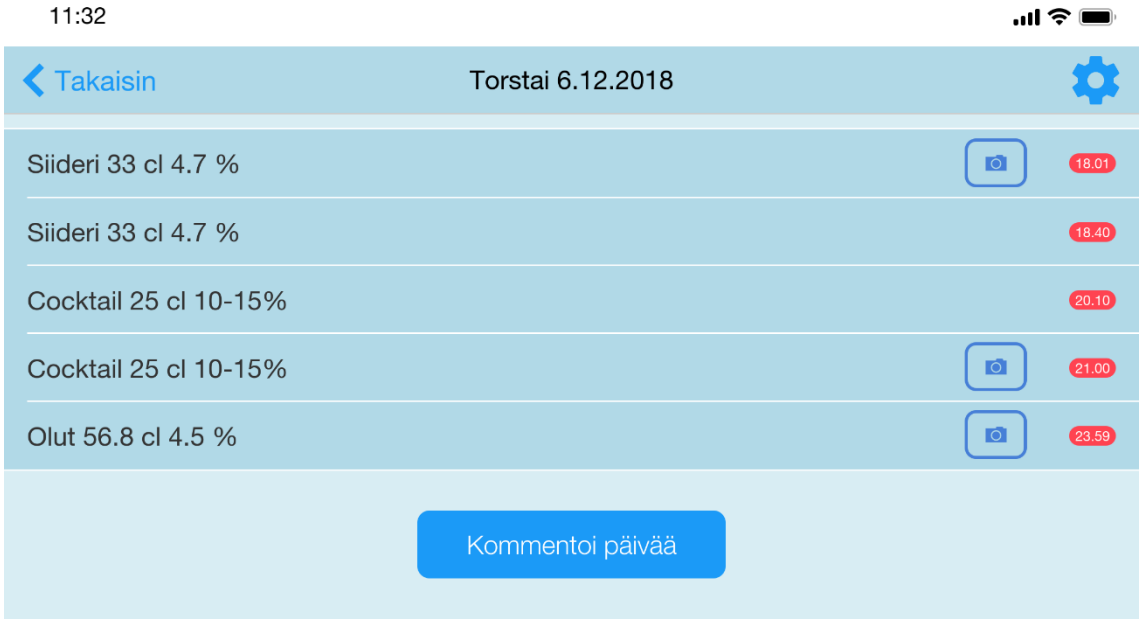


Figure 9. Diary feature with a day view from the calendar feature, displaying the drinks added on a specific date.

Figure 9 depicts the view of a single day from the diary. The screen shows the date and the drinks recorded on that date, with timing of those drinks. The screen also shows the camera button for the drinks that have images attached to them. The big button on the bottom offers the user the possibility to comment on that date.

Figure 10. Widget features added to ease-of-use of the app, with quick drink adding widget (on the left) and informative notification/reminder (on the right).

Figure 10 demonstrates the addition of a widget feature to the project prototype to provide a faster way to add drinking occasions. Streamlining the recording of drinks was a highly requested feature and addition in the interviews. Thus, the use of a widget was implemented to allow the user to add an occasion of drinking from the main screen of their mobile device, without having to open up the entire app. The widget screen presents the most consumed beverages, so the user may add them to the calendar with a single click. Figure 10 also shows how informative notifications pop on the user's screen without the user needing to open up the app separately.

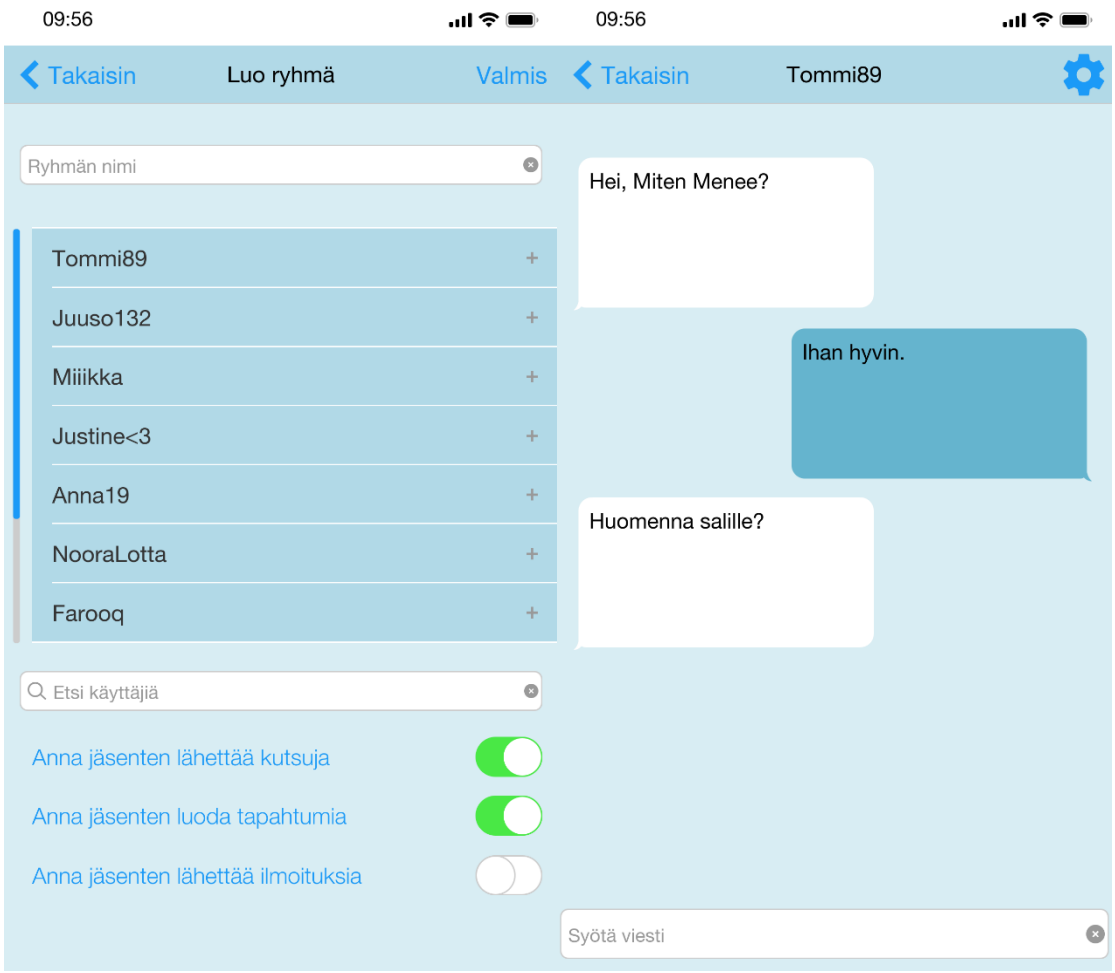


Figure 11. Social features with group creation (on the left) and chat feature (on the right).

Figure 11 showcases the social possibilities of the project prototype. The left side of the image shows the creation of a group, with the name of the group filled in at the top and suggested people for the group shown in the middle. There is also a search function to find users to add to the group. Groups were intended to be supportive in, where users could support each other and engage in discussion about the topic of reducing drinking. At the bottom are three buttons to select whether other group members may invite more people or create events for the group or for other members to send notifications to the group. The right side of the image shows a simple chat feature, where the users may communicate with other users. This was the project prototype that was utilized as the basis for the design prototype, the development of which is described in the next chapter.

4.2 Development of MyLimits

The development process of MyLimits followed the DSR cycles set by Hevner et al. (2007), with the background research refreshing and refining the understanding of the current knowledge base, with the use of the *rigor cycle*. The *design cycle* was then engaged with the development of MyLimits in Proto.io. In development of MyLimits, the design, processes and innovated features, could be tested and evaluated with proper tools allowed by Proto.io. These tools allow the design prototype to simulate a mobile environment, to test features such as user interface and navigation. With the interviews, the *relevance cycle* was engaged, to produce field testing with members of the target audience. These interviews also helped to evaluate the design, along with the innovated

features. As this study focuses on adherence in mHealth apps and a study by Kelders et al. (2012) reports that the effect of social features on adherence is unclear, the social features from the project prototype, were elected to be left out of MyLimits.

Young adults were chosen as the target group for the app, as they are likely to have issues with their personal limits in relation to alcohol. Younger people also have higher acceptance of low-threshold mobile health applications, than older people. This acceptance is especially high towards health behaviour change apps among university students (Messner et al. 2019). Despite having young adults as its target age group, MyLimits is designed and developed so it can be usable by anyone.

The main functioning of MyLimits follows the designs of the project prototype in close detail. As with the project prototype, MyLimits starts with setting the user's baseline of alcohol consumption, along with the goals for reduction. The left side of Figure 12 depicts the welcome screen of the application, where the avatar explains to the user the functioning and goals of MyLimits. While the goal of MyLimits is to reach a conscious level of drinking, it also provides a possibility to use the app only to monitor the user's drinking levels, without the intent to reduce the drinking. Figure 12 displays on the right side the main screen of MyLimits, that is near identical to the one in the project prototype, with navigations to settings, add a drink, my diary and progress pages.

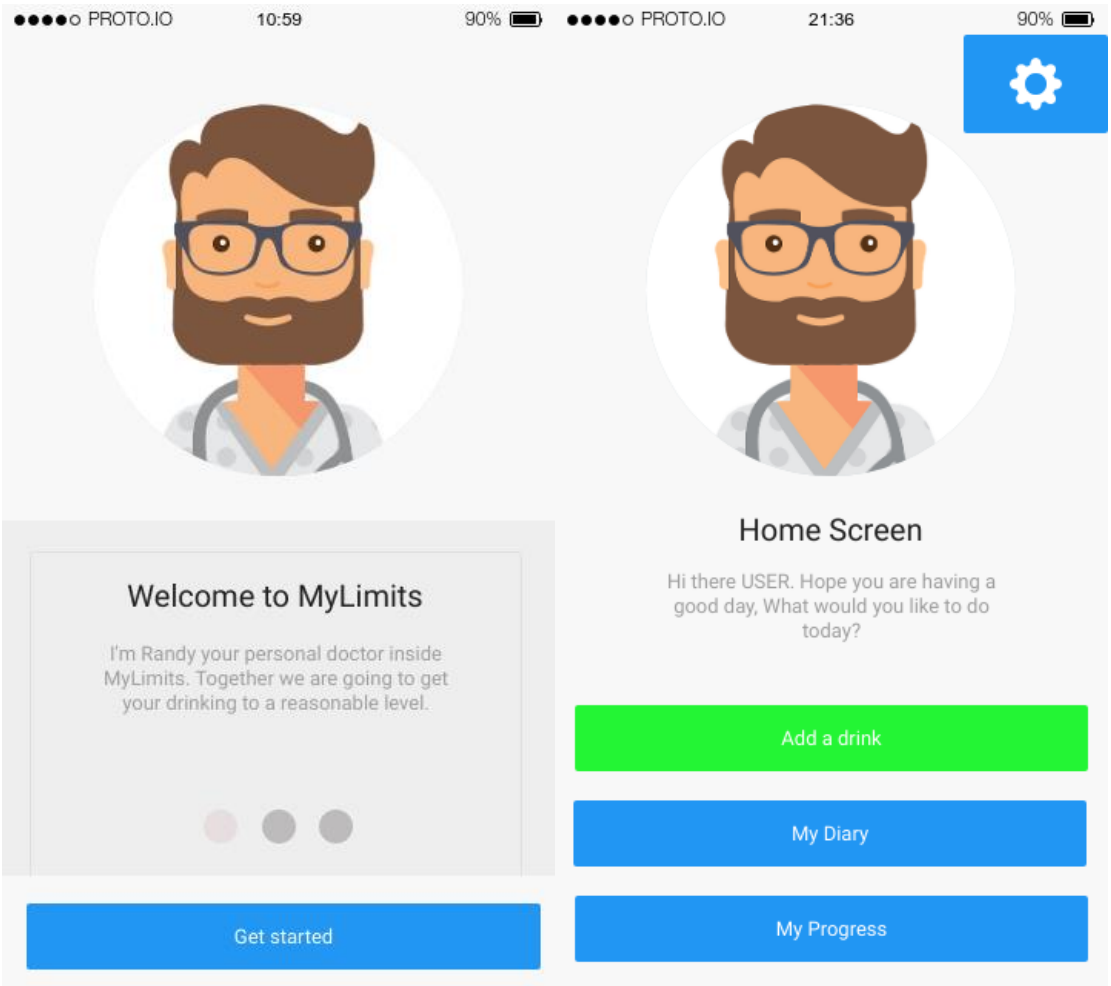


Figure 12. Introduction screen to MyLimits on the left and the main screen of the prototype on the right.

Study by Kelders et al. (2012) found that tailoring and personalization is widely recognized as being important in health communication. Reminders were also found to be an important tool for increasing adherence and effectiveness of the intervention. This was also confirmed in the project interviews for the project prototype. Additionally, in contrast to the project prototype, MyLimits allows for further tailoring with settings and choices of limiting and changing the tools of the app, such as reminders, check-ups and the widget mode. Some form of reminders have been included in the design since the project prototype.

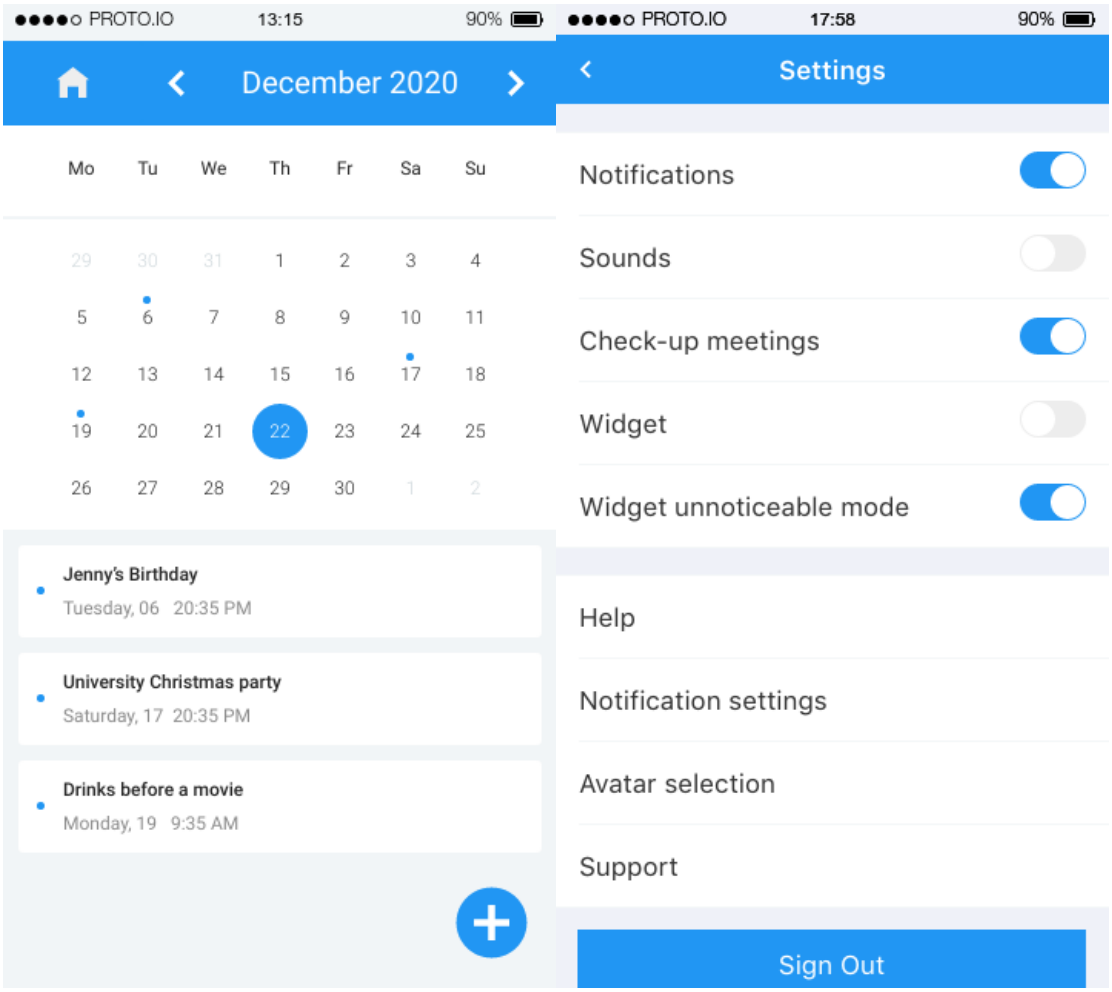


Figure 13. Unnoticeable widget mode with text (on the left) and with icons (on the right).

As the development of the design prototype focused on the new innovations, some features utilized template pages, taken from the libraries of Proto.io. They were included in the design prototype, to demonstrate the intended functionality of MyLimits in the interview sessions. The calendar page (Figure 13, on the left) uses a template calendar page from the libraries, with minor adjustments to maintain context to the app and navigational functioning. The settings page (Figure 13, on the right) was the only addition after the project prototype, besides the innovated features. Settings page was used to illustrate the customising options MyLimits offers, by allowing the user to turn off features like the notifications or the new innovated features. This concludes the features developed from the basis of the project prototype, in the next chapter the newly innovated features are presented.

4.2.1 DSR innovations for MyLimits

For this design prototype, MyLimits, two new features were innovated. The innovated features were:

1. Widget unnoticeable mode.
   1.a. Version 1 utilizing coded text.
   1.b. Version 2 utilizing icons.
2. Check-up meetings with a chatbot.

The first innovated feature was an option to change the widget feature to a more unnoticeable mode, for cases where users might feel embarrassed or shamed to use the app in public. Two versions of the unnoticeable mode widget were developed, with one utilizing code language and other one icons to hide the purpose of the widget. Second innovated feature was check-up meetings with a chatbot, to track the user's progress and feelings about their progress.

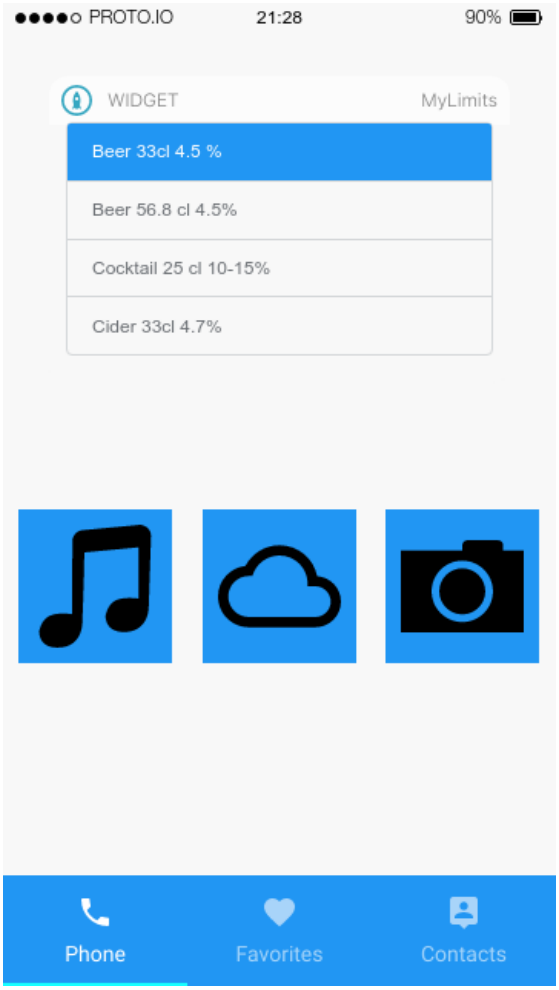


Figure 14. MyLimits version of widget feature.

Widget was a feature, that surprisingly was not mentioned in any of the existing backgrounds studies. This was especially interesting, because ease-of-use and the tediousness of monitoring is a great challenge with behaviour change apps, and widgets can help solve both of these challenges. Based on this, the adding of drinks could be more streamlined and faster, adding to the ease-of-use without the user having to load up and open the entire app to just add a single occasion of drinking. Widget idea from the project

prototype (Figure 14) was already a good quality idea, but to add new value to the idea, the unnoticeable mode option was invented for it.

Studies have shown the effect of shame and social stigma on alcohol relates apps, presenting that users would be cautious to use alcohol reduction apps in public situations (Ashford et al., 2019; Attwood et al., 2017; Meredith et al., 2015; Sawares et al., 2017; Weaver et al., 2013). To solve this, the idea was to allow a version of the widget feature to hide the context of what it was used for. This was so the user could use the feature, without bystanders understanding what the user was actually doing. The first version, depicted on the left side of Figure 15, utilizes code language to hide the meaning of the options. In this example the options include generic sentences in place of the alcohol drinks shown in Figure 15. Intention behind this is that the user assigns drink values to the option sentences, and they can use the generic sentences to add a drink to the diary. The hope with the generic sentences is to hide the true context of the widget, so bystanders would be less noticing of it. This way, in case the widget is noticed by others, the user could pretend that it is a reminder or a memory, thus hiding the actual more sensitive nature of the app. Second version shown on the right in Figure 15, works on the same intent of hiding the meaning of the widget, but behind the use of icons. Similar to the text-based version, the user assigns values to the icons and when they are pressed the app adds an occasion of drinking to the diary with the drink assigned to the icon. These two versions will be evaluated in the interview sessions, to see if potential users will engage more with the text based or with the icon based unnoticeable widgets.

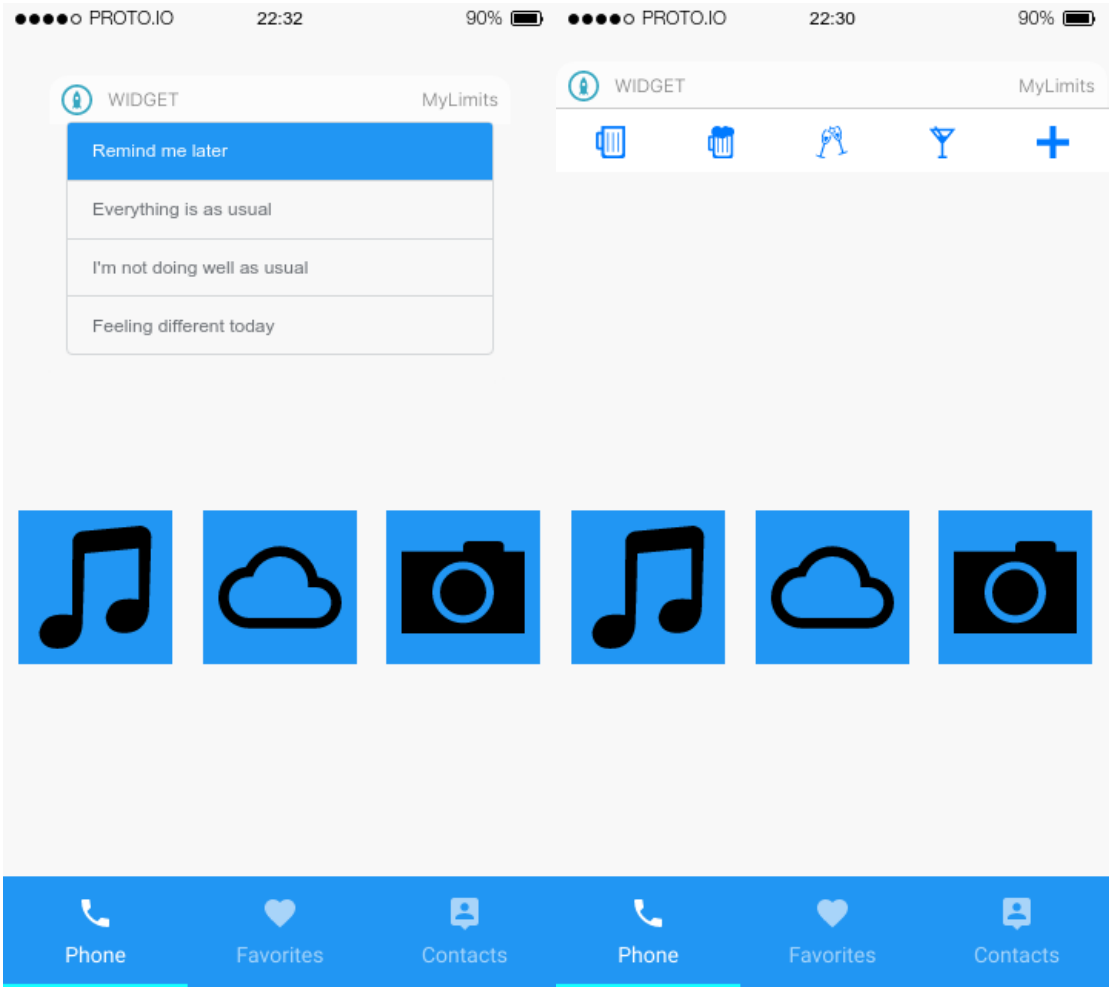
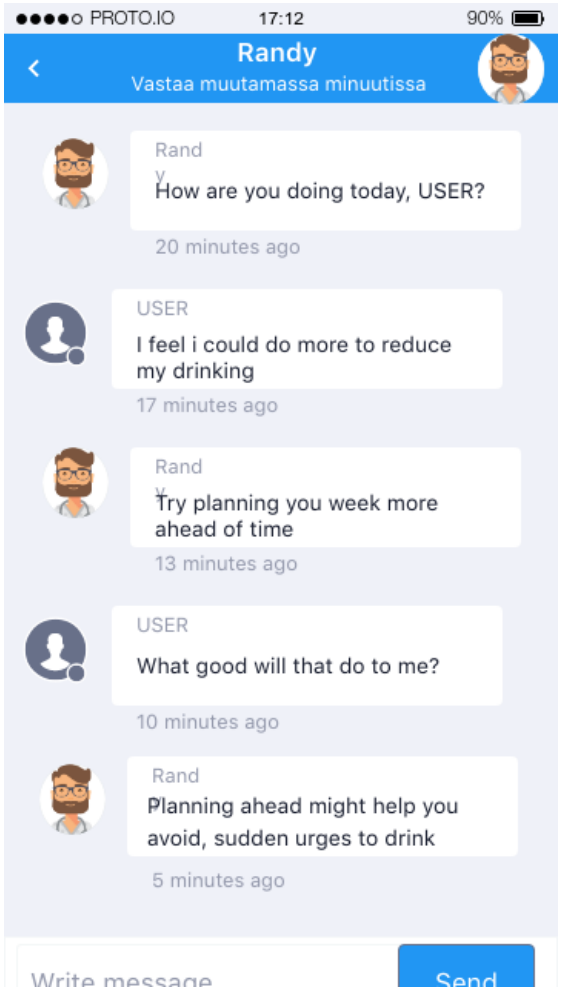


Figure 15. Unnoticeable widget mode with text (on the left) and with icons (on the right).

Kelders et al., 2012 found in their study that frequent visits and communication with a health counsellor were a significant predictor for adherence. Adding that, regular face-to-face sessions paired with eHealth solutions produced the best results in adherence. This idea was the basis for the new innovation feature of check-up meetings with a chatbot. In the new feature a chatbot would be equipped to the app, to allow real-time, responsive interaction with the app. As MyLimits is designed and intended primarily young adults but it is also available for other people, deploying actual health counsellors for every user is just not feasible or realistic. The discussions with the chatbot could be done in regular intervals, weekly or once a month, depending on the user. The chatbot would engage the user in a chat and enquire about how they are doing with their drinking and progression with the app. Previous studies have used similarly time-framed surveys to engage the user on their progress. The idea behind using a chatbot instead of a survey, would be to allow real-time engagement for the user, instead of the same repetitive survey each time.



Figures 16. Check-up meeting with a chatbot, represented by the avatar.

The chat would also allow the user to engage the bot with possible simple questions about alcohol usage and reducing consumption of alcohol. The intention is that the check-up meetings would provide a more individual and personalized update on the progress, compared to the surveys. The chat with the bot is able to provide support, encouragement and praise when they are needed, as well as being able to answer some rudimentary questions the user might have. Hope is that this increases the user's engagement with the app and therefore improves adherence. The interviews are used to engage the target audience and study the possible intertest for the proposed chatbot feature. The chatbot feature is demonstrated with an example in the Figure 16.

4.2.2 Avatar options

The use of avatars has been a topic of discussion from early parts of the project course. In the studies for the project course, the project team found avatars to be a quick way of engaging with an app. Kelders et al., 2012 highlight the importance of engaging with the app and how it is highly advantageous for the adherence of the app. However, the context of the avatars remained a constant discussion through the process from the project course to this thesis, so it was decided that it should be tested in the interviews. The hope with the avatars was to increase the user's engagement with the app, which would further increase the adherence of the app. Especially in conjunction with the chatbot, it was hoped that avatars would give the chatbot an image for the user to connect with. The images for the avatars used here were freely available images from Pixabay.com.

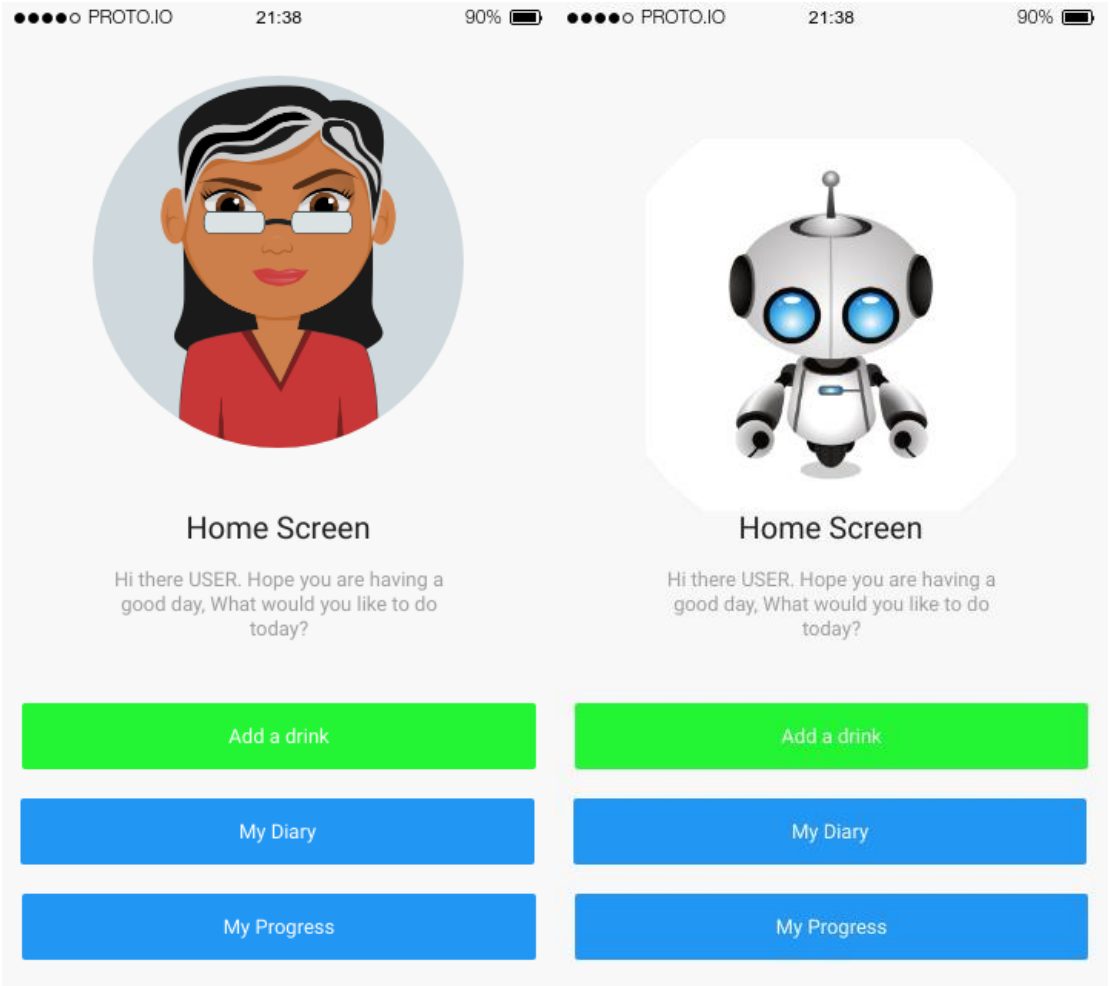


Figure 17. Options for avatar with a female avatar (on the left) and a robot avatar (on the right).

The doctor avatar was used in the design prototype of MyLimits as seen in Figure 12. Two alternative versions of the main screen were made to demonstrate the optional avatars: the female human shown on the left in Figure 17 and the robot figure shown on the right. It had to be considered whether the avatars should be presented before or after the demonstration of the design prototype in the interview sessions. Presenting them at the beginning would allow the user to use the avatar they wanted for the duration of the presentation, whereas at the end the user would understand the overall context and functionality of the app before choosing their preferred avatar. One of the goals/intentions of the interviews was to find out which avatar the interviewees thought would be best suited for MyLimits. Thus, it was decided to present the avatars only after the introduction

of the app, so the interviewees would have full understanding of its operations/features. This concludes the description of the interview process, with the next chapter discussing the results of the interviews.

5. Evaluation

This chapter describes the evaluation phase that took place after the development phase. The data was gathered from the two interview days held in mid-December 2020, with five interviews being performed. The results were evaluated, by profiling each of the interviewees, by their drinking history and their answers. This data was entered into tables and evaluated further. This chapter is divided into five chapters discussing different topics from the interviews. Chapter 5.1 discusses the personal experiences the interviewees had with behaviour change apps. In chapter 5.2 the experiences and need for an app like MyLimits are discussed. Chapter 5.3 focuses on the DSR innovation of unnoticeable widget modes. Chapter 5.4 includes the findings for the DSR innovation of check-up meetings with a chatbot. Chapter 5.5 focuses on the interviewee's reception of the avatars.

5.1 Personal experiences with behaviour change apps

At the beginning of the interview sessions, the interviewees were asked about their history of alcohol consumption. Based on this the interviewees were profiled, with a title suiting their background with alcohol.

Table 3. Interviewee's responds to the first section of the interview.

Profiling name	**Non-Drinker**	**Ex Heavy Drinker**	**Experimenter Drinker**	**Social Drinker**	**Casual Drinker**
Drinking history	Doesn't drink	Six years sober, used to drink heavily	Doesn't drink, has been drunk twice	Socially drinking once every two months. Sometimes sauna drinks	Considers normal, drinks socially and to relax
Experience with behavior change apps	Experience with some non-alcohol related apps	Familiar with activity bracelets.	No experience	"Tested some, but not for long periods"	No experience
What makes mobile apps more useful than others	The basic thing that its always with you and it is easy to mark down.	Not asked	Not asked	It is always available and with you.	You carry it with you always.
Time spent with BC apps	Quick tests, with some for longer, even years	Faded after instructed use period	Not asked	Apps in use maximum of week	Not asked
Most important value for adherence	"General ease-of-use and user's personal needs"	Not asked	Not asked	Matching the user's needs	Not asked
Why stopped using	Lost interest	Just faded off	Not asked	"Just forgot and never bothered to return once forgotten"	Not asked

As seen in Table 3, out of the five interviewees two (Experimenter Drinker and Casual Drinker) have no experience with behaviour change applications. Ex Heavy Drinker was interested in alcohol related behaviour change apps but was not familiar with them beforehand. He had had personal experience with activity bracelets, which he had used as a part of a recovery program, but the use of the bracelets faded fast after the instructed recovery period. Non-Drinker and Social Drinker had personal experience with behaviour change apps, not alcohol related however, that they had searched by themselves. Non-Drinker had experienced some apps, with time used ranging from days to even years. Social Drinker had tried several apps, but none of them had lasted over a week. When enquired about the most important attribute for engagement and adherence, both Non-Drinker and Social Drinker mentioned how the app should match the needs of the user. Additionally, Non-Drinker mentioned the value of "*general ease-of-use*" with the app. Finally, the reason for stopping the use of the apps was losing interest or just forgetting to use the app. Social Drinker stated that he "*Just forgot and never bothered to return once forgotten*" to the behaviour change apps that he was using. In the following chapter the core features of MyLimits are evaluated.

5.2 Need for the design prototype, MyLimits

General feelings and thoughts on the design prototype of MyLimits were positive, and all of the interviewee's saw value in such an app existing. Ex Heavy Drinker stated that he really loved the idea and would have definitely benefited from using such an app back when he still drank regularly. He stated: "*I think this is a good idea, definitely something if I had it six years ago when I was drinking, I definitely would have used it every day*". Social drinker stated that the design and functioning was really good and innovative and if such an application would be available for smoking, he would be interested in testing it out.

Ex Heavy Drinker was interested in the future potential of MyLimits, stating: "*in Scandinavia there might be a need for something like this* (referring to MyLimits), *even with our services such as alcohol clinics, but especially in somewhere like China and India where the ratio of alcohol users compared to the amount of consultation available does not meet*". Thoughts like these indicate the desire to see an app with the basic features of MyLimits in the market, with the newly innovated features evaluated next.

5.3 Widget unnoticeable mode

The widget feature received similar positive attitudes as rest of MyLimits. Social Drinker really liked the idea of a widget to ease the process of adding drinks to the diary. The unnoticeable modes also received praise for their creativeness. The possible need for them was well understood and Experimenter Drinker, Social Drinker and Casual Drinker, pointed out how they could be useful for users who want to hide their use of alcohol reduction apps. Experimenter Drinker stated: "*there is a lot of social pressure in drinking situations and this solution could be useful*", referring to the widget and its unnoticeable mode options.

Table 4. Interviewee's thoughts on the widget feature and the unnoticeable mode.

Profiling name	**Non-Drinker**	**Ex Heavy Drinker**	**Experimenter Drinker**	**Social Drinker**	**Casual Drinker**
Opinion on widget feature and the unnoticeable mode options	Not asked	Not asked	Understands there is a lot of social pressure in drinking situations and this solution could be useful	Really likes the idea of using a widget. Unnoticeably mode also probably very useful for some people	"Clever idea, to keep it quick and unnoticeable modes allow to hide the act."
Preference on icons vs text widget	"Icons. They are more minimalistic and take less space from the screen"	Icons. They are easier to remember, but might be easier to recognize by others too	Icons	Icons. Personal preference that widget takes as little space as possible.	Icons, thinks they are easier and faster to identify.

The discussion between the two different unnoticeable modes in the interviews followed the presentation of the widget feature (results in table 4). Out of the two different types of modes, text based and icon based, the mode using icons was clearly more popular among the interviewees, with all five choosing it as their preferred version of the unnoticeable mode. Two main benefits identified from using the icon based unnoticeable mode were that icons are more intuitive and easier to recognize, and that they require less space on the screen. Casual Drinker stated that "*they are easier and faster to identify*". Ex Heavy Drinker continued about the icons: "*they are easier to remember but might be easier to recognize by others too*", adding the concern that outsiders recognize them too. Three of the interviewees (Non-Drinker, Social Drinker and Casual Drinker) directly stated that they prefer the widget to take as little space as possible. Casual Drinker directly stating that icons "*are easier and faster to identify*". Icons being faster to identify was also mentioned by Ex Heavy Drinker and Casual Drinker. Widget unnoticeable modes were the first new innovation to MyLimits, with the check-up meetings with a chatbot being the second and it being discussed in the following chapter.

5.4 Check-ups with a chatbot

Following the widget discussions in the interview the innovated check-up meetings with a chatbot were presented for discussion. Check-ups with a chatbot received mixed results in the interviews. Thoughts of the interviewees on the chatbot feature are presented in Table 5.

Table 5. Discussion results on the check-up with a chatbot.

Profiling name	**Non-Drinker**	**Ex Heavy Drinker**	**Experimenter Drinker**	**Social Drinker**	**Casual Drinker**
Thoughts on chatbot	"Interesting idea and depends on the execution and how engaging the bot can be. If it is repetitive it can turn out boring, but not everybody has someone to talk to about this."	Would be willing to use and has no issues with A.I solutions.	"Sounds superficial and even cringy, to open up to a bot." "Could make more sense with the robot avatar."	"I would prefer talking to a real person but prefers this over weekly questionnaires."	"Sounds good, would think the possibility for the bot to link up to real help in cases of really difficult times on the user. Positive encouragement and feedback really important when trying to achieve change in life."

Ex Heavy Drinker and Casual Drinker were the two most positive about these check-ups. Ex Heavy Drinker was right away open to try such a solution stating: "I *would be willing to use and has no issues with A.I solutions*" highlighting the lack existing bias against the chatbot. Casual Drinker thought the concept "*sounds good*" and highlighted the potential for "*the possibility for the bot to link up to real help in cases of really difficult times on the user*", adding the positive possibilities the chatbot might enable. These possibilities could include things like the app contacting actual health personnel or family members, in case the user is really expressing destructive behaviour. Casual Drinker also noted the positive value of positive encouragement and feedback in behaviour change by stating: "*Positive encouragement and feedback really important when trying to achieve change in life*". Social Drinker stated that he would prefer talking to a real human over a chatbot by saying "I *would prefer talking to a real person but prefers this over weekly questionnaires*", however adding that the check-ups do sounds more engaging than weekly surveys mentioned in the existing literature apps. Non-Drinker was on similar path, feeling interested, but stating that it is mainly up to the execution for it not being boring and unengaging. Experimenter Drinker was pessimistic about the whole concept of using a chatbot stating, how it "*sounds superficial and even cringy, to open up to a bot*", however, later in the interview he admitted that if the app used the robot avatar, the chatbot feature would make more sense. To expand on this, the avatar discussions are described in the next chapter.

5.5 Avatar discussions

Discussions about the use of avatar in MyLimits was the final topic in the interview sessions. Results of these discussions are shown in Table 6. First the interviewees were asked on their opinion on the doctor avatar, before being presented with the optional avatars of the female avatar and the robot avatar. Opinions on the doctor avatar were mixed. Social Drinker was the only one to react positively towards the doctor avatar, finding him "*friendly looking*".

Ex Heavy Drinker had "*No special opinion but has no problem with doctor figure*", whereas Casual Drinker found the doctor little uncomfortable, stating "*doctor little uncomfortable as it reminds more of disease or dentists*". Non-Drinker stated that the doctor feels too "*Feels official and would prefer a more of a "buddy" feeling from the avatar*". Experimenter Drinker disliked the avatar, based on the look of the character, stating "*not like because of his beard and shape of face*".

Opinions on the female avatar were positive, with Ex Heavy Drinker stating that the avatar is good and Casual Drinker stating that the female avatar is a better fit specifying how they "*first thought of a teacher. Suits the app as it is not threatening and makes user feel easy*", highlighting how the female avatar is more approachable. The interviewee's focused greatly on comparing the avatar to different authoritative positions, such as teacher, therapist and psychiatrist, with Social Drinker stating how "*first thought is a therapist or psychiatrist. Some might be more ashamed of going to a doctor than a therapist*". Only negative comment came from Non-Drinker who thought the avatar "*feels like an older lady stalking over your shoulder*".

Final avatar in discussion was the robot avatar. The robot avatar received most praise out of all the avatar options, with all the interviewees stating how well it suits the app. Non-Drinker felt the robot was the most "*relaxed*" and less judging stating how the robot "*feels the most relaxed, like I'm your buddy, you can tell me about your problems.*", which might make it easier for the user to open up to it. Ex Heavy Drinker, Experimenter Drinker and Casual Drinker said that the robot avatar suits the app the best, as it reminds the user that it is an app that is helping and guiding the user. Experimenter Drinker stated how it "*makes the most sense that the robot would watch after you*". Casual Drinker followed the same thought with how the robot "*reminds of A.I and that you are using an app*". Ex Heavy Drinker was on the same line with how the robot "*reminds the user that it is program that is evaluating your drinking and not a real person*", adding the point that the human avatars might lead the user to think there is a human helping and supporting them. Social Drinker added that the robot avatar "*is the most ambiguous and doesn't show others what the app is about*", helping to continue the theme from the unnoticeable widgets of hiding the purpose of the app.

Once the individual avatars had been discussed the interviewees had the opportunity to share their thoughts on the avatars in general. Non-Drinker and Ex Heavy Drinker hoped for personalization options with the avatars. Non-Drinker stated how "*customizing and selection of avatar would be wanted*", with Ex Heavy Drinker commenting in the same line with "*option to choose would be good as personal preferences varies greatly*". This highlighted the want for either to choose the avatar they wanted to use or even to edit the chosen avatar with more options. Experimenter Drinker experienced that "*humans (avatars) feel pretentious*", whereas Casual Drinker stated that he "*Would prefer a human image for following own human values*".

Table 6. Discussion results on the avatars of MyLimits.

Profiling name	**Non-Drinker**	**Ex Heavy Drinker**	**Experimenter Drinker**	**Social Drinker**	**Casual Drinker**
Thoughts on doctor avatar	"Feels official and would prefer a more of a "buddy" feeling from the avatar"	No special opinion but has no problem with doctor figure.	Does not like because of his beard and shape of face	"Friendly looking"	Finds the doctor little uncomfortable as it reminds more of disease or dentists
Thoughts on female avatar	"Little different, but feels like an older lady stalking over your shoulder"	Good	"Reminds of a therapist."	"First thought is a therapist or psychiatrist. Some might be more ashamed of going to a doctor than a therapist"	"First thought of a teacher. Suits the app as it is not threatening and makes user feel easy."
Thoughts of robot avatar	"Feels the most relaxed, like "I'm your buddy, you can tell me about your problems". Less judging than the doctor so it might be easier to open up to the app."	"Good also, reminds the user that it is program that is evaluating your drinking and not a real person. "	"Makes the most sense that the robot would watch after you."	Really cute robot. Personally, the most pleasing to the eye avatar is the best. Also, robot is the most ambiguous and doesn't show others what the app is about.	"Reminds of A.I and that you are using an app. Also reminds of gaming and such."
General thoughts on the avatars	Customizing and selection of avatar would be wanted.	Option to choose would be good as personal preferences varies greatly	"Humans feel pretentious."	Not asked	"Would prefer a human image for following own human values"

Following the presentation and discussion about each of the avatars, the interviewees were asked to imagine that they were in charge of developing and releasing the app, and which avatar they would in this role/image choose for MyLimits and why. Results of the avatar discussion can be seen in Table 7.

Table 7. Further discussion results on the avatars of MyLimits.

Profiling name	**Non-Drinker**	**Ex Heavy Drinker**	**Experimenter Drinker**	**Social Drinker**	**Casual Drinker**
What would you choose as the avatar for this app?	"Robot at least to begin with"	One of the humans	Robot	"Robot but might change it after using for a while if the doctor works best with the chatbot feature."	"Doctor, even with own hesitation it might be good for the app, for the avatar to present some authority."
Personal favourite avatar	Robot	Female avatar	Robot	Robot	Female avatar

Non-Drinker, Experimenter Drinker and Social Drinker selected the robot as their first choice for the app. Interestingly, all three were the same people who voted the robot as their favourite avatar. Non-Drinker and Social Drinker, however, added that they might change their opinion after using the app for a while. Non-Drinker stated that the robot avatar is best "*at least to begin with*" and Social Drinker adding that "*Robot but might change it after using for a while if the doctor works best with the chatbot feature*". Ex Heavy Drinker and Casual Drinker voted for the female avatar as their favourite but, changed their answer when imagining operating as a developer of the app. Ex Heavy Drinker could not decide between the two human avatars, so he answered: "*one of the humans*". Casual Drinker switched his answer from the female avatar to the doctor avatar, even after having heavy apprehensions towards it originally, stating that doctor "*might be good for the app, for the avatar to present some authority*". Following this, the interviewees were asked to name their favourite avatar. Non-Drinker, Experimenter Drinker and Social Drinker chose the robot avatar as their personal favourite and Ex Heavy Drinker and Casual Drinker chose the female avatar. This concludes the evaluation done on MyLimits, with the findings being discussed in the next chapter.

6. Findings and Discussion

The goal for this thesis was to study what makes for an effective mHealth app for reducing and monitoring alcohol. This was done by reviewing the existing tools and approaches in alcohol related mHealth applications. Based on the preceding project prototype and the background studies the design prototype of MyLimits was developed and evaluated with interviews. In depth the issue of how to deal with adherence in mHealth apps was studied. As such the following research question (RQ) was formed, with the supplementing sub research questions:

1. What kind of features should a mHealth application for monitoring and reducing alcohol consumption include?
    a. What approaches and tools the existing health applications provide for people who want to reduce and/or monitor their alcohol consumption?
    b. How can mHealth apps plan for adherence in their development?

For this thesis, a design prototype of drinking monitoring and reduction, MyLimits, was created as the Design Science Research design prototype. Using the design prototype along with previous research, preceding project prototype and interview sessions this chapter tries to answer the research question and its sub-questions. This chapter is divided into three chapters. Chapter 6.1 discusses the findings relating to research questions 1a. In chapter 6.2 the findings for the research question 1b are discussed. Finally, in chapter 6.3 the findings for the main research questions are presented and discussed.

6.1 Existing solutions for mHealth

To answer the research questions of "What approaches and tools the existing health applications provide for people who want to reduce and/or monitor their alcohol consumption?", the background studies are reflected on. The existing literature revealed a great field of different existing solutions and apps, that are designed to help people struggling with drinking. The field of mHealth apps is continuously growing, along with it the apps that focus on helping people deal with their alcohol consumption. Study by Messner et al. from 2019 state that 325,000 health apps are available in app stores.

Existing mHealth apps offer a wide variety of features and solutions for people who want to reduce or quit drinking. The design prototype for this thesis, MyLimits, utilizes self-monitoring, goal setting and tracking drinks in its core, along with the invented widget and chatbot tools.

Social features were considered and even included in the project prototype but were left out in the end. The design prototype focuses on adherence. As stated by Kelders et al. (2012) in their study: the effect of social features on adherence are unclear, thus in the end they were elected to be left out from the design prototype.

6.2 Planning for adherence in mHealth apps

Adherence has been noted to be vital for the long-term survival of mHealth and eHealth systems by Kelders et al., 2012. In this chapter the research question of "How can mHealth apps plan for adherence in their development?" is answered, with the help of the background studies, design prototype development and by using data from the interview

sessions. Background studies highlight the value of adherence for the survival of mHealth and eHealth systems. Studies have also shown that adherence has issues in lack of definition for the term itself as well as for individual applications for when their user has been adherent. Study by Kelders et al., 2012 revealed several methods and tools that apps use to achieve adherence, such as segmenting the process to shorter periods and frequent visits to a health professional, that were used as the basis when innovating the check-up meetings with a chatbot. Other key aspects found by Kelders et al., 2012 for adherence were tailoring to allow the user to personalize their mHealth tool and reminders have been shown to increase adherence and effectiveness of the interventions.

Results for the check-up meetings with the chatbot were divisive. Two of the interviewees were really open to the idea of using a bot, even sparring new thoughts on how to grow and develop the idea, with connections to medical help in cases when the user is troubled. Other three interviewees were more hesitant but would be opened to testing it to see how repetitive or boring it might feel.

Riekki (2020) mentioned ease-of-use as a key aspect for user retention and adherence. The widget feature with its unnoticeable modes is designed to improve ease-of-use by allowing users to add occasions of drinking fast and undetected by outsiders. The interview results revealed praise for the unnoticeable widget modes. Three out of the five interviewees understood the value it could bring to those socially difficult situations when the user wants to add drinks to the diary in public. Out of the two versions, code text vs icons, icons were unanimously more popular on the basis that icons are easier to remember and faster to identify while also taking less space from the screen.

Three out of the five interviewees had some level of experience with behaviour change apps, none however related to alcohol. Periods of using the apps ranged from weeks to even years among them. As reasons given for quitting the use of these apps' were of lack of engagement, ending of an instructed period of use and loss of interest. When asked about what the interviewees thought were the most important aspects for adherence in a behaviour change app, both more experienced interviewees answered that the app needed to match the user's personal needs and general ease-of-use is important for them.

It is hard to draw direct conclusions from the data towards alcohol reduction apps, as none of the interviewees had any experience with such apps. Interview results indicate the value of engagement to not allow the user to slip off at the start of using the app. Ease-of use was highlighted by Non-Drinker. Defining a specific way how an application can match a user's personal needs is difficult, but by producing quality features for the features that the app is intended to be used for, therefore maximizing adherence with the users whose needs match the features of the app.

Riekki (2020) too highlighted the value of engagement in successful mHealth solutions to improve engagement and therefore adherence of MyLimits, an avatar was added to the app. There has been no major exploration into background studies on using avatars in mHealth solutions. To test the impact of avatars on the app, three different avatars were tested with: a male doctor, a casual female, and a robot. The female and robot avatars were well liked among the interviewees, with two naming the female avatar their favourite and three naming the robot.

The female avatar received praise for being less threatening than the doctor, however, the female avatar was eluted to different authoritative positions, such as teacher, therapist, and psychiatrist. The robot avatar received praise for how well it suited the application. The robot was seen as the most relaxed and least judging of the options. The interviewees

stated that the robot also made it clear that the user is dealing with a bot, instead of a human. The possibility to choose the avatar was hoped for, as some of the interviewees stated that they might change their preference after using the app a while. Especially the check-ups with a chatbot meetings made the most sense to the interviewees with the robot avatar. This could indicate that the avatar adds a figure for the user to engage with in the chat, instead of a feeling of talking to a blank machine. Based on this, any further studies on the use of chatbots should include some form of avatar to provide the conversation with a face or some level of an image for the user to connect with.

Casual Drinker was the only interviewee to change their favourite avatar to another when imagining themselves overseeing the development of MyLimits. They changed their opinion from the female avatar to the doctor one, wondering if the doctor avatar would present the app with some added authority. Perhaps, indicating that some users need stricter instructions and an authoritative figure to succeed with their alcohol reduction. Despite their personal anxiety about the doctor avatar, they thought starting a change like this would benefit from the authority of the doctor.

Possible limitations for the interview avatar discussions, were the gender differences between the two human avatars. Three of the interviewees praised the female avatar based on their personal experiences with female authority figures, such as teachers, therapists, and psychiatrists. This could skew the results only on the bias towards opening up to women over men, instead of non-doctor over doctor. Further testing with same gender avatars could attempt to remove this bias. Additionally, the avatars were different in art style, so that could also apply a bias towards the avatar that is most pleasing to the individuals' eye, over the values that the avatar represents. Finally, all the interviewees were open to talking about their drinking and none of them admitted to currently having issues with drinking.

6.3 Features for an mHealth app for monitoring and reducing alcohol consumption

In this chapter, the mHealth app MyLimits is discussed regarding the main research question of this study and the existing background literature. The main research question of "What kind of features should a mHealth application for monitoring and reducing alcohol consumption include?" was set for this thesis. Based on an existing project prototype, a mHealth app was designed to support people who want to reduce their drinking. This project prototype was developed based on existing mHealth solutions. As a part of this thesis, two new features were innovated for MyLimits, in form of unnoticeable widget modes and check-up meetings with a chatbot. MyLimits was evaluated and tested in interview sessions with members of the target age group of young adults.

Exploration into the existing literature on mHealth apps resulted in a wide variety of used features and solutions. Study from Tofighi et al. (2019) listed features found from low-cost apps that were designed for tracking of substance use and related consequences (e.g., cost and calorie intake), remote and near peer support based on geospatial positioning and allowing family members to locate treatment programs and mental health services. Other features found by Tofighi in the study were, baseline assessment of drinking patterns, setting personal goals, tracking drinks and urges to drink. In addition to these scheduled notifications, texting, pleasurable alternatives to drinking, and self-monitoring tools are common in mHealth apps (Bock et al., 2014; Attwood et al., 2017; Meredith et al., 2015). Gamification and rewarding the user with different prices are new features that are still

undergoing testing to see their potential in behaviour change (Meredith et al., 2015; Rabbi et al., 2017).

Interviews with members of the target age group highlighted the value of ease-of-use and the tools of the app matching the needs of the user. In this thesis ease-of-use is attempted to be solved with the use of widget features to allow users to register their drinking occasions faster. Studies have shown the effect of shame and social stigma on alcohol relates apps, presenting that users would be cautious to use alcohol reduction apps in public situations (Ashford et al., 2019; Attwood et al., 2017; Meredith et al., 2015; Sawares et al., 2017; Weaver et al., 2013). To solve the issue of social stigma, the unnoticeable widget mode was tested, allowing the user to hide the real purpose of the widget. Out of the two versions created the icon based received much praise from the interviews and it should be explored further.

7. Conclusions, Future Research and Limitations

To conclude; this thesis provided answers to one main research question and two supplementary research questions by developing a prototype of a mHealth app designed to help people monitor and reduce their alcohol consumption, MyLimits. MyLimits was evaluated with semi-structured interviews, using people of the target group of young adults. In addition to the conclusion of this thesis, this chapter includes chapters on suggestions for future research along with the limitations of this study.

The goal for this study was to develop and evaluate the design prototype of MyLimits by using the background studies and interview sessions. MyLimits is aimed for people who want to reduce or monitor their alcohol consumption levels and to guide the user to a conscious level with their drinking. As the Design Science innovations, the features of unnoticeable widget mode and check-up meetings with a chatbot were innovated and tested in the interviews. Reactions to MyLimits from the interviews were highly positive and the hope is that the design prototype gets further development and perhaps even a commercial release one day.

As for the innovated features, the widget feature was well received, but it still requires testing to prove its actual value in a real-world scenario. Especially the icon based unnoticeable widget mode received high praise from the interviews. The interviewees showed interest in the check-up meetings with a chatbot, but it too requires further studying and developing to equip a chatbot with artificial intelligence to be used in personal health application.

Avatars used in MyLimits received praise and the results show that a mHealth app using such avatars, should allow some tailoring for the user to select a preferred avatar. This was due to the varying preferences that the users might have when using the app: where some users might require a more assertive and authoritative presence from the avatar, others might just want a visually pleasing “buddy” to connect with. Avatars were especially useful and valuable in combination with the check-up meetings with a chatbot. In the following chapter the limitations for this study are discussed.

7.1 Limitations

There are limitations that apply to this thesis study. As a thesis is a limited study it was impossible to create a larger long-term testing for MyLimits and to appropriately test its adherence. Therefore, in the interview data was gathered from the interviewees’ previous experiences with behaviour change mobile applications and by having the interviewees imagine situations where they would use MyLimits. Additionally, the if interviewees had no background with behaviour change apps, the topic of adherence was not asked from them. This is a clear limitation and the values and keys to achieving adherence should have been inquired more clearly. The limited number of interviewees was also a limitation for this study. Additional value to studying adherence was brought with the evaluation of the innovated features. On top of this, MyLimits does not contain a definition of adherence. This was left out as the app allows for the user to set their own goals. However, the app could in larger testing benefit from a definition for when the user has been adherent to the app.

As the MyLimits design prototype does not wield an operational chatbot, it would be highly interesting to see further studies and testing done with an operating chatbot. This

would provide the possibility of utilizing chatbot meetings and to measure if they have an effect on the adherence of the app.

When the avatars would be presented in the interview was also discussed. The two options were to present the avatars before presenting the functioning of the app or to present the avatars after presenting the app, which was done in the end. The idea with presenting the avatars last was to allow the interviewees to understand the entire context and use of the app, to fully allow them to reflect on which avatar fits the functioning the best. This presents a possible limitation that they spend the entire presentation of the app with the doctor avatar, which could lead them to becoming preferential towards it. None of the interviewees chose the doctor as their favourite in the end, perhaps indicating that this preferential thinking did not occur.

The role of motivation from the user carries great weight in behaviour change, especially in long-term change for chronic conditions such as alcohol issues. In this thesis motivation of the user was elected to be set aside and focus on accessing the design prototype. However, for adherence motivation naturally plays a great role and it should be accessed in future studies. During the preliminary project course existing solutions in mHealth apps to help reduce or monitor alcohol conception were studied. A notable finding from them was how the goals of the apps varied depending on the motivation of the manufacturer of the app. Abstaining from alcohol has been often linked to religious organizations and beliefs, as well as political groups. During the project this caused caution as it felt in many applications that they were a product of an agenda, instead of an app to help people with a serious issue. Therefore, the aim was to design MyLimits to be accessible to everyone who wish to use it. With the hope that MyLimits gets further development some day, the ideas for future research are discussed in the final chapter.

7.2 Future Research

For future research, the key finding from this thesis is the unnoticeable widget mode. Existing reports on the use of widgets were extremely lacking, compared to the great reception the widget feature received in the interviews. The added ease-of-use enabled by widgets to make the adding of a drinking occasion to the diary as streamlined as possible is a great benefit for the overall engagement and adherence of the app. Additionally, the promising results from the icon based unnoticeable mode, have the possibility to reduce the burden of social stigma and pressure on the subject of drinking. Based on these highly promising results, the widgets could benefit from further testing, especially in a field setting, to see if the streamlined use carries over to the actual situation of a social gathering for drinking.

A potential hinderance for the study could be the limited number of avatars as an option. Even offering a male and female options for the doctor avatar and non-doctor avatar, could have provided different results. It was indicated in the interviews that the interviewees had personal preference of opening up to older women over men. The responds between the human avatars, could be a result of bias towards trusting older women, over the lack of trust towards the male doctor avatar.

Avatars also help set the tone of an app. McCurdie et al. (2012) tested varying tones for their asthma self-management app and interestingly their test subjects reacted strongly against a “fun” tone that they were testing. Reasoning for this was “that the fun content or language belied the seriousness of their chronic disease condition “. Similarly, to this the users of alcohol related mHealth apps could prefer a serious tone towards the subject.

The limited number of interviewees, especially as none of them were risky drinkers, caused them to have a generally relaxed attitude towards the topic. People suffering from alcohol abuse might be more restrained towards the tone of the app and the features presented in MyLimits. So, especially the innovated feature of chatbot meetings would benefit from testing with these subjects.

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Appendix A. Interview procedure for the interviews with target audience

Pro Gradu – haastattelut kohdeyleisön kanssa

Pro Gradu – interviews with the target audience

Tuomas Liimatta

Ensimmäinen osio: Juomistavat ja kokemukset

First Part: Drinking habits and experiences

Ihan muutamalla sanalla millainen on sinun suhteesi alkoholiin ja miten kulutat alkoholia?

In few words how would you describe your relation to alcohol and how you consume alcohol?

Miten seuraat alkoholinkäyttöäsi?

How do you monitor your alcohol consumption?

Mitä mieltä olet käyttösi seuraamisesta sovellusten avulla?

What do you think about following your alcohol consumption with apps?

Oletko koskaan käyttänyt mitään käytöksenmuutos (behaviour change) sovellusta?

Have your ever used any behaviour change application?

Kauanko käytit?

How long did you use it?

Miksi niin pitkään?

Why that long?

Mitä koit, että vaikutti sovelluksen käyttöikään?

What do you think influenced the lenght of use?

Tiedätkö ketään lähituttua, joka oli käyttänyt alkoholin vähennys sovelluksia ja jakanut kokemuksia?

Has anyone close to use used a drinking reduction app and shared their experiences?

Mikä oli syy että lopetit?

Why did you quit using the app?

Mitä mobiili aktiviteetti/äly monitorointi käytöksenmuutos palveluita tunnet/olet käyttänyt?

What monitoring behaviour change services or apps do you know of or have used?

Mitä etuja ja mahdollisuuksia koet, että mobiilius/mukana kulkeminen tarjoaa näille sovelluksille?

What benefits and opportunities do you think that the mobile aspect of these apps offer?

Toinen Osio: Konseptin esittely haastateltavalle

Second Part: Concept presentation to the interviewee

Esitellään periaatteessa ja yleisesti artefakti ohjelma, haastateltava saa keskeyttää, mutta keskustelun pääaiheeksi uudet piirteet.

The principles and functions of the artefact app are presented, the interviewee may interrupt for questions if the wish, but the focus is on the new features.

Kolmas Osio: Keskittyminen personalisointiin ja viikoittaiseen A.I. chattiin botin kanssa

Third Part: Focus on personalization and weekly chat with A.I. chatbot

Mitä mieltä olet sovelluksen personalisoinnista ja kuinka paljon mielestäsi sovelluksen pitäisi tarjota personalisointi mahdollisuuksia?

What do you think about the apps personalization options and how much do you think an app should over them?

Miten haluaisit muokata sovellusta käytön aikana?

How would you like to personalize the app during use?

Kuvitellaan että käytät sovellusta: Kerro miten käyttäisit sovellusta? tilanne, määrä etc.

Imagine you are using the app: Tell me how you would use it? situation, amount etc.

Puuttuuko sovelluksesta mitään? Kerro lisää..

Is the app missing anything? Tell me more..

Onko ominaisuuksia josta et pidä? Kerro lisää..

Is there features that you dislike? Tell me more..

Neljäs Osio: Keskittyminen Avatariin ja hänen tuomaan vaikutukseen

Part Four: Focus on avatar and their effect

Mitä mieltä olet Avatarin vaikutuksesta sovelluksen vaikutukseen?

What do you think is the infleunce of an avatar on the impact of the app?

Tuoko eri Avatarit enemmän tai vähemmän auktoriteettiä/samaistuttavuutta?

Do the different avatars present more or less authority or relatability?

Mikä avatari sinusta on sopivin alkoholin käytönvähentämiseen tarkoitettuun sovellukseen?

In your opinion what avatar is the most suitable for an app aimed at alcohol reduction?

Mikä avatari sinusta on paras ja miksi?

In your opinion what is the best avatar and why?

Viides Osio: Palaute haastattelusta ja ideoita jatkoa varten

Part Five: Feedback on the interview and ideas for future

Onko kommentoitavaa sovelluksesta, anna tilaa hengittää ja miettiä?

Any comments on the app, give the interviewee time to breath and to think?

Kokemus haastattelusta (riippuen sensitiivinen aihealueeseen)?

How did you experience the interview (in relation to the sensitivity of the subject)?

Voidaanko haastattelu säilyttää Oulun yliopiston tietokannassa mahdollisia jatko tutkimuksia/koulutuksia varten?

Can this interview be kept in the University of Oulu database for potential future research?

Kiitos haastattelusta!

Thank you for the interview!

Appendix B. Data protection form for the interviewees

TIETOSUOJAILMOITUS TUTKIMUKSEEN OSALLISTUVALLE EU:N YLEINEN TIETOSUOJA-ASETUS 12-14 ART.

CONFIDENTIALITY AGREEMENT FOR PERSON PARTICIPATING IN THE STUDY EU GENERAL DATA PROTECTION ARTICLE 12-14 ART.

PÄIVÄYS: 14.12.2020

DATE: 14.12.2020

Tutkimuksen suorittaja: Tuomas Liimatta

Researcher: Tuomas Liimatta

Olet osallistumassa Oulun yliopiston tekemään tutkimukseen. Tässä selosteessa kuvataan, miten henkilötietojasi käsitellään tutkimuksessa.

You are about to participate in a study done by the University of Oulu. In this form the data protection processes are explained.

Tutkimukseen osallistuminen on vapaaehtoista. Sinuun ei kohdistu mitään negatiivista seuraamusta, jos et osallistu tutkimukseen tai jos keskeytät osallistumisesi tutkimukseen.

Participation to the study is voluntary. No negative repercussions will be placed on the participant if they choose to leave or quit the study.

1. Kuvaus tutkimushankkeesta ja henkilötietojen käsittelyn tarkoitus

1. Description of the study and personal data management processes

Suoritan Oulun yliopiston tieto- ja sähkötekniikan tiedekunnassa pro gradu -tutkielmaa älypuhelimien sovellusten roolista ja käytöstä alkoholin kulutuksen seuraamisessa ja vähentämisessä. Hankkeen toteutukseen osallistuu kaksi tiedekunnan tutkimusyksikköä: INTERACT ja OASIS (https://www.oulu.fi/tst/yksik%C3%B6t). Hankkeen tavoitteena on osallistaa mahdollisia käyttäjiä uusien ratkaisujen suunnitteluun ja arviointiin.

I am performing a pro gradu-thesis at the Oulu University Faculty of Information Technology and Electrical Engineering on the use of mobile applications in managing and reducing the conception of alcohol. The research units of: INTERACT ja OASIS (https://www.oulu.fi/tst/yksik%C3%B6t) participate in the study. Purpose of study is to involve potential users in the development and evaluation of invented solutions.

Osallistuminen opinnäytetyötutkimukseen suoritetaan verkon välityksellä äänipuhelulla ja näytönjakamisella, jolla esitellään ehdotettu prototyyppi ja sen ominaisuudet. Haastattelujen suorittamiseen käytetään Discord-ohjelmaa.

Participation is done online by the use of voice calls and screen share, which is used to present the proposed prototype and its features. Interviews are performed with the Discord program.

Haastateltavana suostut osallistumaan yllä kuvailtuun tutkimukseen ja annat luvan osallistumisesta syntyneen ja siinä tuotetun materiaalin käyttämiseen tutkimustarkoituksessa. Olet lukenut ja ymmärrät tätä tutkimusta koskevan oheisen tietosuojailmoituksen.

As the interviewee you are agreeing to participate in the aforementioned study and give the rights to use the material created as part of the interview process in research purposes. I have read an understand the data management process.

Suostuminen varmistetaan haastattelun alussa suullisesti äänipuhelun välityksellä.

Agreement is confirmed at the beginning of the interview in the audio call.

2. Tutkimuksen rekisterinpitäjä

2. Makers of the study

Mikäli haluat tutkimuksesta lisätietoja, voit ottaa meihin yhteyttä.

If you wish to receive further information, you may contact us.

Tuomas Liimatta (Tutkimuksen tekijä), sähköposti: tuomas.liimatta@student.oulu.fi

Tuomas Liimatta (Performer of the study), email: tuomas.liimatta@student.oulu.fi

Tonja Molin-Juustila (INTERACT tutkimusyksikkö) ja Pasi Karppinen (OASIS tutkimusyksikkö)

Tonja Molin-Juustila (INTERACT research unit) and Pasi Karppinen (OASIS research unit)

Oulun yliopisto, sähköposti: etunimi.sukunimi(at)oulu.fi.

University of Oulu, email: firstname.lastname(at)oulu.fi.

3. Tutkimusaineiston käyttö, suojaaminen ja säilytys

3. Use of, storage and protection of the research material

Tutkimusaineistoa tullaan hyödyntämään yksinomaan tieteellisessä tutkimuksessa, eikä sitä käytetä kaupallisiin tarkoituksiin. Tutkimusaineisto arkistoidaan pitempiaikaiseen

käyttöön tutkimustyötä varten Oulun yliopiston O365-pilvipalveluissa vastuuhenkilöiden toimesta. Arkistoitua aineistoa voi käyttää ainoastaan Oulun yliopiston INTERACT- ja OASIS-tutkimusyksiköiden tutkimushenkilökunta.

Research material will only be used for academic purposes. The material will be stored in University of Oulu O365-cloud servers by makers. Access to the material is only prohibited to the members of the INTERACT- ja OASIS-research units.

4. Tutkimuksen luonne ja aikataulu

4. Tutkimuksen luonne ja aikataulu

Tutkimus suoritetaan kertatutkimuksena, joka rajoittuu tämän tutkimuksen haastatteluihin, joten haastateltaviin ei olla yhteyksissä jatkotutkimuksia varten.

The research is performed in a single occasion, which is limited to the interviews, so the interviewees will not be contacted for further research.

Tutkimus kestää pro gradu -tutkielman loppuun. Arvioitu valmistumispäivä on 28.2.2021. Haastatteluiden tekstitiedostoja voidaan käyttää tutkimusaineistona mahdollisissa jatkotutkimuksissa.

The research lasts until the graduation of the performer. Estimated date of graduation 28.2.2021. The interview text files may be used as material for further research.

5. Mitä haastateltavan tietoja tutkimusaineisto sisältää

5. What information of the interviewee the research data contains

- Etunimi
- Haastattelujen sisältö: haastattelutallenne, joka ei sisällä tunnistettavia henkilötietoja.
- Jokaiseen haastattelutiedostoon sisällytetään tunnistuskoodi mahdollista tietojen poistoa varten.
- *First name*
- *Content of the interview: audio file of the interview, that holds no identifiable personal information.*
- *Each audio file contains a identification code for possible removal of the data*

6. Mistä lähteistä henkilötietoja kerätään

6. Where the personal information is gathered

Haastateltavilta haastatteluun ilmoittautumisen yhteydessä sekä haastattelutilanteissa äänipuhelua tallentamalla.

From the interviewees as part of the interview and by recording the audio of the interview.

7. Henkilötietojen siirto EU:n tai Euroopan talousalueen ulkopuolelle

7. Sharing the personal data beyond the boundaries of the EU

Ei siirretä.

This will not be done.

8. Henkilötietojen suojauksen periaatteet

8. Principles of protecting the personal information

Tiedot ovat salassa pidettäviä. Pääsy sähköisiin tietoihin vaatii riittävät oikeudet, sekä monivaiheisen tunnistautumisen. Luvaton pääsy estetään myös mm. palomuurien ja teknisen suojautumisen avulla. Rekisteritietoihin pääsee käsiksi ainoastaan rekisterinpitäjä ja erikseen nimetyt tekniset henkilöt. Ainoastaan nimetyillä henkilöillä on oikeus käsitellä ja ylläpitää rekisterin tietoja. Käyttäjiä sitoo vaitiolovelvollisuus. Rekisteritiedot varmuuskopioidaan turvallisesti ja ne ovat palautettavissa tarpeen tullen. Tietoturvan taso auditoidaan toistuvin väliajoin joko ulkoisen tai sisäisen auditoinnin avulla.

Information is kept safe. Access to the stored information requires authorization and a multipart identification. Unwanted access is prevented also by the use of firewalls and technical protection. The data is only accessible to the makers and specifically named technical personnel. Only these people are allowed to access and maintain the data. Käyttäjiä sitoo vaitiolovelvollisuus. Backups of the data are kept securing them. The information security is audited regularly by an outside auditor.

Haastattelutallenteet muutetaan tunnistamattomiksi tekstitiedostoiksi, joista poistetaan mahdolliset tunnistettavat henkilö- ja paikkatiedot. Haastattelutallenteet tuhotaan tutkimuksen jälkeen.

Audio recordings are turned into unrecognizable text files from which every identifiable information is erased. The interview recordings are deleted after the completion of the study.

9.Henkilötietojen käsittely tutkimuksen päättymisen jälkeen

9.Handling of personal data after the completion of the study

Haastateltavan henkilötiedot hävitetään pro gradu -tutkimuksen hyväksymisen jälkeen.

Interviewees personal information will be deleted after the completion of the pro gradu -study.

Hankkeessa kerätty haastatteluaineisto (tallenteet) arkistoidaan tunnistamattomiksi tekstitiedostoiksi muutetussa muodossa Oulun yliopiston palvelimille mahdollisia

jatkotutkimuksia varten. Haastattelutallenteet tuhotaan tutkimuksen jälkeen. Kaikki säilytettävä aineisto arkistoidaan pseudonymisoidussa muodossa siten, ettei tutkimukseen osallistuneen haastateltavan henkilöllisyys ole lähtökohtaisesti tunnistettavissa. Kerättyä aineistoa saa käyttää mahdollisiin myöhempiin tutkimustarkoituksiin vain sellaisessa muodossa, joissa henkilöitä ei voi tunnistaa.

Data gathered in the study (recordings) is archived in unrecognizable form on the University of Oulu servers for possible further research. Interview files are deleted after completion of the study. All the data is stored in pseudonymised form, so the participants remain unrecognizable. The fathered data may be used for further research purposes only in such form.

10. Valitusoikeus

10. Right of appeal

Tutkittavalla on lisäksi oikeus tehdä valitus tietosuojavaltuutetun toimistoon, mikäli hän katsoo, että henkilötietojen käsittelyssä on rikottu voimassa olevaa tietosuojalainsäädäntöä.

The subject has the right for appeal with the data protection offices, if they see, that the data protection law had been breached as part of this study.

Yhteystiedot:

Contact information:

Tietosuojavaltuutetun toimisto

Office of the Data Protection Ombudsman

Käyntiosoite: Ratapihantie 9, 6. krs, 00520 Helsinki

Street address: Ratapihantie 9, 6. krs, 00520 Helsinki

Postiosoite: PL 800, 00521 Helsinki

Postal address: PL 800, 00521 Helsinki

Vaihde: 029 56 66700

Switchboard: 029 56 66700

Faksi: 029 56 66735

Fax: 029 56 66735

Sähköposti: tietosuoja@om.fi

E-mail: tietosuoja@om.fi