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Master Thesis

Personal Health Technology for Behaviour Change in Alcohol Misuse

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Summary

Alcohol abuse is a huge burden worldwide and its consequence is a percentage of the global deaths. Symptoms such as, slow speech and reactions, loss of attention, impaired verbal learning and memory, are some of the effects that alcohol causes on someone's body and brain.
In particular young people are one of the groups that are most affected by alcohol abuse through Heavy Episodic Drinking (HED) and the biggest reason is due to a social behaviour.
A mobile application has been designed and developed with the aim of reducing excessive alcohol consumption among young adults using Behavioural Change (BC). The design process included a User Centred Design (UCD) methodology in order to address the users' needs and build an easy-to-use mobile app.
Therefore, a qualitative study with 15 subjects was carried out to evaluate the usability and perceived usefulness of this system. In addition, usage data was analysed in order to investigate drinking patterns and symptoms. The mobile application obtained a score of 76.67, which corresponds to a B in the System Usability Scale (SUS). Moreover, 53% subjects agreed and 26% strongly agreed on the perceived usefulness of the app. Qualities such as, 'learnability', 'feeling of skillfulness', and 'ease of use' were highly rated by subjects. Unlike the features 'improve quality of life' or 'include features expected by user', which most users reported not to be clearly present.

Preface

This master thesis was prepared at the department of Applied Mathematics and Computer Science at the Technical University of Denmark in fulfillment of the requirements for acquiring a Master Science degree in Digital Media Engineering. The thesis began February 22, 2018.
The content of this thesis is written to be understood by a broad audience, containing knowledge in Behavioural Change (BC), and User Centered Design (UCD). The thesis emerged as a combination in between (1) the knowledge in Behavioural Activation (BA) gathered by the author as part of the student assistant job in Copenhagen Center for Health Technology (CACHET), which is closely related to BC and (2) a talk on "The potential in research across institutions and recommendations from 'Vækstteam' for Life Science" by Liselotte Højgaard [28] held in 2017 CACHET seminar. The talk strongly stressed the potential of research to solve problems in the healthcare sector. Alcohol is very accepted in the day-to day life, nevertheless young adults do not realise the gravity of its abuse. Therefore, as the author has the skills to develop a technological system to rise awareness of this topic, it derive into the present Master Thesis.

Kongens Lyngby, June 22, 2018

Andrea Quemada (s161632)

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Antonio Plaza, Marina Puentes, Diana Abad, Darius A. Rohani, and more who collaborated in this project as participants, subjects and testers of the system throughout its development and suffer extremely annoying bugs, see Figure 1 .

(a) App crashing (b) Activity creation in loop

Figure 1: Bugs of *DropIt* through its development

My family and Joseba Ruiz-Olalla who supported my decision to move to Denmark and get the education that I aspired to.

Contents

CHAPTER 1

Introduction

In a recent large systematic review, it has been concluded that alcohol abuse is still one of the greatest burdens of disease and mortality [52]. In fact, 5.9% of the global deaths in 2012 were caused by alcohol consumption, which is found to have a causal link to many major diseases [51] with strong association to HIV infection [24, 59]. Alcohol is basically a depressant drug that affects the entire body [29, 71, 50, 11]. It has life-threatening symptomatic consequences including the deprivation of vital functions (speech, movement, perceptions and reactions), and brain functions that are responsible for attention, verbal learning, visuospatial processing and memory [60]. In particular among young people this results in imprudent behaviour, such as car crashes and unforeseen injuries [27]. Despite of this, in 2010 the consumption worldwide was, surprisingly, 6.2 litres of pure alcohol per person, among people aged 15 and older. 16% of these people were engaged in heavy episodic drinking [69].

Children, adolescents and elderly people are usually the most vulnerable groups to alcohol-related harm as drawn from interviews done by Mäkelä et al. [36]. Heavy drinking is particularly likely among people (1) who experience stress, (2) who drink as a coping mechanism, (3) whose friends experience heavy drinking episodes, and (4) who drink for social reasons themselves, which is a very popular drinking motivation amid young people [32]. Additionally, an early initiation of alcohol consumption indicates that there is a high probability of impaired health status, along with an increased risk for alcohol dependence in an advanced age [21].

The immense health burden that alcohol causes for the individual and the society [12], yells for preventive efforts. As young people are more likely to commit heavy episodic drinking, it is important that the preventive efforts are easy-reachable and able to engage them. An understanding surrounding the cause of such destructive behaviour is needed to intervene and promote a behavioural change among young people towards reducing excessive alcohol consumption.

1.1 Background

Throughout the time, stakeholders including the healthcare ministry, the alcohol producers themselves, and the research community, have attempted to change peo-

ple's behaviour approaching a healthier and moderate alcohol consumption. The performed endeavours arose from completely different backgrounds, for example:

Mass media campaigns - A well-known method to influence the population towards healthy habits are the mass media campaigns. Unfortunately, with the exception of mass media campaigns to reduce drink driving, campaigns to lessen alcohol intake have had very little success [67]. And moreover, a systematic review from the University of Nottingham, UK, claims that there is little evidence of reductions in alcohol consumption [70].

Pharmacy-delivered interventions - A systematic review was done on interventions for public health priorities, and one of them was alcohol reduction including 2 studies. The conclusions don't show that these kinds of interventions have an effect on alcohol reduction [10].

Nowadays, the rapid development of technology brings to light new methods of tackling health issues. Indeed, it was found that the widespread adoption of mobile phones highlights a significant opportunity to impact healthy behaviours globally [72].

Mobile applications - There are great amounts of mobile applications related to behavioural change in alcohol reduction and these were selected for having (1) a high number of Behavioural Change Techniques (BCTs), (2) a high User Experience (UX) rating, and (3) evidence on reduction of alcohol intake [15]: DrinkLess [20], Alcodroid and The Alcohol Predictor [15].
A recent analysis on the usage data of the Drinkaware app on approx. 120,000 users and the qualitative feedback from 21 of them, proved this app to be motivational to reduce users' alcohol consumption for those who already were committed to do it [3].

These mobile applications still lack features (e.g. provide accurate feedback on Blood Alcohol Content (BAC) level) that could improve the effectiveness of reducing excessive alcohol consumption in young people [19].

1.2 Goal and research question

The purpose of this thesis is to design and build a mobile application that aims to change the behaviour of young people towards high alcohol consumption in social environments.
The research question that this master thesis will resolve is:

"What is the design and usefulness of a mobile application system for the everyday monitoring and reduction of alcohol abuse?"

In pursuance of that answer, this master thesis will accomplish the sub-goals:

1. Survey existing research and technologies related to behavioural change in reduction of alcohol abuse.
2. Design a mobile application with the purpose of reducing alcohol consumption
3. Build the designed mobile application applying UX knowledge
4. Run a study and evaluate the design and usefulness of the implemented system

1.3 Overview of thesis

The process of designing, building, and evaluating a mobile application with the aim of reducing alcohol abuse is documented in the following chapters.

Chapter 2: Clinical background and related work - This chapter will describe the consequences of drinking alcohol, the reasons for young people to binge drink, and raise awareness about the problem that excessive alcohol consumption is in Denmark. The concepts of Behavioural Change (BC) and Behaviour Change Intervention (BCI) will be explained. Then the active factor of BCIs will be described, which are the different Behavioural Change Techniques (BCTs).
As one of the main goals of this thesis is to build a mobile application with the aim of reducing alcohol consumption, a research on existing technologies regarding this topic will be performed and presented.
The device for measurement of BAC level also needs to be investigated and reported in this project, due to the integration of this feature in the system.

Chapter 3: Design Process - The design process will use a User Centred Design (UCD) method, due to the significance of the user's preferences in this project. Therefore, the theory behind this method and its performance will be explained.
The UCD process will include a workshop with participants, and an early prototype built with the feedback gained from the workshop.
UCD involves iterative processes, so the description of this chapter will contain the sections:

- Description of the workshop and corresponding feedback
- Description of the prototype and corresponding feedback

Chapter 4: Implementation - This chapter provides the technical understanding of how the composed system of a mobile application and a breathalyser will be implemented.

Firstly the reader will find the description and instructions on how to use the breathalyser.

The process of building the User Interface (UI) will be explained in 5 parts. At the end of this section, in the 5th part, a storyboard of the final version of the app will be included.

Lastly, the description of the data management section will be done by explaining 4 types of interaction with the database. Those interactions are; either sending data to or fetching data from the built database.

Chapter 5: Study - This chapter will contain a description of the study that will be performed when the mobile application is finalised. The description will involve details such as recruitment, experimental setup, and questionnaires to evaluate the developed system.

Chapter 6: Results - The results from the study will be presented and contain 3 focus areas; (1) Interviews *'in-the-wild'*, (2) Data analysis, and (3) Qualitative questionnaires

Chapter 7: Discussion - This chapter will discuss the results beginning with (according to the order above) (2) Data analysis, continuing with (1) Interviews *'in-the-wild'*, and finalising with (3) Qualitative questionnaires.
From this review, the BCTs and elements chosen for the mobile app, and the UCD design method will be discussed. Aiming to discover the reasons for the results that will be obtained.

Chapter 8: Conclusion - A conclusion will be built based on the findings of this project. Furthermore, improvements and new suggestions to the current solution will be proposed as feasible future work.

CHAPTER 2

Clinical background and Related Work

2.1 Alcohol

Alcohol is a psychoactive substance with dependence-producing properties.

There are three main direct mechanisms of harm caused by alcohol consumption in an individual as defined by Babor et al. [5]:

- Toxic effects on organs and tissues
- Intoxication, leading to impairment of physical coordination, consciousness, cognition, perception, affect or behaviour
- Dependence, through which the drinker's self-control over his or her drinking behaviour is impaired.

The World Health Organisation (WHO) affirms there is a wide range of problems related to alcohol and its consumption, although the burden of disease and death endures significantly in most of the countries. Alcohol's harmful use ranks among the top five risk factors for disease, disability and death all over the world.

Drinking alcohol is associated with a risk of developing health problems such as: alcohol dependence, liver cirrhosis, cancers and injuries. From the Global status report on alcohol it is know that the latest causal relationships suggested by research findings are those between alcohol consumption and incidence of infectious diseases such as tuberculosis and HIV/AIDS. Moreover, it is known that the net effect of harmful use of alcohol is approximately 3.3 million deaths each year, meaning that it accounts for 5.9% of all deaths worldwide [69].

2.1.1 Heavy Episodic Drinking

Heavy Episodic Drinking (HED) or Binge Drinking is a term used to describe a single drinking event with an excessive amount of alcohol consumption [48]. An excessive amount is defined differently from country to country. In Denmark, where this thesis is being conducted, the amount is set at 5 or more alcoholic beverages.

More accurately 60 or more grams of pure alcohol on one occasion at least monthly [16].

A review from the Norwegian Institute of Public Health found solid evidence of less alcohol use by wealthy countries' youth since the millenium shift. However, there is also indications of heavy drinkers not having reduced their alcohol intake [49].

As it was known by a last year's article from WHO, the Danish youth are the heavy drinkers who drink the most in Europe. Actually, among 15-16 year-old-danes, 32% addressed having been drunk in the past 30 days, compared to the European average of 13%. Every year 1400 Danes around 17 years old, who are the greatest heavy drinkers compared to different age groups, attend the hospital due to HED (see Figure 2.1). Moreover, in 2016 1 out of 10 15-16-year-old danish youth reported having had unprotected sexual relations under the influence of alcohol, likewise experienced undesired sexual insinuations [61].

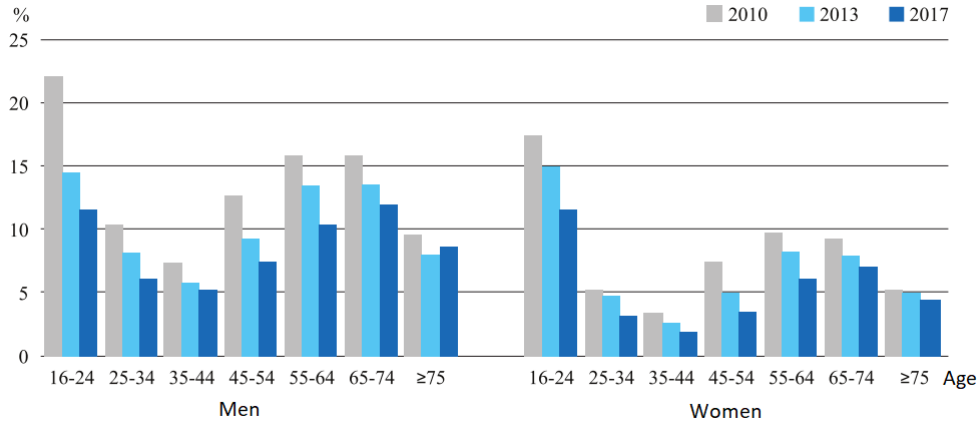


Figure 2.1: Percentage of population that exceeds the recommended limit for alcohol intake during a typical week, among men and women of different age groups in 2010, 2013 and 2017 [61].

All these facts tell that HED is a big common problem for the world's society and specially for Danish citizens. However, to tackle HED there is firstly a need to understand what triggers this behaviour in young people.

2.1.2 Why do we drink?

Humans make a huge amount of decisions a day, including the decision to drink. According to the article *"Why do young people drink? A review of drinking motives"* from the Swiss Institute for the Prevention of Alcohol and Drug Problems [32] there are four main drinking motives as antecedents to a drinking behaviour; drinking to (1) enhance positive mood, (2) obtain social rewards, (3) mitigate negative emotions,

and (4) avoid social rejection. As it was stated, two of these methods account for social behaviours. Consequently, those will be the reasons to be analysed throughout this manuscript.

2.1.3 Measurement

In order to work with the problem of excessive alcohol consumption in young people, there are two main things to be measured: alcohol content in a drink and alcohol content in a person.

- *Drinks' alcohol content:* The alcoholic content of a drink is always shown in the container of the commercialised drinks. It is called Alcohol by Volume (ABV) and is measured in percentage (%), see Figure 2.2.

Figure 2.2: Alcohol By Volume (4.5%) in a standard beer

- *Blood Alcohol Content (BAC):* BAC refers to the amount of alcohol circulating in the bloodstream, and is the best estimate of the effects of alcohol on the brain. BAC varies as a function of dose of alcohol, time, gender, body weight, age, beverage type, and individual differences in absorption and metabolism of alcohol [4].

  In brief, BAC level is based on how much alcohol went into a person's body over a period of time. It depends on three parameters: the initial concentration of alcohol in the stomach after ingestion, the rate of alcohol absorption into the blood stream, and the rate at which the alcohol is metabolised by the liver [63]. The maximum driving BAC level in Denmark and in most of the countries is 0.05% according to International Alliance for Responsible Drinking [18]. At this level, a person is already showing symptoms related to alcohol consumption. Table 2.1 shows the typical symptoms at different BAC levels, as defined by the

U.S. National Library of Medicine [45] and the approx. corresponding number of drinks (i.e. 1 drink = 330 ml beer) for a person who weights around 70 kg [1]:

BAC level	Approx. no drinks	Symptom
0.05	2	Reduced inhibitions
0.10	5	Slurred speech
0.20	10	Euphoria and motor impairment
0.30	>10	Confusion
0.40	NA	Stupor
0.50	NA	Coma
0.60	NA	Breathing stops and death

Table 2.1: Approx. no. of beers and symptoms Corresponding to a certain BAC level

The Danish Healthcare Institution, *Sundhedsstyrelsen*, recommends a maximum of 14 and 7 standard alcohol units per week for men and women, respectively [2]. One standard alcohol unit is equivalent to 12 grams (1.5 cl) of pure alcohol 100% . The standard units for the most typical alcoholic beverages (based on footnote[2]) are listed below:

 Beer (33 cl and 4.6 %) - 1 standard unit

 Glass of wine (17.5 cl and 12%) - 1.4 standard units

 Drink or spirit (2.5 cl and 40%) - 0.6 standard units

 Shot (2 cl and 40%) - 0.4 standard units

2.2 Behavioural Change

For the majority, our re-programmable brains have the ability over time to rewrite the processes that direct what humans think, feel, and do. By trying new things and forming new relationships, humans automatically reprogram perceptions, feelings, thoughts and skills. This happens when new behavioural routines or Behavioural Change (BC) is practised [41].

Digital Behaviour Change (DBC) in particular is defined as a behaviour change that makes use of technology to either: promote the delivery of the intervention, enhance the environment through which the intervention occurs, or encourage patterns of interaction that fortify the intervention [23].

[1] `https://dui.drivinglaws.org/drink-table.php`
[2] `https://www.sst.dk/da/sundhed-og-livsstil/alkohol/anbefalinger#`

2.2.1 How does it work?

A behavioural change requires a Behaviour Change Intervention (BCI). This intervention is usually designed through a 3 stage model known as the Behaviour Change Wheel (BCW) [47]:

> *Stage 1: Understand the behaviour* - In this stage intervention designers need to define the problem in behavioural terms, then select and specify the target behaviour to be able to identify what needs to be changed.
>
> *Stage 2: Identify intervention options* - There is a need to identify the intervention functions and policy categories in this stage.
>
> *Stage 3: Identify content and implementation options* - Lastly, the Behavioural Change Techniques (BCT) and mode of delivery is identified.

The designed BCI is then evaluated by answering the following questions:

1. Did the intervention change the behaviour it targeted?
2. How did the intervention work? Did it change the regulatory mechanisms targeted?
3. How much does the intervention cost for a given degree of effectiveness?

2.2.2 Behavioural Change Techniques

Behavioural Change Techniques, referred in this document as BCTs, are defined as the active components of an intervention designed to change behaviour, a BCI. BCTs are required to be: observable, replicable, irreducible components of a BCI, and active ingredients within the intervention [43]. A BCT can be used alone or combined with other BCTs.

BCIs to reduce excessive alcohol consumption have a small but important effect. There are several types: (1) *Theory-based interventions* that include BCTs from guidance documents, treatment manuals or Cochrane review [31], (2) *Pharmacy-delivered interventions*, and (3) *Digital interventions* such as, mobile apps.
According to the research report from S.Michie et al. [42] the taxonomy of BCTs contains the groups:

- Address motivation
- Address self-regulation
- Promote assisting activities
- Address general aspects of the interaction

When focusing on the mobile based intervention, which is the area of interest of this master thesis, the reported 5 most used BCTs are [15]:

- facilitate self-recording
- provide information on consequences of excessive alcohol use and drinking cessation
- provide feedback on performance
- give options for additional and later support
- offer/direct towards appropriate written materials

2.3 Related work: Mobile Apps for Behavioural Change in Alcohol Consumption

A study by Norman et al. [48] suggests that heavy episodic drinking is a social behaviour which is eased by their social environment. In order to attempt to reduce that incidence, the most effective interventions may be those that influence the context of consumption either directly or through social guidance. Also, the Youth Alcohol Action Plan from the UK [64] states that young people need to receive accurate information about alcohol, its effects and potential harms.

Besides those facts, it is known from the evidence review written by J.Zhao et al. [72] that health-related mobile apps provide a significant opportunity to impact health behaviours globally. Consequently, if the previous mentioned knowledge is combined with the mobile technology, a new arousal of digital BCIs come to take part in the area of reduction of HED.

This section will provide an overview of 4 mobile applications. 3 of them were selected for having (1) evidence on reduction of alcohol intake, (2) a high User Experience (UX) rating, and (3) a high number of BCTs [15]; and the 4th app was selected for (4) having proved, by the qualitative feedback of 21 users, to be motivational to reduce users' alcohol consumption for those who already were committed to do it [3]. These mobile applications are: (1) DrinkLess, (2) Alcodroid the Alcohol Tracker, (3) the Alcohol Predictor, and (4) Drinkaware.

2.3.1 Drink Less

The mobile app Drink Less was proved to help reduce hazardous and harmful drinking using five intervention modules or BCTs. It allows the user to keep track on his/her alcohol intake, set goals to drink less, get feedback on his/her progress, play games

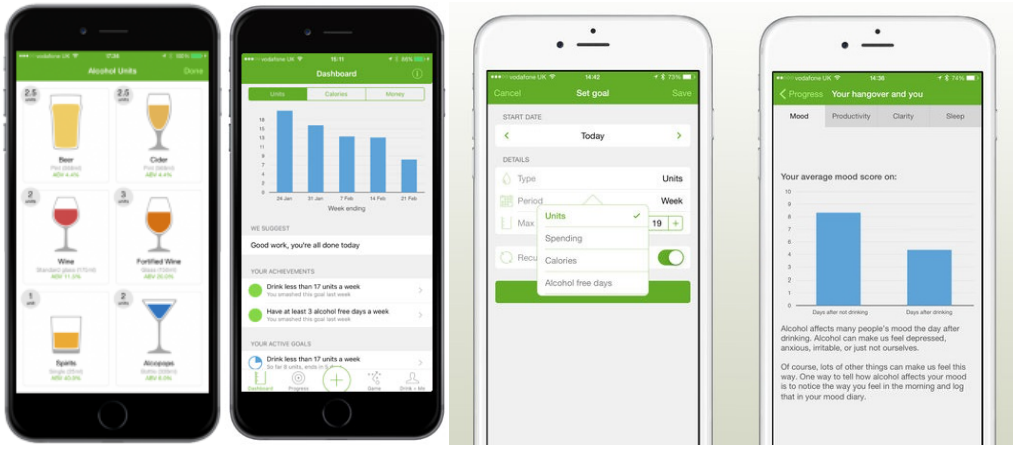
designed to strengthen the willing to drink less, as well as, create plans for likely alcohol intake situations and take part in exercises designed for BC [20].
The 5 BCTs that this app provides are:

1. Self-monitoring and feedback
2. Action planning
3. Normative feedback
4. Cognitive bias re-training (i.e. Change the tendency to approach alcohol to an 'avoid' bias)
5. Identity change (i.e. Smokers focused: strengthening an ex-smoker identity)

However, the Drink Less app is only developed for iOS (Apple's Operative System) according to their statements, to avoid issues of fragmentation associated with Android. And the same reference stated that, that fragmentation is precisely what provides the basis for Android's global reach.

Drink Less app was also only developed for iOS because there tends to be a greater retention rate for apps amongst iPhone users compared with Android [20].

There is no method to calculate the BAC level with this app. Moreover, Drink Less does not allow the user record his/her hangover, instead it gives the possibility to record the mood.



(a) Self-reporting drinks (b) Progress (c) Setting personal goals (d) Mood

Figure 2.3: Drink Less app: (a) Illustrates how to report different kind of drinks consumed; (b) Shows feedback on progress regarding units, calories, and spent money; (c) View to set personal goals; (d) Shows progress on how user feels

2.3.2 AlcoDroid Alcohol Tracker

The AlcoDroid app is one of the most popular and highest rated alcohol consumption trackers. It is a drinks diary and optionally it tracks costs of drinks. AlcoDroid also provides an estimate of the BAC level based on the logged drinks, plots its progress in a chart, and indicates when the user gets above the legal limit or back to sobriety, as stated in Google Play Store [3].

This app allows the user to show, edit and export the drink logbook. The user's drinking habits are displayed daily, weekly or monthly, and can be exported as well. Furthermore, the user can share this information and the BAC level on Facebook, by e-mail, and other platforms.

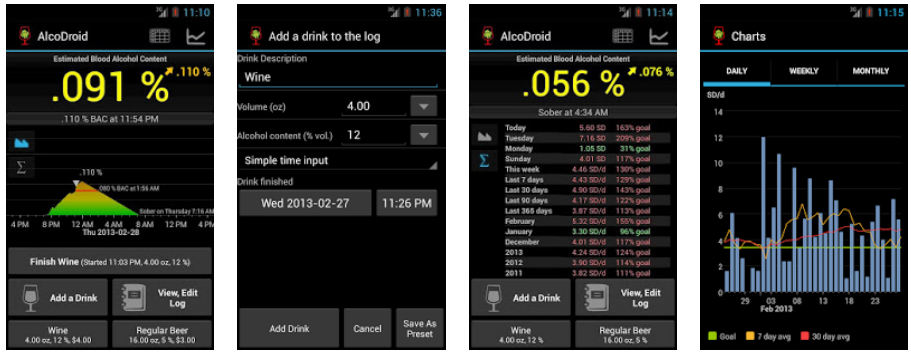
According to D.Crane et al. [15, 22] AlcoDroid includes 7 BCTs:

1. Provide information on consequences of excessive alcohol use and drinking cessation
2. Boost motivation and self-efficacy
3. Provide feedback on performance
4. Facilitate goal setting
5. Prompt review of goals
6. Facilitate self-recording
7. Provide information on withdrawal symptoms

On the other hand, as stated previously in this document BAC varies as a function of dose of alcohol, time, gender, body weight, age, beverage type, and individual differences in absorption and metabolism of alcohol [4]. Therefore, the accuracy of the BAC level in this mobile app it is inaccurate due to its base in logged drinks.

In addition, pop-up ads are one of the biggest drawback that this app contains. Alternatively, the user can pay a fee to upgrade the system and remove the ads.

[3] `https://play.google.com/store/apps/details?id=org.M.alcodroid`



(a) Overview: Estimated BAC (b) Personalization of drinks (c) BAC progress over the days (d) Progress over time

Figure 2.4: AlcoDroid Alcohol Tracker app: (a) Illustrates the estimated BAC level and how to report drinks; (b) Shows the detailed drink reporting; (c) View of log and goal performance; (d) Provides feedback on progress and set goal

2.3.3 Alcohol Abuse Predictor

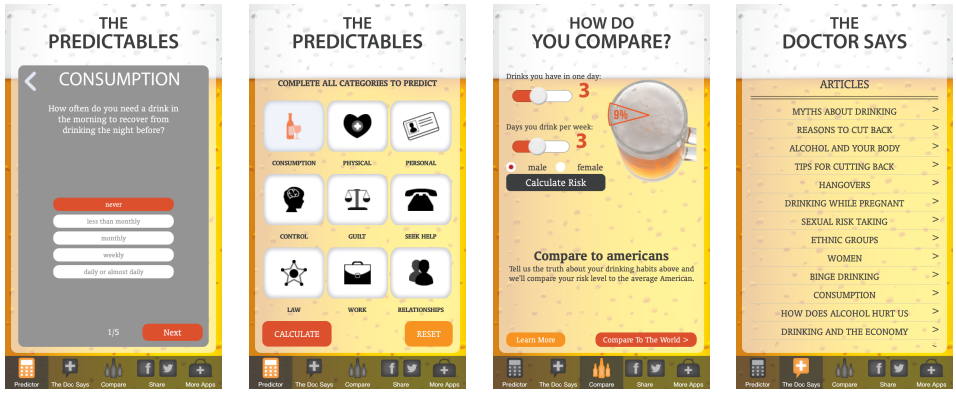
The purpose of the app is to rise awareness about signs and symptoms of alcohol abuse in people that has an interest in it. This app provides options to explore if the user thinks himself/herself or someone else is at risk of alcohol related harm. The Alcohol Abuse Predictor provides the user with the AUDIT screening tool - which assess alcohol consumption, drinking behaviours, and alcohol-related problems [55]. It also claims to give the user's perspective on his/her drinking patterns by calculating how much the user drank over time and how that compares to others.

The Alcohol Abuse Predictor is one of the systems with the highest number of BCTs (13) [15, 22] :

1. Provide information on consequences of excessive alcohol use and drinking cessation
2. Provide feedback on performance
3. Provide normative information about others' behaviour and experiences
4. Facilitate action planning/know how to help identify relapse triggers
5. Facilitate goal setting
6. Facilitate self-recording
7. Advise on environmental restructuring

8. Advise on avoidance of social cues for drinking
9. Give options for additional and later support
10. Assess current and past drinking behaviour
11. Offer/direct towards appropriate written materials
12. Provide information on withdrawal symptoms
13. Behaviour substitution

The Alcohol Abuse Predictor does not provide the possibility to input the user's hangover or to measure the user's BAC, as occurs with previous mobile apps.



(a) AUDIT screening tool

(b) Categories to predict

(c) Comparing your drinking to others

(d) Related articles

Figure 2.5: The Alcohol Abuse Predictor app: (a) Illustrates the AUDIT test [55]; (b) Shows information to fill for BAC prediction; (c) Provides a comparison with people from other countries; (d) Provides credible sources on healthy alcohol intake

2.3.4 Drinkaware

The Drinkaware app is a helpful tool to reduce excessive alcohol consumption. It supports behaviour change in individuals who are already motivated and committed to reduce their alcohol consumption by tracking units and calories in their drinks [3]. This app also allows the user to set goals and provide support with personalised feedback. The users are intended to attach to those goals and change their habits favourably as a result of the encouragement provided by the app. Drinkaware makes the users be aware of the benefits of reducing their alcohol intake and understand the impact of drinking in their bodies and brains. In fact, 2 experts on BC confirmed the

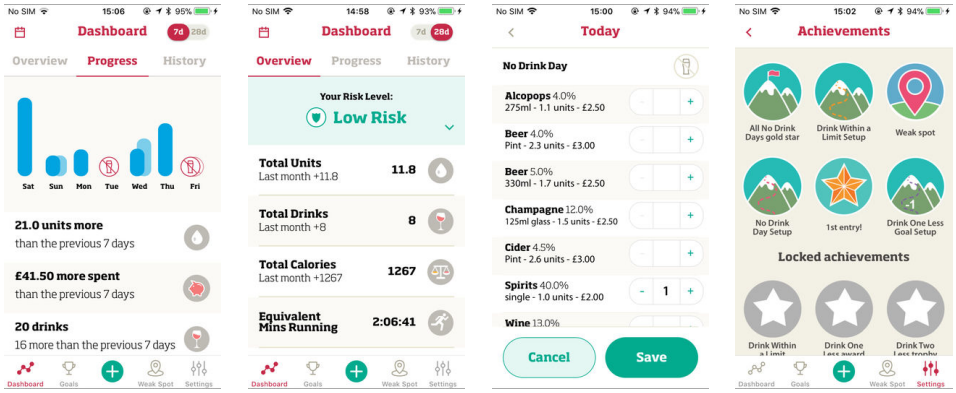
evidence on reducing alcohol consumption of this app [15].

Drinkaware is the app that has the highest amount of BCTs, and those are:

1. Provide information on consequences of excessive alcohol use and drinking cessation
2. Boost motivation and self-efficacy
3. Provide feedback on performance
4. Provide rewards contingent on successfully reducing excessive alcohol use/abstaining
5. Prompt commitment from the user there and then
6. Provide rewards contingent on effort or progress
7. Facilitate barrier identification and problem solving
8. Facilitate goal setting
9. Prompt review of goals
10. Facilitate self-recording
11. Set graded tasks
12. Give options for additional and later support
13. Tailor interactions appropriately
14. Emphasize choice
15. Assess current and past drinking behaviour
16. Assess current readiness and ability to reduce excessive alcohol use
17. Offer/direct towards appropriate written materials

Drinkaware is an app only available in United Kingdom which does not contribute to its research and evaluation. Moreover, the app is lacking in personalising and would benefit of tailoring to promote long term use.

This mobile app does not give the user the possibility of reporting his hangover, neither of self-recording the BAC level.
However, as affirmed by B.Jones et al.[30], negative expectancy items (e.g. *'I expect to have a hangover if I drink'*) represent an important component of motivation to restrain towards excessive alcohol consumption. Hence, providing feedback on the user's hangover might motivate to reduce his alcohol consumption.



(a) Progress over time

(b) Summary of drinks

(c) Self-recording of drinks

(d) Encouragement of reducing alcohol intake

Figure 2.6: Drinkaware app: (a) Provides weekly progress on amount of drinks and spent money; (b) Shows the user's risk level and a monthly summary on drinks and calories ; (c) Provides a simple way of reporting drinks; (d) Illustrates the accomplished and locked achievements

2.3.5 Summary

The following table contains a comparison of the most important features of the mobile applications analysed for this project.

System	Drink Less [20]	Alcodroid Alcohol Tracker [15]	Alcohol Abuse Predictor [15]	Drinkaware [3]
Number of BCTs	5	7	13	17
Available platforms	iOS	Android	Android	Android / iOS
Score: Google Play Store / iTunes	- / 3.9	4.3 / -	3.7 / -	4 /2.5
No. of ratings	- / 36	5,169 / -	3 / -	1,870 / 59
BAC Calculation	No	Yes, not accurate	No	No
Hangover report	No - instead Mood, Productivity, Clarity and Sleep	No	No	No
Result	Help reduce hazardous and harmful drinking	Popular apps in the market for reducing alcohol consumption using BCTs	Evidence on reducing excessive alcohol consumption	Useful behaviour change tool in individuals who are already motivated

Table 2.2: Comparison of analysed mobile applications that aim to reduce alcohol abuse using BC

CHAPTER 3

Design Process

Every single product or system needs to go through a Design Process. A successful design is usually characterized by an easy-to-use user interface. This means that the system needs to provide good quality in 5 components: learnability, efficiency, memorability, errors and satisfaction [46].
Usability is the root for Human-Computer Interaction (HCI), which focuses on how humans relate to computing products. Simultaneously, HCI was the origin for User-centered design (UCD), which is the design method that will be used in this master thesis project [65].

3.1 Design Method: User Centered Design

User-centered design (UCD) emerged from HCI and is a software design methodology for developers and designers. Essentially, it helps developers and designers make applications that meet the needs of their users.

To understand what UCD is, the reader should also understand what it is not. UCD is not subjective and often relies on data to support design decisions. It involves much more than making applications aesthetically pleasing, meaning design plays an important role; however, it's not the only focus. An advantage that is frequently underestimated by developers is that UCD can actually save time by helping avoid costly mistakes. Going through a UCD session ensures that the focus is on the right things: meeting users' needs with the proper technological solution [65].
The important concept about UCD is that users are involved in the design process. There is a spectrum of ways in which users are involved. For example, some types of UCD will exclusively question users about their needs at specific times during the design process; typically during requirements gathering and usability testing. At the opposite end of the spectrum there are UCD methods in which users have a deep impact on the design by being involved as partners with designers throughout the design process [40].

Within UCD there are some phases that require special focus: (1) information gathering, (2) users' needs identification, and (3) envisioning and evaluation.

One of the goals of this thesis, is to design an easy-to-use user interface. Therefore, a UCD method will be used involving the above mentioned phases.

Each phase can be explored using different techniques, such as stakeholder and context of use analysis for phase (1); user interviews, focus groups, or workshops for phase (2); and prototyping for phase (3) [35]. Hence, this design process will include: (1) creation of personas and scenarios, and (2) workshop, and (3) prototyping involving users.

3.2 Personas and scenarios

A persona is a character-driven element that helps the designer remember who he/she is building the application for. It is a fictional character that is a personification of the real users of the solution.

The following characters are a few examples of personas that were created with the purpose of targeting the correct users with the right needs:

Figure 3.1: Example of 2 personas: reasons to drink through frustrations and goals. (See rest of analysis in **Appendix B.2.1**)

These personas' frustrations were based in the most popular motives for young people to drink, which are: drinking to enhance positive mood or well-being , to obtain social rewards, to attenuate negative emotions, and to avoid social rejection [32]. And their goals or rather, needs are features that the system that will be developed could potentially solve.

Once the personas were created to reflect the users of the application, the scenarios need to be created. Scenarios are mini stories that reflect situations the personas may find themselves in. In each scenario, particular attention is payed to how the system will enhance the experience of the user.

The scenario that is presented next, is an example corresponding to the persona *Marie Larsen*:

"Marie loves music festivals. They usually last for days, long days. She is very active, doesn't like to miss a concert and she loves to give good vibes to the group. Unfortunately, in order to keep this enthusiastic mood she usually goes through binge episodes. However, this year for the Roskilde festival, she is using an alcohol tracker which sends the data to an app. In this app she can see her BAC along the day and she can set up goals (e.g. Daily max no. of beers = 3). This goals keep her motivated and engaged to reduce her alcohol intake and still have a nice time."

3.3 User Centered Design - Workshop

Once the previous analysis of the user-personas and scenarios was done, it was time to involve the real users in the design process of this project. In order to promote the co-creation and a creativity way of thinking in the users a workshop was held.

Figure 3.2: Participants doing an energising exercise during the workshop

A workshop is a way for participants to cooperate to create something new and creative.

The main purpose of this workshop was to decide upon which BCTs to use in the final solution and which UX features should the mobile app have to be easy to use.
The workshop was planned (see the plan in **Appendix B.2.2**) following the guidelines provided by *The Cookbook*[1], a collection of valuable instructions from the course *"Staging co-creation and Creativity - 42081"*.
The workshop was performed with 6 potential users, 4 males and 2 females. The session lasted 3 hours and it targeted the User Centered Design methodology.
In short, the plan of the workshop consisted of 3 tasks; debating about alcohol consumption, reviewing existing mobile applications, and prototype new solutions, which are elaborated in subsection 3.3.1, subsection 3.3.2, and subsection 3.3.3.

3.3.1 Debate: The WHY for alcohol

To understand why young people drink, and especially HED, a debate session was built among the workshop participants. Each participant was provided with a paper that had 3 questions written in it. The participants were expected to answer each question individually and then talk aloud about them. An example of the material provided for this task can be found in **Appendix B.2.3**

3.3.1.1 Outcome

The answers to the 3 raised questions were the following:

- Do you like drinking alcohol? Why?

  5 out of 6 participants said they like the fact of drinking and one said sometimes he/she did. The main reasons for drinking in order of importance were: social implications (as stated in the literature review), taste, enjoyment and enhance positive mood, effect of lack of inhibition produced by alcohol, and alcohol as a self prize.

- What makes you buy the next drink? What prevents you from doing it?

  - *Next drink*: The main reasons for the participants in this workshop to buy another drink was the atmosphere(if the general mood of people is high), the participant's own mood is high, pursued effect with alcohol (meaning lack of inhibition), social pressure, the fact of feeling an awkward if not holding any drink, planned time to go home being far from actual time, owing someone a drink or cheap drinks.
  - *No more*: The most mentioned motive to stop drinking was: *"I already drank too much and feel that I will have a hangover tomorrow"*. Then, the

[1] `https://vinismidthc.wixsite.com/playbook-javikan/dictionary`

progressively less important reasons were: the planned time to go home is close to the current time, not willing to be drunk, bothersome to hold a drink while dancing, and saving money.

- In which occasion do you decide to drink more than X (4 for women and 5 for men) [2] units of alcohol?

  The main reasons for participants to have a heavy drinking episode are: special occasions - birthdays, weddings, etc.-, if the atmosphere is good and people is in a positive mood, social pressure, day-time parties, if having a tasty drink and if there is a combination between, not having anything planned for the rest of the evening and inexpensive drinks. Indeed, P4 affirmed: *"I go crazy with alcohol in weddings. The atmosphere is so cheerful and it makes me forget about the consequences of excessive drinking."*

3.3.2 Mobile App rating and analysis

In this part of the workshop, 3 mobile applications were rated and analysed. The apps were selected based on an initial literature review on existing solutions. More specifically, the top app within evidence of alcohol reduction (Drink Less), user rating (AlcoDroid Alcohol Tracker), and number of BCT (Alcohol Abuse Predictor) were selected. The app Drinkaware, mentioned in *chapter 2: Clinical Background* was excluded from the workshop due to its unavailability in the Google Play Store or AppStore.

Figure 3.3: Participants working on *Task 2: Mobile App rating and analysis*

[2] Being those amounts close to consider an event as a heavy drinking episode [69]

In this task the participants were divided in 3 groups of 2 persons each. Each group was provided with a template; so 3 different templates, one per app to be rated (templates can be found in **Appendix B.2.4**. The groups were asked to evaluate the exposed apps based on the design and functionality. The rating was done by providing each participant with 6 post-its, divided in 2 groups of 3 post-its each (3 for design and 3 for functionality) of different colours, meaning 3 points (pink), 2 points (orange) and 1 point (yellow) per post-it. Subsequently, participants were asked to give detailed comments about each of the apps, to understand what they liked and dislike from the user interface or their functionality.

3.3.2.1 Outcome

Participants gave the same rating, regarding design and functionality, to each mobile application. The ratings from high to low correspond to AlcoDroid Alcohol Tracker, Drink Less,and The Alcohol Abuse Predictor, respectively.
A more in depth analysis of the apps was given by participants and it's described below.

- Drink Less

  The Drink Less app was proved to help reduce hazardous and harmful drinking, and it contains the least number of BCTs (n = 5). One of those BCTs was action planning, and participants thought that this app has a good design to set personal goals taking into account calories, units or money. Nonetheless, the participants also stated that there was a lack of information to reach their goals.
  Some participants claimed that they liked the look of the icons for the beverages, but they presumed it would be easily forgettable to self-report the drinks. And they consider the self-reporting should not require that many taps. To finalise, they conclude that they would like to self-record their feelings or mood. The believe the purpose of this feature is to discover if it exists any correlation in between drinking event, amount of drinks and mood. These were the comments from the participants that rated this app with a medium score in design and functionality.

- AlcoDroid Alcohol Tracker

  Besides containing 7 BCTs, the AlcoDroid Alcohol Tracker is one of the most popular in the market and the one that has the highest rating of the selected systems (rating = 4.3).
  The participants of this workshops rated the design and functionality of this app as the best of the three systems. The clear visualisations for alcohol consumption and the simplicity to self-report the drinks were the main reasons for

those ratings. The participants found useful to have graphs with their progress, but in this case they stated - *"This progress graphs are confusing, because they are showing data from a window of 7 and 30 days in the same screen"*. As a big drawback they said the app was overwhelming for the quantity of data that shows. Over and above, the participants stated that BAC visualisations are interesting to see, however the number is taking too much space of the screen and it gives too much relevance. Lastly, one of the participants claimed - *"Knowing the estimated time of being sober is a good point"*.

- The Alcohol Abuse Predictor

  The Alcohol Abuse Predictor app was evaluated as a system with evidence on reducing excessive alcohol intake and has the highest number of BCTs (n = 13). However it has one of the lowest ratings of the selected mobile applications (rating = 3.7) and the participants of this workshops had the same opinion. They rated this app with the lowest score in both design and functionality and the reasons were:

  – No challenge against myself
  – No goal setting
  – The comparison with what others drink is not relevant
  – Tracking of user's progress is missing

  Nevertheless, participants found very valuable to read about BCT theory and that the app provides the user with health advices.

The next table shows a summary of the rating of the mobile applications from the participants.

Systems	Drink Less	AlcoDroid Alcohol Tracker	The Alcohol Abuse Predictor
Design	12 Medium	14 High	10 Low
Functionality	11 Medium	17 High	8 Low

Table 3.1: Mobile apps rating comparison. Number of earned points out of the total, 36 points.

3.3.3 Prototypes

The purpose of this task is to give the participants the opportunity to freely express their thoughts and ideas on how an app for alcohol reduction should be designed. The 6 participants were divided equally into two groups. Each group was asked to

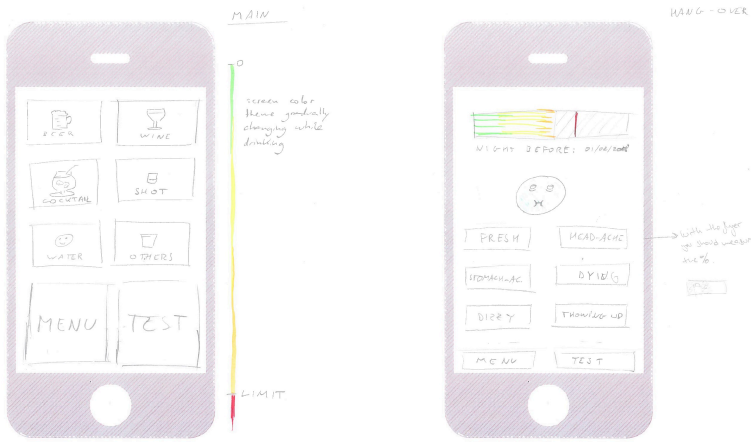
sketch a prototype of an app with the aim of alcohol consumption reduction. The participants were reminded of the possibility of including features from the 3 analysed apps in the previous task, as well as provided visualisations in paper.

3.3.3.1 Outcome

- 1st Group

  The first group prototyped an app focused in the self-reporting of drinks. This is the full list of features that the prototype would ideally include, in order of importance:

  - Self-report of drinks
  - Setting a weekly personal goal
  - Feedback of the drinks you should not take, considering the set goal
  - Weekly BAC progress
  - Self- report of meals previous to drink
  - Special alerts for special occasions (i.e. Set football match the morning after)
  - Feedback of last night out
  - Accurately report your feelings/mood previous to drink
  - Fast-to-play games to test how drunk you are. Show feedback according to performance.



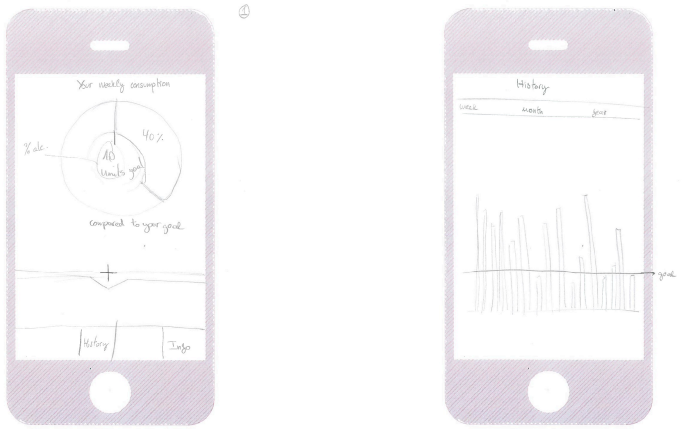
(a) Self-recording drinks (b) Rating hangover

Figure 3.4: Example of 1st group's prototype. A full prototype can be found in **Appendix B.2.5.1**

- 2nd Group

  An app prototype with focus on visualisations for weekly limits was done by the second group. The following key points were noted down from these participants' sketches, in order of importance:

  - Visualisations of weekly limits (i.e. "How far are you from reaching your limit of 10 units/week")
  - Accurate information of what you drank last night (i.e. Number of units, type of alcohol, percentage, calories, and money). Calculate totals.
  - Database of drinks that the user could drink without over-passing the weekly limit - use colour coding
  - Progress graph of drinks - weekly, monthly and yearly - and show your goal/limit within the graph



(a) Weekly limit visualisation (b) Drinking progress

Figure 3.5: Example of 2nd group's prototype. A full prototype can be found in **Appendix B.2.5.2**

Participants lastly collaborated by giving some extra suggestions/ideas, such as: reporting how was the hangover if the user drank the previous night or linking the app with the user's credit card to automatically record the number of drinks.
Moreover, some participants suggested to provide a database with the number of standard units corresponding to each alcoholic beverage, in order to know the contribution of their drinks to the weekly limit.

3.4 Prototype

Once the workshop was finalised, the author of this thesis analysed the participants' comments/suggestions/critics and used them in order to make the first prototype. Marvel [3] was the online tool used to make the first prototype. Marvel helps creating a digital prototype from pen & paper or from a design application. In this project the prototype was firstly sketched and then uploaded to Marvel. This web application helped to create connections in between the different screens, and then make the prototype publicly accessible in this link.

https://marvelapp.com/3a6088j

[3] `https://marvelapp.com`

The findings from the workshop contributed to the included components in the prototype with the purpose of meeting the needs of the user.

The main screen shows an overview of what the user drank during the week and how far it is from the weekly limit. In that way, the user knows if he is exceeding the recommended maximum standard alcohol units for the week.
There is also a summary of the drinks taken in the last drinking episode, because providing this information has an effect in the user. Going through a learning process of what users drink, helps them become more self-aware of the amount of alcohol consumed. This self-awareness process might contribute to a behavioural change towards the quantity of alcoholic beverages consumed or the way the consumption is spread over the week.

An essential component of this prototype was the self-recording of drinks. This feature was a basic need for the app and the requirements were to be: simple, fast, clear and easy to input.
This need brought the design to include a *floating button*, see Figure 3.6. A floating button is typically used for positive actions; such as, create, add, take picture, write ... (not delete). Therefore, this kind of button was used to let the user self-record the drinks easily.

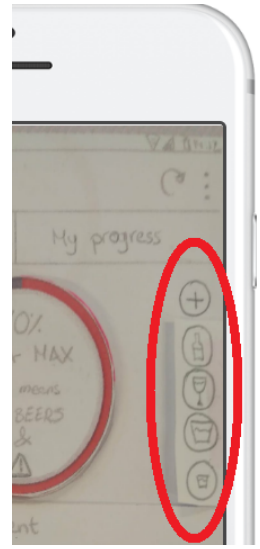


Figure 3.6: Sketched floating button

Moreover both components, the *'previous-to-drink'* food intake report and next day's hangover report, were added in the prototype. These components are particularly important since they contribute to one of the 5 most used BCTs - 'provide information on consequences of excessive alcohol consumption and reducing excessive alcohol consumption'.

The second screen was sketched with the purpose of giving feedback to the user about how his drinking habits evolved over the time, as well as his/her BAC level. Providing feedback on the user's progress is a well known BCTs which addresses motivation.

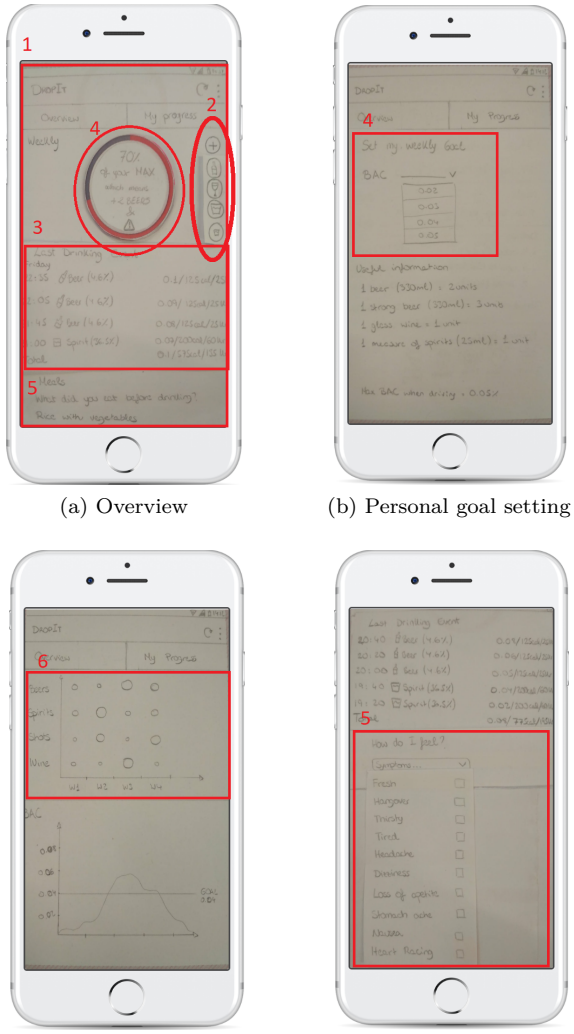
3.4.1 Prototype's feedback

The first prototype was completed and user feedback was needed to iterate over the design and functionality with the purpose of improvement. A questionnaire was created in Google Forms [4], in order to get feedback in a fast and accessible manner. The questionnaire was filled in by 12 people, being most of them students in between the

[4] `https://www.google.com/intl/es/forms/about/`

age of 22 to 29. The questionnaire can be found in **Appendix B.2**.

Figure 3.7 shows a collection of screenshots from the prototype. The figure contains numbers from 1 to 6, which correspond with the feedback that interviewees gave and that can be found below the figure.



(a) Overview

(b) Personal goal setting

(c) My progress

(d) Hangover assessment

Figure 3.7: Screenshots of first prototype

1. Overview: Interviewees liked to have a simple visualisation, such as the circular gauge showing the weekly progress. Nonetheless, some feedback was focused on the dislike of the prototype being designed in a weekly basis, while they would rather focus on the single current drinking event. In general they liked that there is only 2 tabs on the top for navigation - from *Overview* to *My Progress*, and vice versa.

2. Floating button: According with some interviewed people the floating button's action was not clear, in regards to the specific drinks. Interviewees requested some labels for it to be fully understandable. While others stated - P5: *"Nice way to input my drinking so fast."* - or - P11: *"The icons are really intuitive."*

3. List of drinks: There was a general comment about the first screen being overwhelming, because too much text was included regarding the list of drinks from the last event. In addition, there was a complaint about the understanding of the first value of the list. This value wasn't labelled, therefore interviewees could not know that this value was referring to the BAC level.

4. Goals: Setting personal goal is a real need that interviewees liked from the prototype. However, an interviewee stated - P7: *"I don't understand the screen that appears when the circle is tapped. Which number am I supposed to choose?"*. From this feedback it is assumed that a redesign of the goal screen needs to be carried out.

5. Hangover and meals report: Interviewees liked to report what they ate and how they felt after a night with drinks, to be able to look at it and consequently, take decisions.

6. Progress: The scatter plot was confusing for some people and don't see the relevance for a monthly visualisation. However, they agree about showing the progress as a visualisation, and not as text.

7. Missing features:

    - Information about the recommended limit by the Danish law and the driving limit.
    - Possibility of sending drinking data
    - Hangover prediction
    - Adding a summary of the last event or last week *(i.e. How fast did you reach 70% of the goal last week?, max BAC reached, hangover symptoms, etc.* , every day or every Monday you open the app, respectively.
    - Historical data about the top worst hangover days, with the purpose of not repeating the same drinking episode

The feedback showed that most of the interviewees thought the prototype to seem *'Easy'* or *'Very easy'* to use. Additionally, the graph shows that the score of the perceived usefulness of the prototype was high; due to the fact that 7 out of 12 people thought that this potential app could be useful in a future.

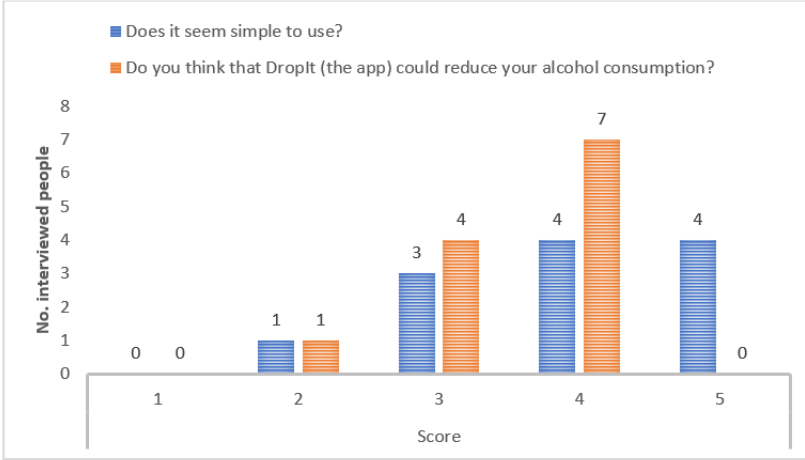


Figure 3.8: Feedback on usability and perceived usefulness of the prototype

The full feedback document can be found in **Appendix B.2**

CHAPTER 4
Implementation

This chapter contains the methodology for building the solution of the mobile application that intends to change the behaviour of young people towards excessive alcohol consumption, by making a usability friendly and useful system using BCTs.
Firstly, the merge of the software with the acquired breathalyser will be explained in the section 4.1.
Subsequently, the *User Interface* section will tell in the form of a story, the process of coding the designed human-computer interaction.
And lastly, the section *Data Management* will describe in detail what occurs in the back-end of the implemented software piece - this is, what happens *'behind the scenes'*.

4.1 Breathalyser - BACTrack VIO

After the research in devices to measure Blood Alcohol Content was accomplished (see Table 4.1), the breathalyser BACTrack VIO[1] was chosen to be used in the project.

The reasons to select this breathalyser, in order of priority, were:

- Compatible with smart-phones: BACTrack VIO is both compatible with iOS and Android devices
- Open source API - SDK available in BACTrack's website
- Compact design, in order to be portable: Design to be used as a keychain
- Accurate BAC level results: Using semiconductor sensor technology
- Affordable: BACTrack VIO's prices is 50 $

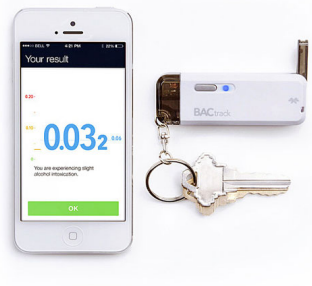


Figure 4.1: BACTrack VIO and BACTrack App

[1] https://www.bactrack.com/products/bactrack-vio-smartphone-keychain-breathalyzer

Device	BACTrack VIO	WrisTAS [2]	SCRAM [3] [38]	FLOOME [4]
Compatible with Android and iOS	Yes	No	Yes	Yes
SDK / Data Available	Yes / Yes	No / Yes	No / Yes	Yes / Yes
Portable	Yes	Yes	Yes	Yes
Accurate BAC	Yes, not the best	Yes	No	Yes
Affordable	Yes (320 kr.)	No (15000 kr. + 7500 kr. /year)	No (25000 kr.)	No (800 kr. + 7500 kr.)

Table 4.1: Hardware comparison

One BACTrack VIO unit was bought for the implementation process. The BACTrack App (for iOS[5] and Android[6]) was downloaded to test how the system worked - how was the interaction with the breathalyser to measure the BAC level.
The project's mobile application was chosen to be developed for Android devices in the platform Android Studio[7], but not for iOS devices. This decision was made because of several reasons:

- The fact that there are 2 different SDKs, one per operative system. Which implies a need for coding in the native language of each operative system, iOS and Android.
- In the mobile world there is a higher amount of Android users than iOS. Specifically in the beginning of 2017, 70% more according to International Data Corporation (IDC)[8].
- The knowledge about Android programming language of the developer of this system is much stronger than what it is about Swift programming language

For those reasons, the BACTrack SDK for Android was downloaded. The SDK contains a demo version which was run and understood.
The demo included the functionalities that can be seen in Figure 4.2 and for this project two of them were essential: *'Connect to Nearest BACtrack'* and *'Start Blow Process'*. Therefore, the project's mobile application was developed with this demo as a base code.

[5] `https://itunes.apple.com/us/app/bactrack/id553347498?mt=8`
[6] `https://play.google.com/store/apps/details?id=com.bactrack.bactrack_mobile`
[7] `https://developer.android.com/studio/`
[8] `https://www.idc.com/promo/smartphone-market-share`

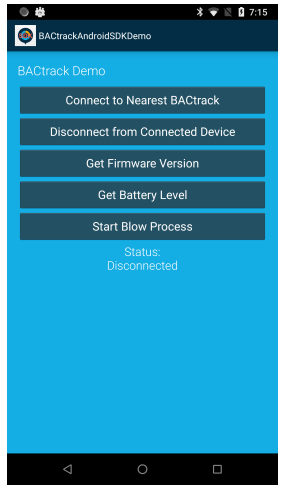


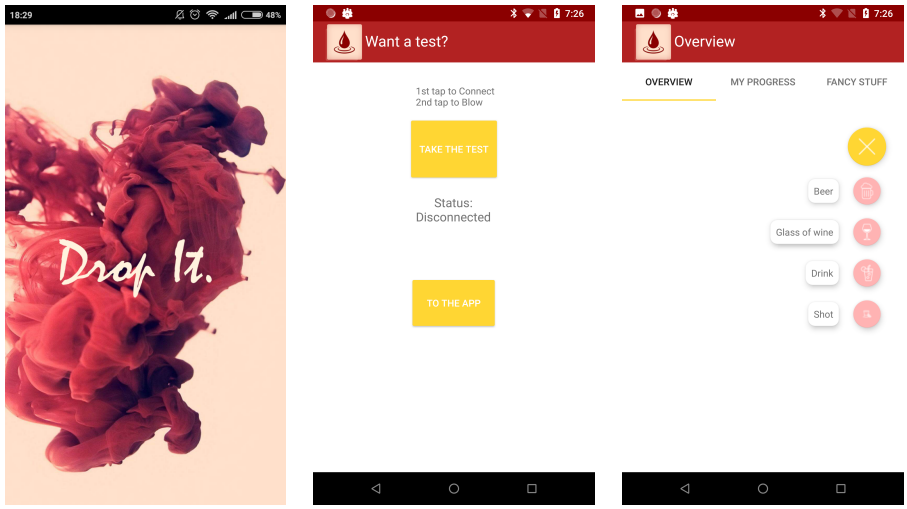
Figure 4.2: BACTrack SDK Demo

4.2 User Interface

This master thesis is focused in building a mobile application with a good usability and evaluate its perceived usefulness. This section describes the chronological process of applying the knowledge gained from the UCD to the development of the app.

4.2.1 PART I - Take a BAC test

The name of the app was decided to be *'DropIt'* in regards to the slogan *"Dropping that extra drink you don't need"*, which promotes a healthy drinking. As a start the Software Development Kit (SDK) was modified to be able to connect to the BACTrack VIO and take a test simplified in one button.
The *'TAKE THE TEST'* button needed to be tapped twice: first time to connect to the breathalyser and second to start the blowing process, as seen in Figure 4.3b.
The Figure 4.3c presents the screen that shows when *'TO THE APP'* button is tapped. A 3 tab screen was created to offer an easy navigation for the user. In the first tab the user can report his/her drinks using a floating button, included due to its great acceptance. However in order to make the type of drink input completely clear, labels were added. A small but important usability detail is the icon in the floating button. A 'plus' icon is shown to add drinks, and a 'cross' icon to close the type of drinks option.

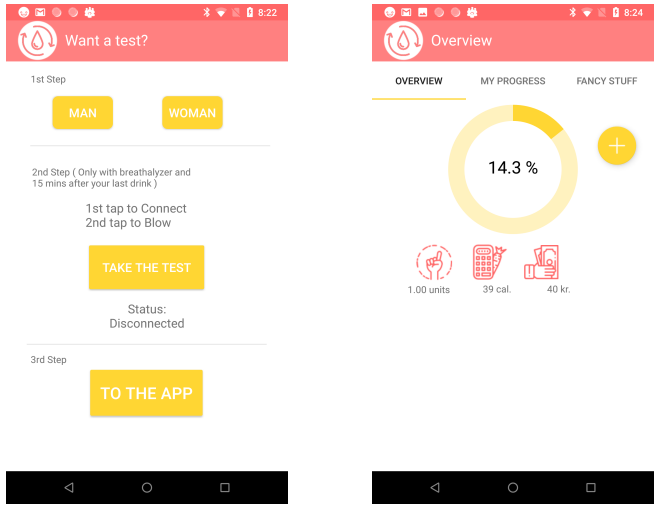


(a) Splash screen (b) First screen (c) Tapped floating button

Figure 4.3: Part I: Take a BAC test

4.2.2 PART II - Visualisations and Recommended Limits

In this second part visualisations were included to give feedback to the user about what he/she drank.
Figure 4.4b presents a gauge indicating the percentage of the weekly alcohol intake out of the maximum std. alcohol units recommended by the Danish Health Board [61], being 7 and 14 respectively for women and men.
From this information arose a need of obtaining the gender of the user. This feature is included in a procedure of 3 steps: 1) Choosing gender with normal buttons, 2) Take a BAC test by tapping twice, and 3) Go to the tabbed view of the app (see Figure 4.4a).
From the workshop it was observed that there was a big interest in number of consumed calories and spent money. Hence, corresponding icons and texts were included to easily identify each item and provide the relevant information (see Figure 4.4b).



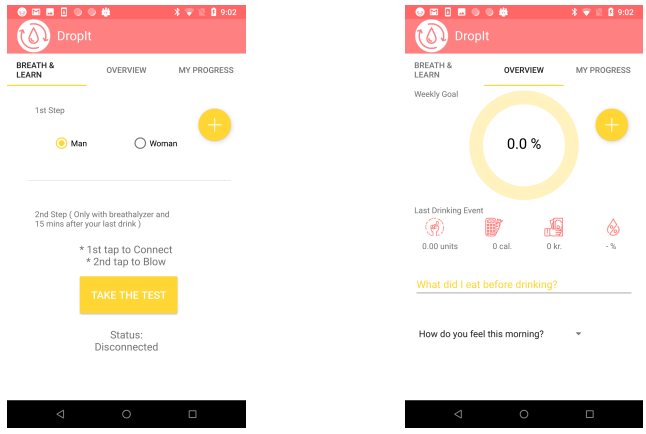
(a) Test screen (b) Overview

Figure 4.4: Part II: Visualisations and Recommended Limits

4.2.3 PART III - Navigation issues and Personal Data

At this point there was inconsistency in the navigation and accessibility issues with the BAC testing screen. Therefore, the BAC testing was merged within the tabbed view.
Moreover, the normal buttons for the selection of Man or Woman weren't suitable for their functionality. Consequently they were substituted by radio buttons, which allow the user to choose just one of the options, as can be seen in Figure 4.5a.
In addition, the drop icon of the app was enabled as navigation component to go to the first tab. The below listed components were also included (see Figure 4.5b):

- Text fields to indicate time the visualisations correspond to (e.g. Weekly Goal)
- In previous versions the BAC level was only visualised below the *'TAKE A TEST'* button and it disappeared with every new measurement or every disconnection of the breathalyser. In this way the users weren't able to check on the last BAC level. Therefore, this feature was included in the information about the *Last drinking event*.
- Text input field for meals before a drinking event. This field was a user need identified in the UCD workshop, due to participants' conviction in food's influence on alcohol symptoms. Indeed food has an impact on the metabolic process of the alcohol; thus, also in the BAC [25].
- Selection of hangover symptoms. This feature, provides the user with feedback on alcohol intake consequences, which is part of a BCT discussed in the UCD workshop.



(a) Test screen (b) Overview

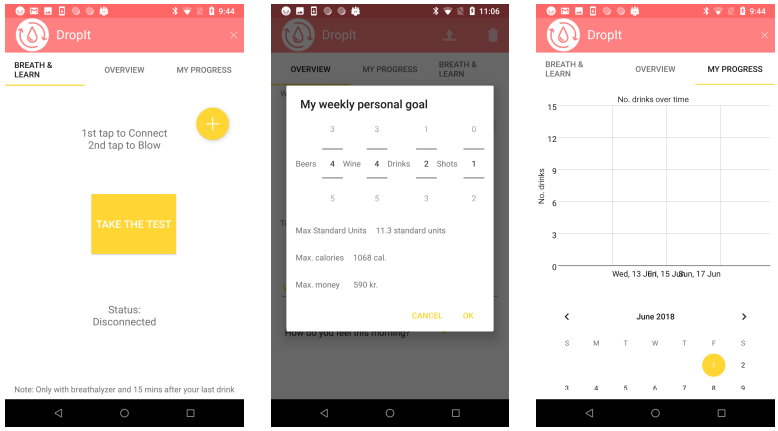
Figure 4.5: Part III: Navigation issues and Personal Data

4.2.4 PART IV - Usability, User Control and Feedback on performance

Once the navigation issues were solved, the next step was to have a greater focus on the user. In this part of the UI development the good usability was a priority.

- *Breath & Learn Tab:* The radio button which allowed the user to choose gender was removed from the first tab and moved to a screen that can only be seen when installing the app. This modification was done for the simple reason that users do not need to specify gender more than once. *Note: The start screen will be shown in the final solution in subsection 4.2.5.*
- *Overview Tab:* The inner circle of the gauge incorporates setting personal weekly drinking goals, which in fact are maximum drinking limits. It works by tapping the inner circle that is shown in Figure 4.5b. Then an alert dialog pops-up where the user can specify weekly maximum number of: beers, glasses of wine, drinks, and shots (see Figure 4.6b ; **Appendix C.1** for information about calculations[9]) [66, 25, 16, 61]. The selected number of drinks will translate into standard units, calories and approx. money predicted to spend. Those values will be presented, hence the user has the opportunity to choose an economic, caloric or official recommendation type of reason to reduce alcohol consumption.
- *My Progress Tab:* A graph with the user's consumed drinks over time and a calendar were introduced in the middle tab, as part of the BCT mentioned in *Part IV*. Firstly, the graph users will rise awareness on users' drinking habits and evolution over time. Secondly, the calendar is a useful component for the user to see what he/she: ate, drank and felt on a specific date. The expected usefulness of this feature is high, since the user can learn the effect of alcohol on his/her body depending in type and amount of food and alcohol beverages.

[9] `https://ndb.nal.usda.gov/ndb/search/list?qlookup=14050`



(a) Breath & Learn Tab (b) Weekly Goal Setting (c) My Progress tab

Figure 4.6: Part IV: Usability, User Control and Feedback on performance

4.2.5 PART V - Final solution

The final elements were included and last modifications were done, so that the system was as pleasant to use as possible. (See Figure 4.7 to follow the changes of this part).

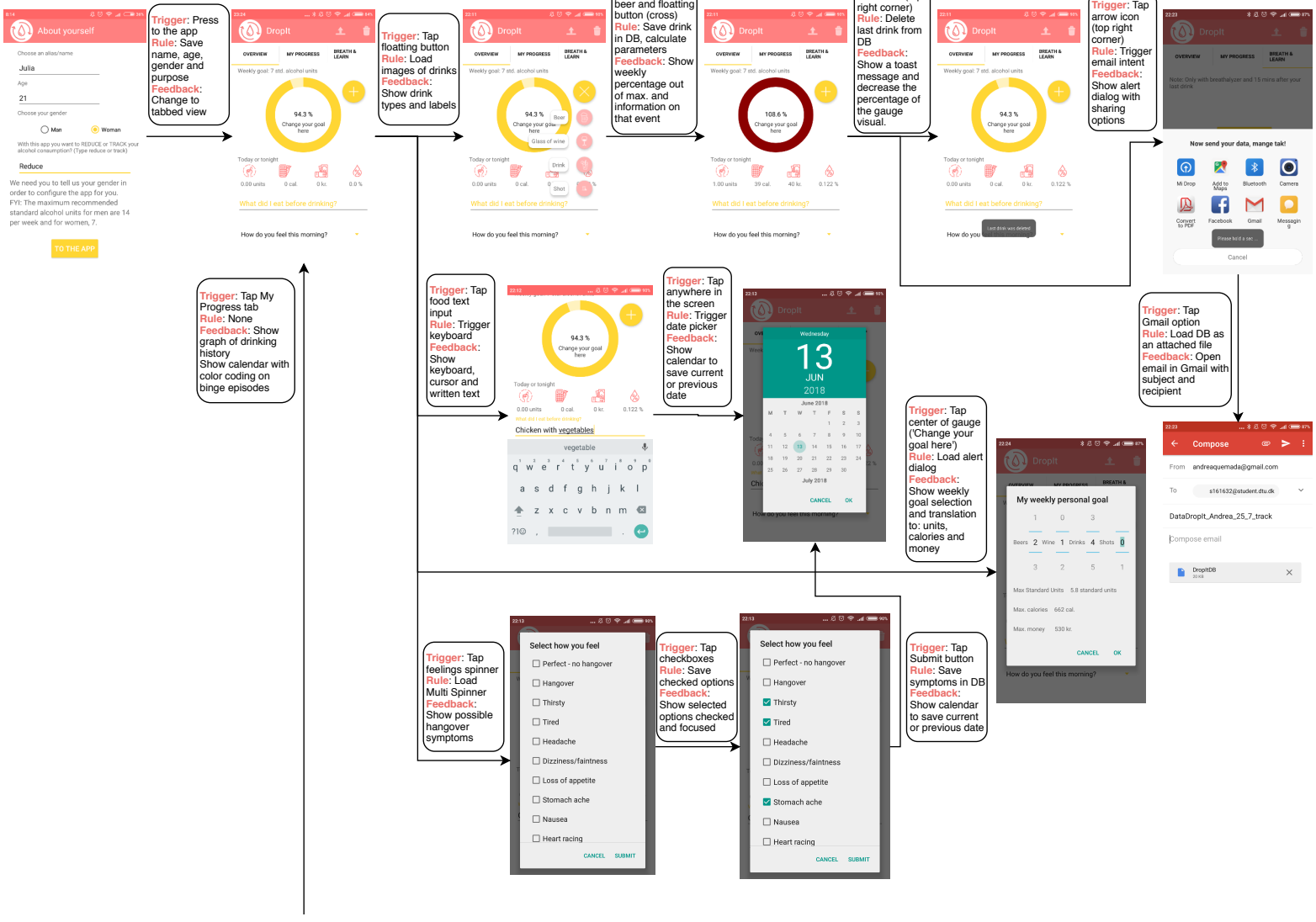
- *About Yourself Screen:* As explained in subsection 4.2.4, gender selection was moved to a screen that appears only when the app is installed. Besides, this screen requires: name/alias, age, gender, purpose of using the app (track or reduce alcohol consumption), valuable information when analysing data.

- *Overview Tab:* Includes possibility to delete the last reported drink and send data by: email, Facebook, and other social media platforms, in the upper right corner of the screen.
  The floating button was presented in every tab because it was thought to provide accessibility.However, it was later discovered to be a confusion utility, as quoted from one user: *"The button press did not provide any feedback if I wasnt in the right tab"*.
  Additionally, the number of maximum weekly standard units are displayed on the top left corner of the gauge, due to the need of a reference of standard alcohol units

- *Breath & Learn Tab:* It was observed that users looked at the text inside the yellow button (Figure 4.6a), but never the text above. As a result of this bad interaction, the guiding text on top of the button was removed and changed to be displayed in the yellow button, which changes with the tapping.

- *Notification:* Lastly, as the self-reporting of drinks was not a daily habit, it was noticed by testers that it was difficult to remember. For this reason, a notification was sent everyday at 21:00 which acted as a reminder to report the drinks of that day

5.2.5.1 Storyboard with MicroInteractions



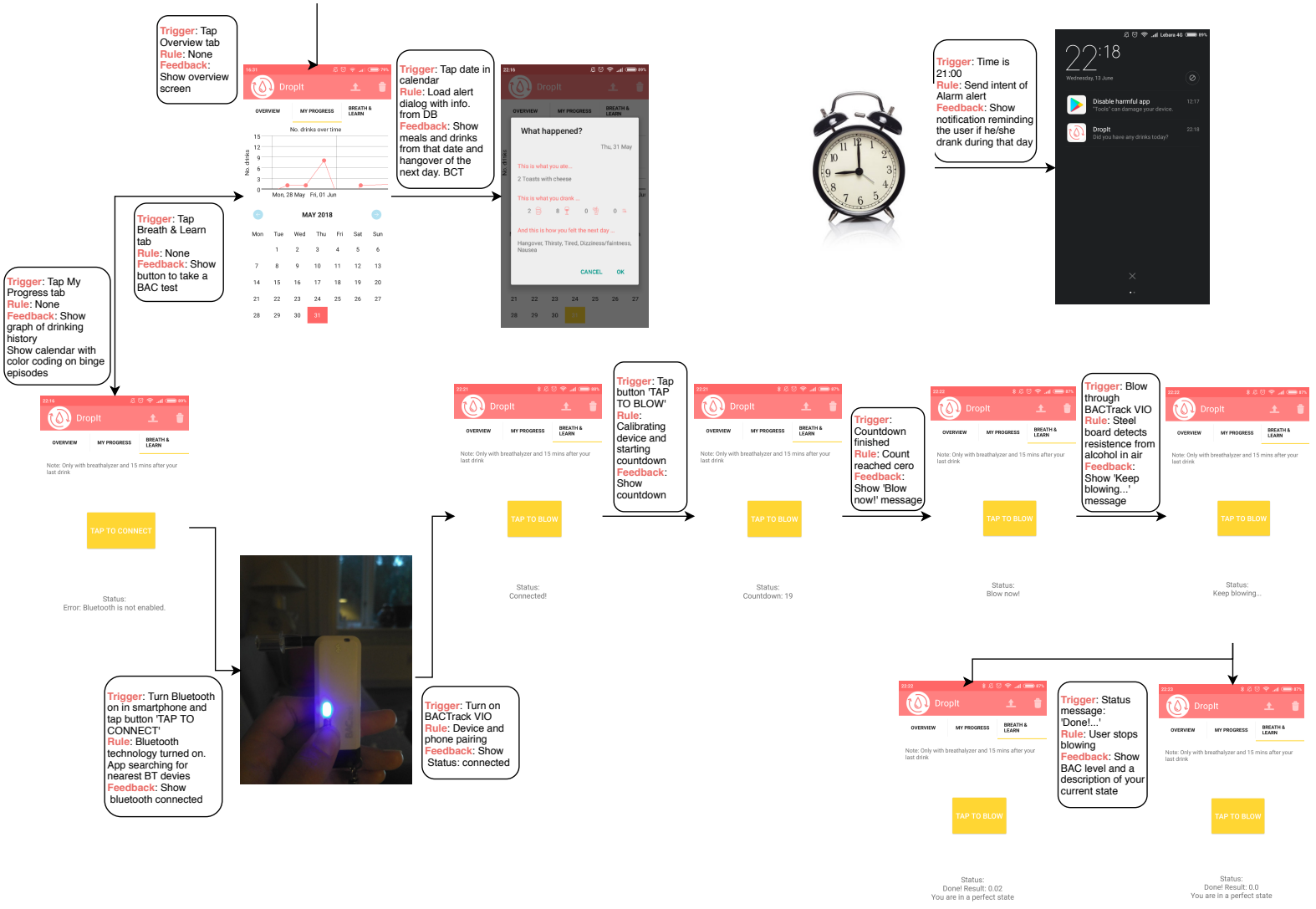


Figure 4.7: Part V: Storyboard with Microinteractions DropIt App

4.3 Data Management

This section contains the background interaction between the mobile application and a local SQLite database. The database called DropIt contains two tables, named *Drinks* and *Body*. The table *Drinks* contains the drinks that a user had, including type of drink and timestamp; and the table *Body* contained data about meals and hangover symptoms.

The source code of the mobile application *DropIt* can be found in **Appendix D, section D.1**.

4.3.1 Breath & Learn

The following flowchart, Figure 4.8 explains the data collection that occurs in the tab *Breath & Learn*. Basically when the user takes a test, the app finds the closest BACTrack breathalyser and automatically connects to it. After the user has blown in the breathalyser, the result value is stored in the database as an entry in the *Drinks* table.

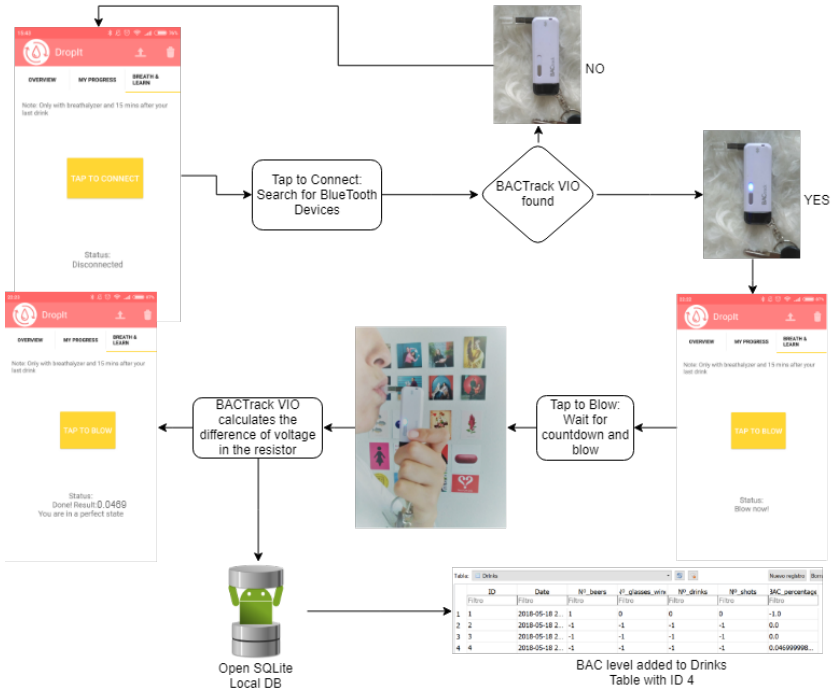


Figure 4.8: Tracking BAC level process

4.3.2 Overview

4.3.2.1 Self-reporting

Figure 4.9 illustrates how the data the user inputs is stored in the database. Specifically, data type A is stored in table *Drinks* and data types B and C are stored in table *Body*.

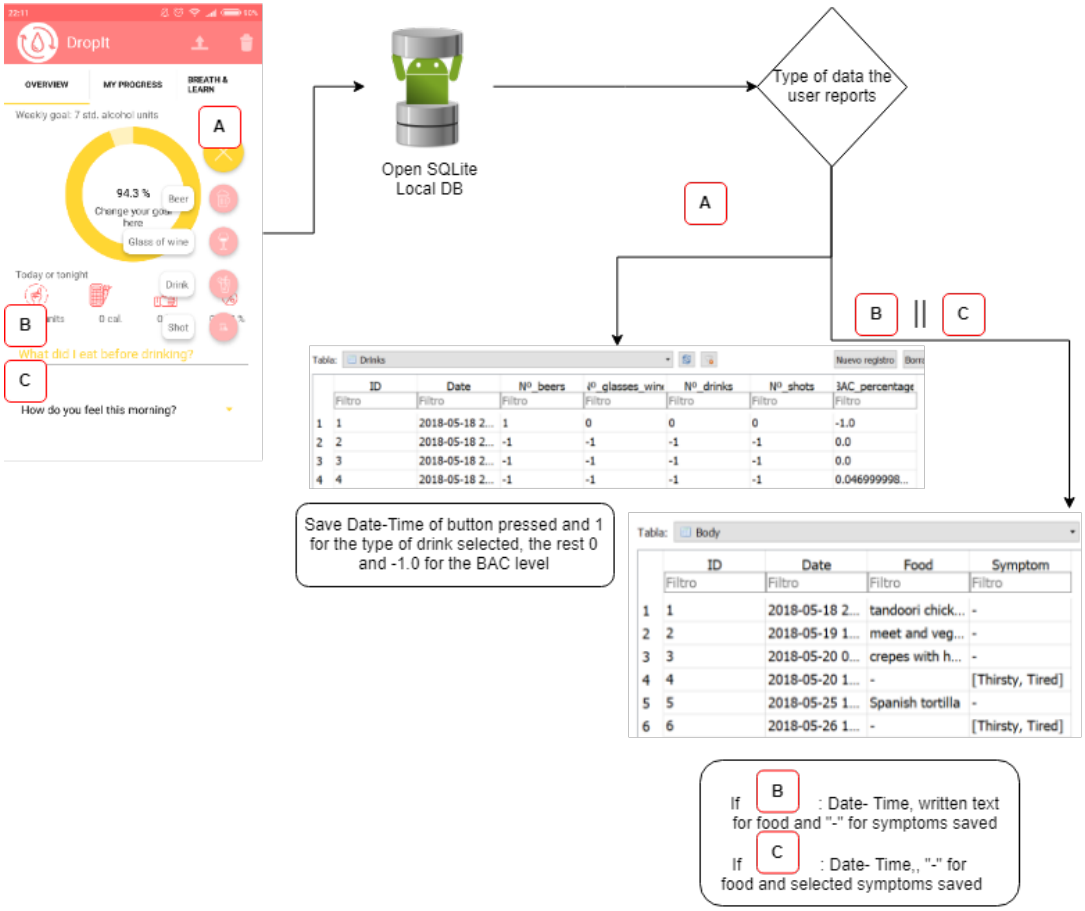


Figure 4.9: Data reporting process

4.3.2.2 Visualisation

Figure 4.10 describes how the data stored is fetched to be presented on the mobile application. This data is filtered depending on the visualisation. For the gauge (visualisation A) the data is fetched weekly, meaning from Monday to Monday. Differently, the data displayed just under each icon (visualisation B) are fetched daily, meaning from 8:00 a.m of the current day until 7:59 a.m of the next day. Finally, the visualisation C, the BAC level is fetched by taking the last entry in table *Drinks* that doesn't have a *BAC_percentage* of -1.0.

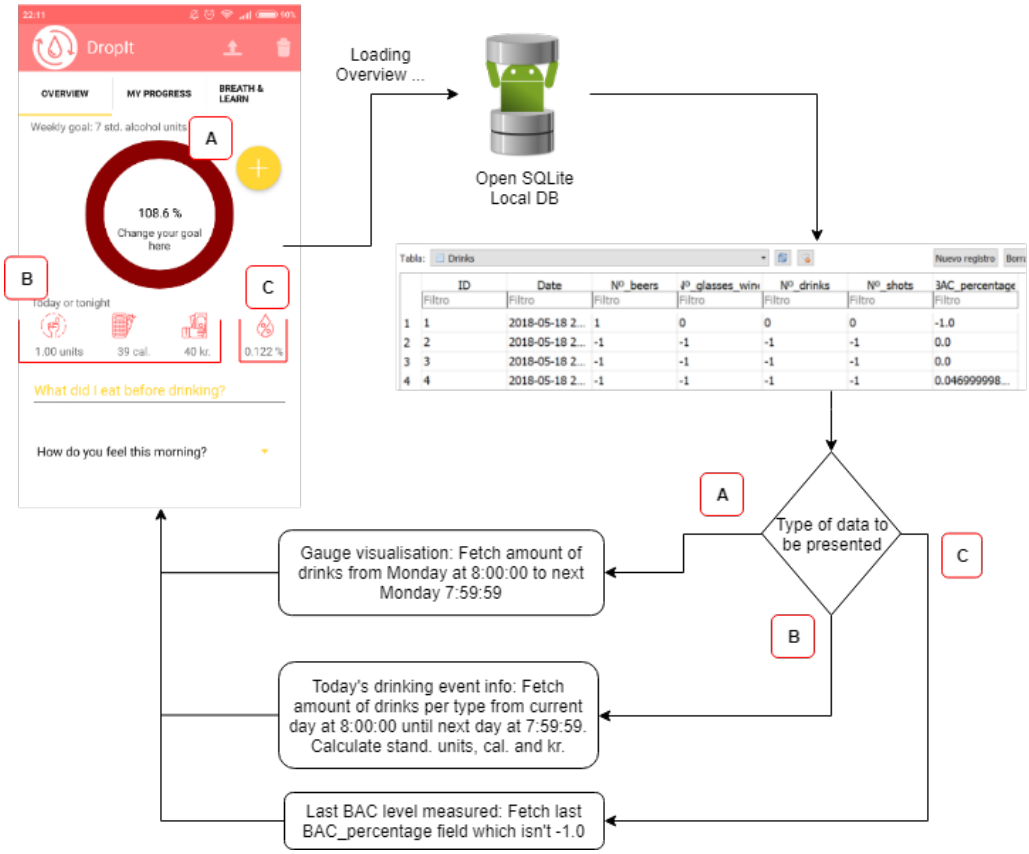


Figure 4.10: Overview presenting data

4.3.2.3 Sharing data

The arrow that is placed in the upper right corner of the screen (see Figure 4.11) gives the user the opportunity to send the data to the author. The control of this action was given to the users because it was desired to make them feel that they had control over their data.

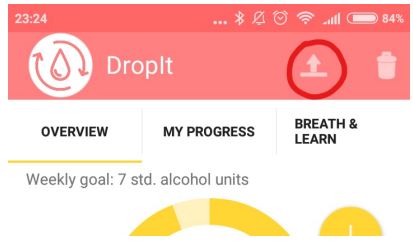


Figure 4.11: Option: Send data

The data from will be collected and converted from SQLite database format to csv format. Indeed, the data will consist of 2 csv files; one corresponding to the table *Drinks* and one to the table *Body*. The data from those csv files will be analysed using Jupyter Notebook version 5.5.0[10] and Python version 2.7[11].
The result of this analysis can be found in chapter 6.

4.3.3 My Progress

In the tab *My Progress* there is 3 places where the data needs to be fetched from the DB. To create the graph the amount of daily drinks are fetched from the *Drinks* table. If that value is equal or greater than 5 standard alcohol units, the calendar shows that day in red, because it's labelled as a heavy drinking episode. The data presented in the alert dialog saying *"What happened?"* (interaction C in Figure 4.12) is fetched from both tables in the DB, *Drinks* and *Body*. The symptoms presented correspond to the data from the next day to the drinking event, since the user is expected to input the hangover in the next morning.

[10] `http://jupyter.org/`
[11] `https://www.python.org/`

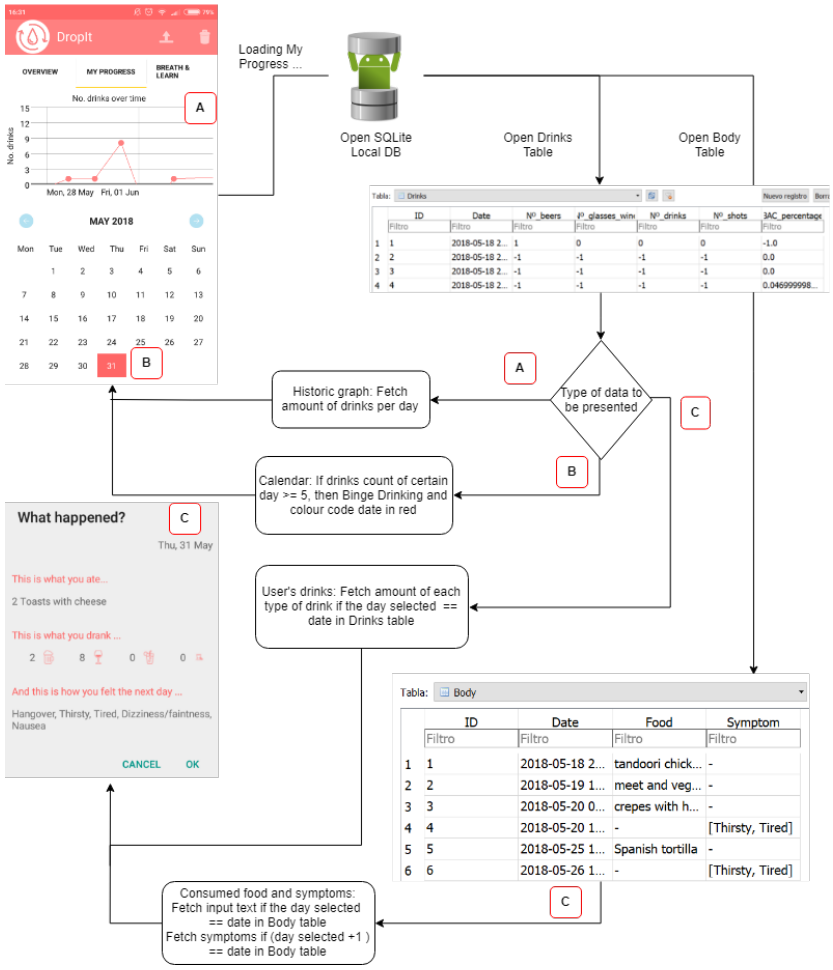


Figure 4.12: Data visualisation

CHAPTER 5

Study

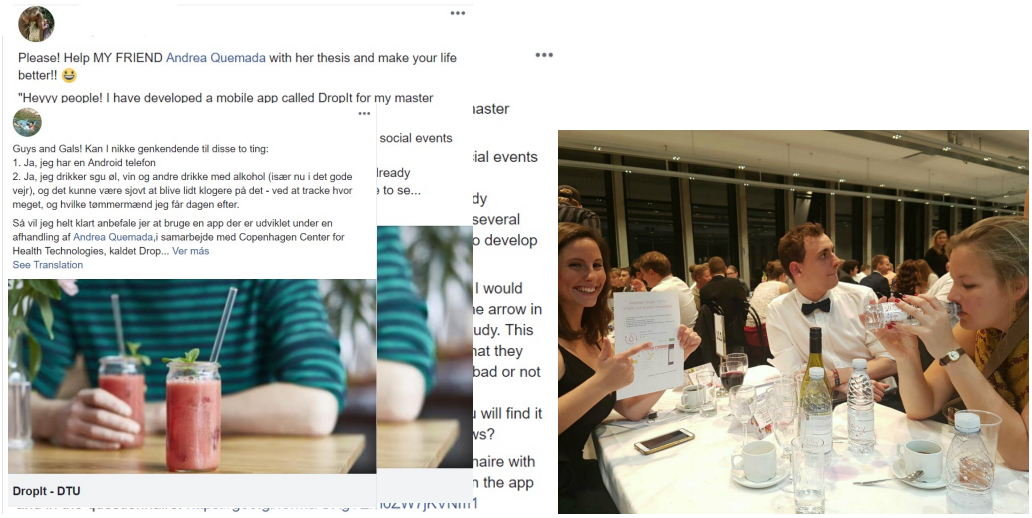
An *'in-the-wild'* study was carried out in order to test and evaluate if *DropIt* is an easy-to-use mobile application and whether there is a future behavioural change possibility, as assessed by the perceived usefulness.

5.1 Recruitment

A snowball recruitment process was used within three areas. (1) Flyers were distributed with the potential of reaching over 1,800 from the Technical University of Denmark's (DTU) Annual Party (DTU Årsfest[1]) in Lyngby (see **Appendix B.3**), (2) social-media recruitment of 510 from the author's network on Facebook (see Figure 5.1), (3) by word of mouth in the near network of the author.

In the first day of the study 23 people downloaded the app, the second day 36, and the maximum amount of users was reached in half-way of the study with 53 downloads. For this study, only people that had completed the pertinent questionnaires and decided to share the data with the project, were considered subjects. Therefore, the dropouts were consequence of not filling out the required questionnaires, uninstalling the app due to small bugs, and installing the app but never sending data to be analysed during the project.

[1]Number of attendants in the Facebook event 'DTU Årsfest 2018'



(a) Social-media posts

(b) Distributing flyers during the DTU Årsfest

Figure 5.1: Different recruitment forms

There were some requirements and some discriminatory features for users to be part of the study.

- *Inclusion criteria:*
  1. To be an Android smartphone user
  2. To have English language skills
  3. To drink alcohol beverages
- *Exclusion criteria:*
  1. To be below the age of 18 years old, since it is an app related to alcohol
  2. Not participating in one or both of the tasks: filling out questionnaires and sharing data collected by the app with the study

A total of 15 subjects (40% females) were eligible in the age range of 23 to 31 years old. The study started from the beginning of May, and subjects were first asked to fill out the Alcohol Use Disorders Identification Test (AUDIT) [55, 2, 6]. The AUDIT test is a 10 item questionnaire that provides a simple method of early detection of hazardous and harmful alcohol use in primary health care settings. The questionnaire is useful to identify drinking profiles of the subjects involved in a study, and can be categorised in 3 groups: low, medium and high risk.
The AUDIT questionnaire was delivered online by a *Google Forms* survey[2].

[2] `https://goo.gl/forms/9qtMIkd1MENnyfLB2`

5.2 Experimental Setup

The study was performed *'in-the-wild'*, which is believed to provide more revealing results than other experimental lab-based approaches, due to the high external-validity, as stated in [14].

The BAC measuring device called BACTrack VIO Breathalyser was required to utilise all of the apps features. However, only 4 units were purchased and handed out with the support of Copenhagen Center for Health Technology (CACHET[3]). There was a limited amount of units due to economical reasons. The mobile application, *DropIt* was sent to the participants of the study through an online link to the app on Google Play Store. The link can be found in **Appendix B.4**
The participants were instructed to use *DropIt* for 1 month, and the 4 subjects with breathalysers were told to bring the breathalysers with them whenever they went out.

5.3 Questionnaires

Once the study ended, subjects were sent two questionnaires to assess the usability and perceived usefulness of the built system. These questionnaires are the System Usability Scale (SUS) and the Unified Methodology for Assessment of Clinical Feasibility (UMACF), respectively.

5.3.1 System Usability Scale

The SUS is a 10-item reliable, low-cost usability scale that can be used for global assessments of systems usability[9]. It is made as a 5-point Likert scale; 'strongly disagree', 'disagree', 'neutral', 'agree', and 'strongly agree' [34, 1, 39], which was validated by the article [33]. As in previous cases, the questionnaire was delivered to subjects through a online *Google Forms* survey[4].
SUS questionnaire's answers were submitted to the AUDIT website[5] in order to get the results that will be presented in chapter 6.

5.3.2 Unified Methodology for Assessment of Clinical Feasibility

Perceived Usefulness is defined in this project as "the degree to which a person believes that using *DropIt* would help drink alcohol in a healthier manner". This follows from the word useful: "capable of being used advantageously". *Perceived Ease of Use*, in contrast, refers to "the degree to which a person believes that using *DropIt* would

[3] `http://www.cachet.dk/`
[4] `https://goo.gl/forms/iqpLsvkbPTvyRVWJ2`
[5] `http://auditscreen.org/page.php?Using-Audit-1`

be free of effort".

The Unified Methodology for Assessment of Clinical Feasibility (UMACF) questionnaire likewise the SUS, applies a 5-point Likert scale which evaluates; perceived usefulness, perceived ease of use, perceived importance, perceived robustness, and perceived behaviour intention.
It is based on the article *"Perceived Usefulness, Perceived Ease of Use, and User Acceptance of Information Technology"* from Fred D. Davis [17]. The mentioned document proved that perceived usefulness is significantly correlated with both, self-reported current usage and self-predicted future usage. In the same way perceived ease of use was proved to be significantly correlated with both, current and future use .

There are different ways to present and visualise Likert scales results as discussed by Robbins et al.[53]. However, it is recommended to present data in (i) a table and (ii) as a so-called 'diverging stacked bar chart'. This method will be used to present the results of this questionnaire in chapter 6. Additionally, subjects received the UMACF questionnaire through a online *Google Forms* survey[6].

[6] `https://goo.gl/forms/MEywf4XELfx2Ao1L2`

CHAPTER 6

Results

To evaluate the developed mobile application a *pre* and *post* qualitative study, quantitative analysis and *'in-the-wild'* interviews were conducted. The qualitative evaluation consisted of two independent questionnaires; the System Usability Scale (SUS) and the Unified Methodology for Assessment of Clinical Feasibility (UMACF).
These questionnaire's results will be presented in this chapter. However, preceding those questionnaires the subject's 'on-the-go' feedback will be introduced; feedback which was collected while the subjects were using *DropIt*.
Additionally, the data collected from the subjects when using *DropIt* was analysed and the corresponding results are presented in the present chapter too.

6.1 Subject's drinking profile

As explained in the chapter 5, an AUDIT test was filled by the subjects of the conducted study which helped identifying the drinking profiles. Those profiles were categorised in 3 groups: low, medium and high risk.

There were 5 subjects corresponding to the healthy low risk category. However 8 out of 15 were classified into the medium risk category. These 8 subjects have a drinking pattern that is putting themselves at a risk of harm in the short term (such as injuries) and in the long term (such as diseases of the liver, heart, brain, muscle, nerves and other key organs and systems of the body). The splinter group, with a minority of 2 subjects, belong to the high risk category which indicates alcohol dependency. People in high risk category are recommended to seek medical help because if alcohol dependence is untreated, it has a seriously progressive course [6].

6.2 Data analysis

This chapter will reveal the results found from the data analysis of the mobile application. Each of the following subsections will contain one-single graph about; drinking patterns of subjects, BAC level measurements, gender differences when drinking, most consumed drink types, most common hangovers, and hangovers depending on amount of drinks.

The source code for the data analysis can be found in **Appendix D, section D.2**.

6.2.1 Drinking patterns over time

Firstly, an analysis of general drinking patterns over time was conducted. Figure 6.1 [1] shows the amount of drinks consumed over the period of one month (duration of the study) per subjects. In the scatter plot, each colour identify a subject, and the size of each bubble represents the amount of drinks in one day. The bigger the bubble, the higher amount of drinks. There are subjects with more entries than others, which suggest they drink in more occasions. However, the fact that subjects could have forgotten to input their drinks needs to be taken into account.
From the graph it is observed weekend drinking patterns for subjects; 1, 2, 3, 5, 6, 11, and 14 (being the weekends during the study; 5-6, 12-13, 19-20, 26-27 of May and 2-3 of June), except for the first and last weekends. It perfectly coincides with the event of the DTU Årsfest (4th of May, date of app publishment) and the Distortion Festival(30th and 31st of May) in Copenhagen. Meaning that subjects decided not to drink or drink less those weekends when they drank during weekdays. Subject 11 and 5 are the ones that had the highest amount of drinks in a single occasion.

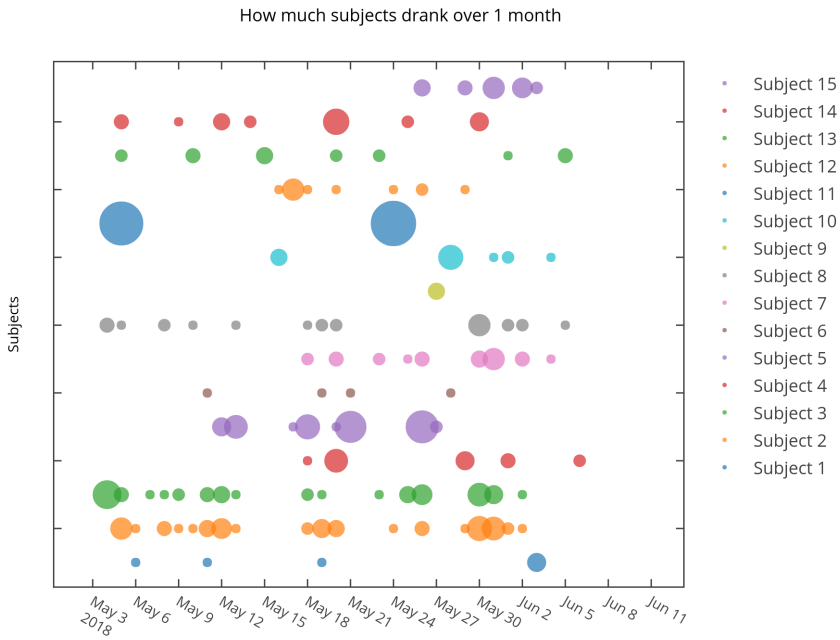


Figure 6.1: Drinks over time per subject

[1] Note: An interactive version of Figure 6.1 can be found in: `https://plot.ly/~andreaque/43.embed`

6.2.2 BAC level measurements over time

Figure 6.2 [2] presents the BAC measurements per day over the duration of the study, per subjects. Likewise in the previous Figure 6.1, each colour represent a subject, but in this case the Y axis indicates the level of BAC in g/dl [3]. As a reference to understand the BAC measurements, a BAC of 0.05 is the common driving-limit in European Countries, including Denmark [69, 18]. Subjects 2, 3, 8, and 14 were the ones that owned breathalysers, however the breathalysers were occasionally shared among the participants and therefore data from 8 subjects was collected. The highest levels on BAC were reached by subjects 15, 2 and 14, but never overpassed 0.2, which correspond to the symptoms euphoria and motor impairment as described in Table 2.1. Weekend drinking patterns can be seen again for the weekends; 12-13, 19-20, 26-27 of May and then, the Distortion festival.

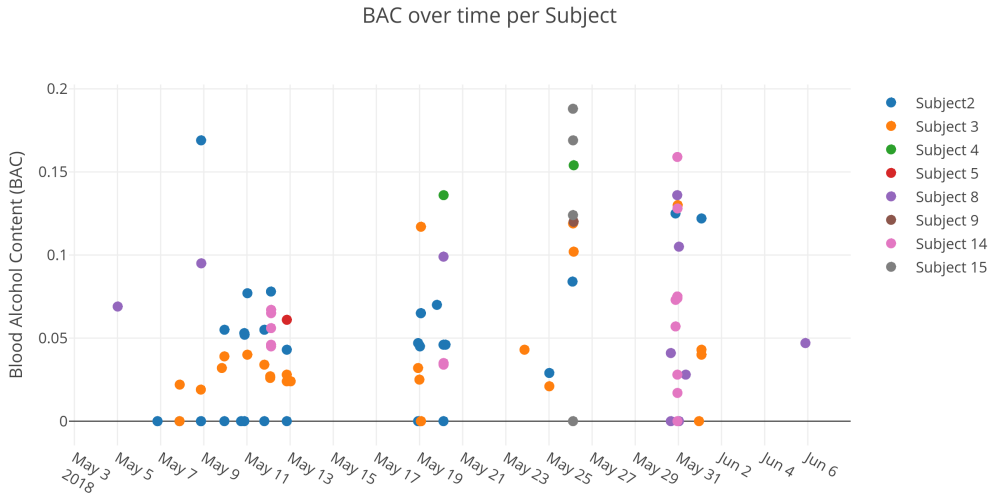


Figure 6.2: BAC level over time per subject

[2] Note: An interactive version of Figure 6.2 can be found *here*

[3] `https://www.bactrack.com/blogs/expert-center/35044037-what-is-bac`

6.2.3 Drink Type disparity per gender

Figure 6.3 [4] presents the percentage of subjects within 2 different groups - females (in blue) and males (in orange) - divided in the possible beverages; beer, wine, drinks, and shots. The graph illustrates that males have a more skewed distribution with a majority drinking beer. The distribution for female is more uniform between beer, wine and drinks. However shots were never reported by this group.

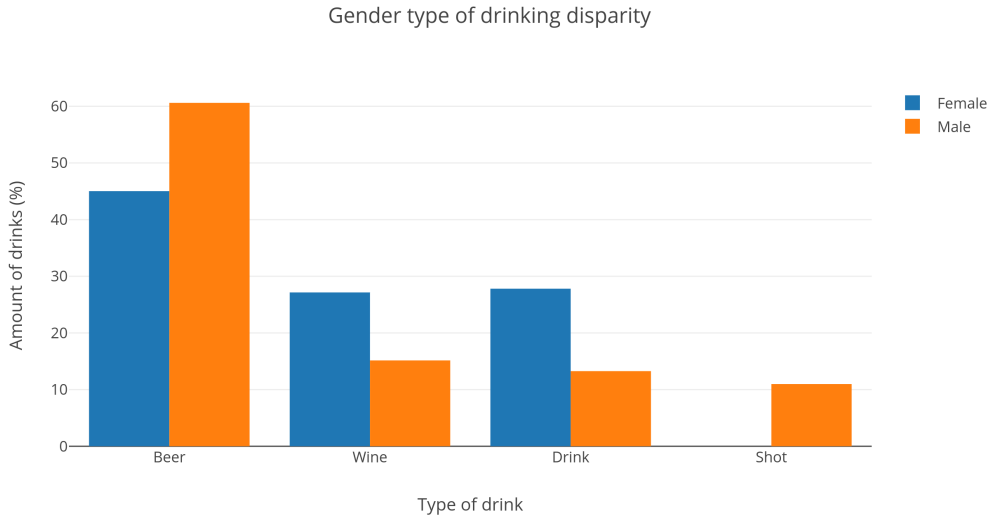


Figure 6.3: Drinking disparity per gender

[4]Note: An interactive version of Figure 6.3 can be found in: `https://plot.ly/~andreaque/57.embed`

6.2.4 Drink Type disparity per subject

Figure 6.4 [5] shows the total amount of drinks (categorised in four types; beer, wine, drink/spirit and shot) each subject drunk during the study. In the same manner as in Figure 6.3, different colours represent different subjects and the size of the bubbles quantity of drinks.
Repeatedly, it is noticed that beer is the most liked alcoholic drink and what people drinks most. It is also interesting to see that both subjects who had the highest amount of drinks in a single-occasion, drank beer and shots.

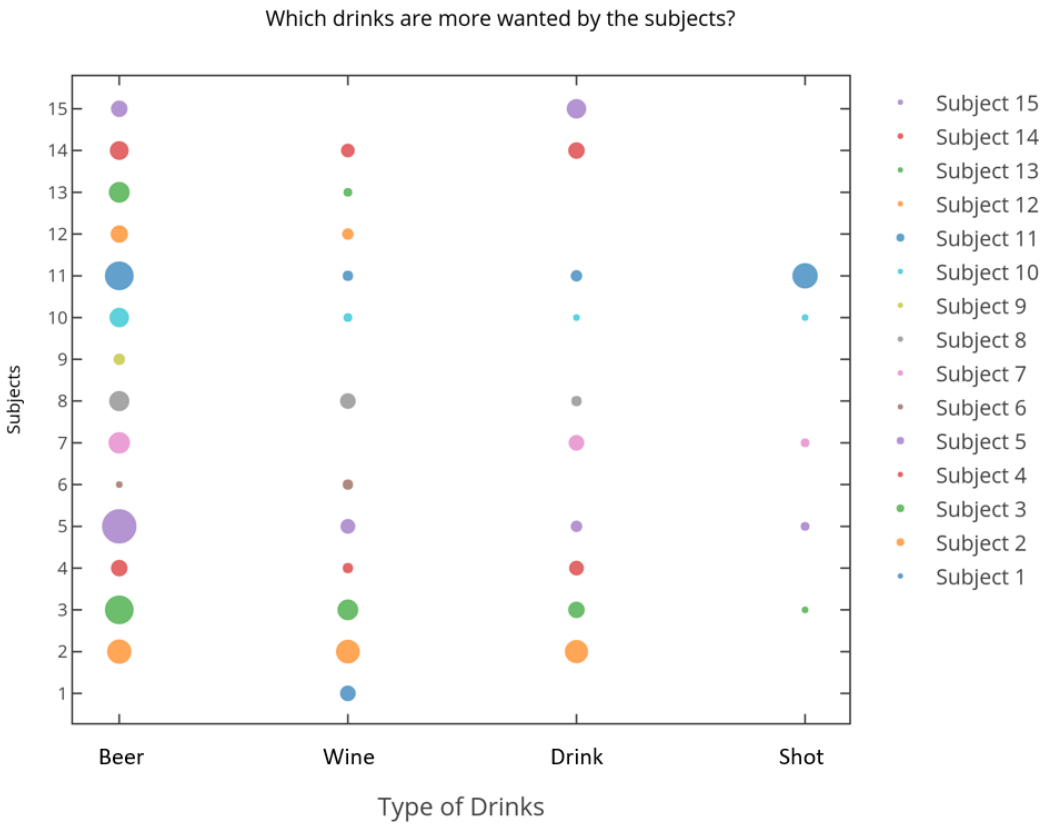


Figure 6.4: Amount of type of drink per subject

[5] Note: An interactive version of Figure 6.4 can be found in: `https://plot.ly/~andreaque/45.embed`

6.2.5 Hangover symptoms per subject

This subsection presents a graph which shows how many occasions a subject had a certain symptom of hangover, see Figure 6.5 [6]. The X axis contains symptoms of hangovers, based on *The Acute Hangover Scale* [54]. The Y axis instead, shows the number of subject identified per colour. And the size of the bubbles indicate the amount of occasions in which a subject had a certain symptom of hangover during the study. The graph shows that subjects reported not having hangover in more occasions than having it. Within hangover symptoms, being 'tired' and having a 'headache' were most common. A difference in hangover symptoms can be noticed between subject 8 (in gray) and the rest. Subject 8 reports to have more severe symptoms than the rest of subjects, which in most of the occasions are 'thirsty', 'tired', or have a 'headache'.

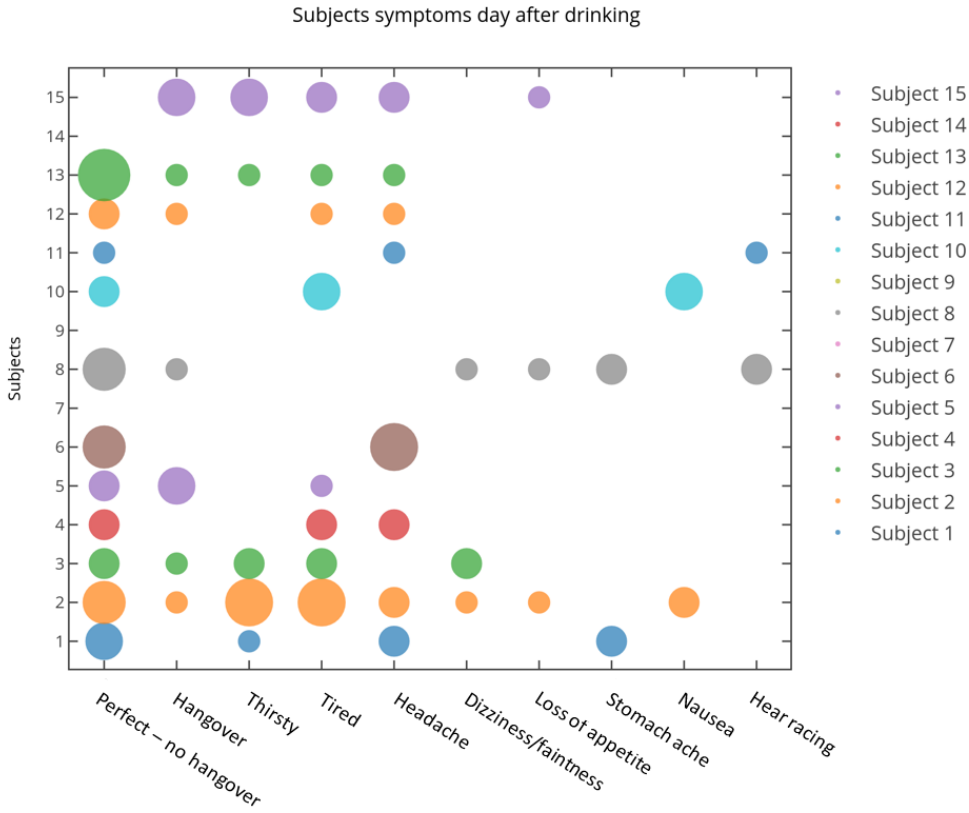


Figure 6.5: Hangover symptoms per subject

[6]Note: An interactive version of Figure 6.5 can be found in: `https://plot.ly/~andreaque/51.embed`

6.2.6 Hangover Occurrence and Binge Drinking

Figure 6.6 [7] shows the hangover symptom occurrence (%) depending in 2 types of drinking events; heavy episodic drinking (HED) [16] and moderate drinking.
The orange trace shows the occasions in which subjects drank below 5 std. units and the blue one, the binge drinking or heavy drinking episodes. The X axis shows the types of hangover symptoms and the Y axis, the amount of drinking episodes in percentage.

From this graph we can see that heavy drinking episodes yield larger percentage occurrence of hangover symptoms such as, 'thirsty', 'tired', 'dizziness/faintness', 'loss of appetite', and 'nausea'; while almost 45% of the moderate drinking episodes report no hangover.

Figure 6.6: Hangover occurrence if binge drinking or not

[7] Note: An interactive version of Figure 6.6 can be found *here*

6.3 Usability

One of the purposes of this master thesis is to evaluate the usability of the implemented system, *DropIt*. The usability was evaluated by the SUS questionnaire [9]. SUS provides a single number representing a composite measure of the overall usability of *DropIt*. Equation 6.1 is used to calculate the total SUS.

$$SUS_{\text{Total}} = 2.5 \left(\sum_{i \in L1} SUS(i) - 1 + \sum_{j \in L2} 5 - SUS(j) \right) \tag{6.1}$$

where $L1 = (1, 3, 5, 7, 9)$ and $L2 = (2, 4, 6, 8, 10)$ represents a list of the specific items from the questionnaire, and i, j are extracting the results from the particular items SUS score which ranges between $0 - 4$ [33, 56, 57].
The SUS score will vary from 0 to 100. The grade corresponding to the obtained score can be found in the Table 6.1.

Grade	SUS	Percentile range
A	$84.1 - 100$	$96 - 100$
A	$80.8 - 84$	$90 - 95$
A-	$78.9 - 80.7$	$85 - 89$
B	$77.2 - 78.8$	$80 - 84$
B	$74.1 - 77.1$	$70 - 79$
B-	$72.6 - 74$	$65 - 69$
C	$71.1 - 72.5$	$60 - 64$
C	$65.0 - 71.0$	$41 - 59$
C-	$62.7 - 64.9$	$35 - 40$
D	$51.7 - 62.6$	$15 - 34$
F	$0 - 51.6$	$0 - 14$

Table 6.1: Curved Grading Scale for SUS. The middle column represents a total SUS score range, and shows the corresponding grade level on the left column. The resulting range for *DropIt* is illustrated with a bold outline

The SUS score of the mobile application *DropIt* is 76.67 and the pertinent calculations can be found in Appendix D.3.

According to 6.1 the achieved score corresponds to a B grade in usability, equivalent to the percentile range 70-79.

6.4 Perceived Usefulness and Ease of Use

In order to assess the perceived usefulness and perceived ease of use of the mobile application, the Unified Methodology for Assessment of Clinical Feasibility (UMACF) questionnaire was delivered to the subjects of the study.

Inspired on the proposal from Heiberger Robbins [26], the results for the questionnaire are presented in a table (see **Appendix D.4** for questionnaire data) and a stacked bar chart, see Figure 6.7. The Y axis indicates the features that are being evaluated; where *HE* stands for Health Expectancy, which corresponds to the features belonging to perceived usefulness and where *EE* stands for Effort Expectancy, which corresponds to the features belonging to perceived ease of use.
The X axis, on the other hand, represents the 5-point Likert scale; 'Strongly disagree' (in darkest purple), 'Disagree', 'Neutral', 'Agree', and 'Strongly agree' (in lightest purple). The 'Strongly Disagree' and 'Disagree' labels overlap, due to the low percentage they cover.

From the results in Figure 6.7 it is observed that, in general, a high percentage of the subjects agreed or strongly agreed with the features presented, both about perceived usefulness and ease of use.

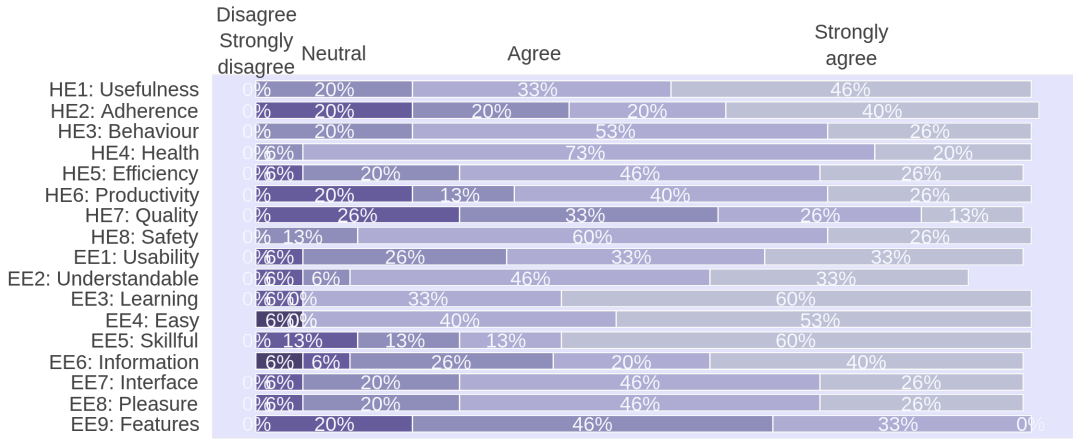


Figure 6.7: UMACF score

6.5 Interviews *'in-the-wild'*

During the study, the subjects were called or had short feedback sessions with the author. From this feedback several usability issues were registered:

- Subjects would like to have the option to input the drinks from a previous night to avoid phone usage during social activity.
- The app lacks a BAC level progress chart that correlates with the consumed drinks, in addition to spent money and consumed calories chart. Moreover, the calendar is missing a summary of BAC measurements when tapped on a certain day.
- *DropIt* shows information in the *'Overview'* tab that is not relevant for the user, depending in the time of the day (i.e. What did you eat before drinking?, asses your hangover, etc.). Subjects demand an event-based user interface.
- The pairing of the BACTrack VIO with the smartphone is surprisingly easy, intuitive and fast. However, in order to take a BAC test there is a 20 second waiting time until blowing is possible. Users reported that it was very bothersome, as well as carrying it in the pocket as a key-chain.
- There was unanimity regarding that the floating button is clear and useful. Nevertheless, it wasn't clear how to remove drinks if subjects were mistaken when reporting.
  Moreover, the navigation was clear and showed the purpose of the app.
- Subjects demanded a monthly summary of their drinking events, including spent money, consumed calories, standard alcohol units, number of drinks per type, BAC measurements and hangover symptoms.
- A minority complained about not including an icon for introducing a consumed cider or champagne.
- Some subjects believe that prompting the number of standard alcohol units was not very relevant. This feature and other additional information could be added as pop-up info when pressed a *'What is this?'* button or interrogation mark icon, as suggested by subject 11.
- Subject 3 affirmed: *"I really feel that the app has given me a need that I did not have before! I would really much like to continue to use the app and learn where my limit is regarding hangover, and what type of alcohol I should drink less of etc."*
- Random notifications containing alcohol related facts and healthy lifestyle advices which rise awareness in alcohol consumption, was definitely a feature that subjects desired for a future version of *DropIt*.

CHAPTER 7

Discussion

The results obtained in this master thesis will be interpreted and discussed in this chapter. A more in-depth explanation of the methodology will be provided, due to a comparison with other systems.

7.1 Data Analysis

The analysis carried out about the data collected from the app conveyed interesting results, such as drinking patterns of subjects, like/dislike of types of drink, and consequences of HED were easily detected.

Firstly, the number of drinks consumed per subject per day was analysed, see Figure 6.1. It was noticed that most of the subjects had a weekend drinking pattern, except a few that drank regularly during weekdays.
It is known that weekends are when people have more spare time and gathers together in social events. This fact supports the literature research on motives for the young people to drink [32]; meaning that the recorded drinking patterns by the app prove social motives to be the main reason for drinking. At a glance, it is possible to notice that during the first half of the study there is fewer data points, than in the second half. Moreover, notifications were implemented on May, 14th which perfectly concurs with the increase on self-reporting drinks. Thus, it is reasonable to say that notifications promote self-reporting.

The graph presenting BAC level measurements shows a large amount of 0.0 and high BAC levels in the same day, see Figure 6.2. From this data 2 things can be inferred; (1) the breathalyser is not extremely accurate, which causes false negatives, and (2) once the user remembers to use the breathalyser, he/she enjoys to use it. (1) could occur because of the use of Semiconductor Oxide sensors, instead of Fuel Cell Sensor Technology which has a higher accuracy [62].

Regarding the type of drinking between men and women, differences can be detected through the self-reporting of the app, see Figure 6.3. *DropIt* was capable of exposing that men tend to drink much more beer than other drinks, while women drink beer, wine and drinks in a more homogeneous manner.

Figure 6.4 showed type of drinks users consumed most. Besides the knowledge stated in chapter 6, the system provides the possibility to build profiles of specific drink taste. For example, from the graph different types of drinkers were found: the type who only drinks wine, the type who drinks every type of drink except shots, the type that just drinks beer and shots, etc. Building profiles could help giving suggestions in a future version of *DropIt*.

Figure 6.5 and Figure 6.6 analyse the symptoms of the subjects after drinking. From this information conclusions could be drawn in regards of connection between detailed consequence of drinking and type and amount of drinks. This is, subject 11 was the one who drinks the most within the heavy drinking episodes and it is also one of the subjects, together with subject 8 who had the most severe symptom, heart racing. Subject 13 felt 'thirsty', 'tired' and had a 'headache' the same amount of times, whether subject 12 and 4 felt 'tired' and had a 'headache', but was never feeling 'thirsty'. This indicates that an identification of hangover type may be possible through *DropIt*. Nevertheless, in general the data tells that out of 9 hangover symptoms, if the user goes through a HDE is more likely to experience 6 of them, rather than just 3.

DropIt is capable of replicating real drinking behavioural patterns and registering on people's drinking in an unbiased way, proving the app to be a great tool for self-reporting.

7.2 Usability

In accordance with James R. Lewis & Jeff Sauro [33], it was perceived that it is becoming a common industrial goal to achieve a SUS of 80 as evidence of an above average user experience. Thus, they stated that it seems like a reasonable benchmark given that an 80 is a B in the Bangor et al. absolute grading scale [8] and an A- in the Sauro-Lewis curved grading scale [33].

The usability score of *'DropIt'* was 76.67 which almost reached the benchmark proposed. And looking into the specific items of the SUS questionnaire, it was noticed a clear majority reported the app had the qualities: *'learnability'* and being *'effortless'*.

Drink Less, AlcoDroid Alcohol Tracker, and the Alcohol Abuse Predictor are the mobile applications reviewed in this thesis, however none of them had an evaluation on usability or perceived usefulness. Hence it is difficult to compare and judge how easy it was to use or how useful users thought the app was. Nevertheless *DropIt* conducted a usability study and it exists knowledge on which features should be improved and which satisfied the users' needs.

Related to usability, it is also interesting to contemplate some objective data (see Figure 7.1), which shows a wider overview of what occurred during the study aside from what was described in this manuscript.

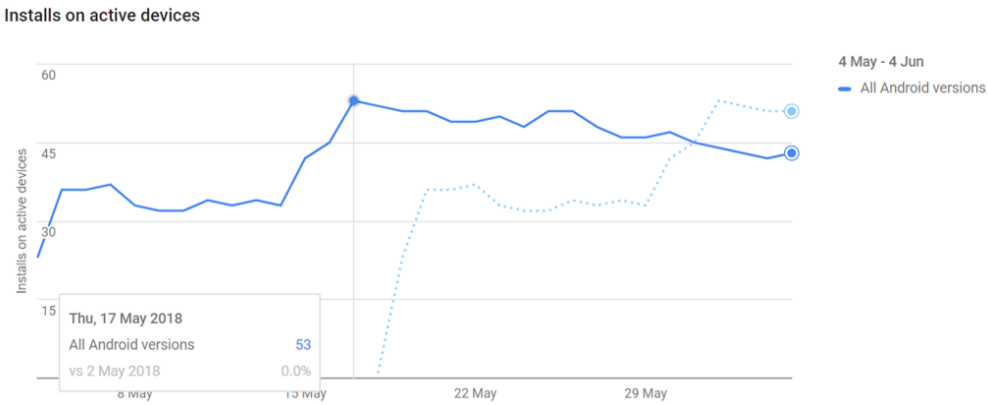


Figure 7.1: Installs during the study (4th May - 4th June)

The statistic board in Google Play Console [1] shows the number of installations of the app over the period of the study.
In addition to the 15 subjects involved in the study, the application reached 38 additional users at halfway of the study and decreased to a total of 43 users by the end of it.

7.3 Perceived Usefulness and Ease of Use

A more in-depth view tells that the app didn't succeed at *'improving quality of life'* or *'including the features that the user expected'* according to the responses of the UMACF questionnaire. Nevertheless, the 4 features that highest percentage of respondents strongly agreed in were (from highest to lowest); *'learnability', 'feeling of skillfulness', 'ease of use', and 'usefulness'.*
Regarding behavioural change towards excessive alcohol consumption, 53% agreed and 26% strongly agreed that the app could help reduce hazardous and harmful drinking.

7.4 Relation between Feedback - Qualitative Questionnaires

The interpreted results from the questionnaires are analog to the obtained feedback from calls and short *'think-aloud'* sessions with subjects.

[1] Google Play Console: Software through which the mobile app was published and distributed

7.4.1 Unfavorable analysis

Subjects stated missing features in the app; such as the possibility of including drinks the next day to the drinking event, a chart of BAC measurements, or monthly summary of drinking patterns; which perfectly correlates with the low score on adequate feature expectancy from the UMACF questionnaire.

- The first mentioned missing feature, *'Self-reporting drinks from previous days'*, raises a discussion with various pros and cons, that needs to be considered.
  There are 3 types of self-reporting; *'Interval-contingent recording', 'Signal-contingent' and 'Event-contingent'*. The developed system promotes signal-contingent self-reporting. Meaning that the user is sent a notification as a reminder to report the drinks of that day. According to L.Wheeler & H.Reis the signal-contingent and event-contingent methods (user is instructed at the beginning of the study to report whenever a certain event occurs) require recording that is very close in time to the event, reducing the subjects' likelihood of forgetting or reappraisal [68].
  This theory is contradictory to what the user demands, and it derives in a usability issue which relies on how pleasant is the app to use. Nonetheless, as stated in the *Developer's Guide to Building User-Friendly Applications* from Travis Lowdermilk, users are not designers, neither always right [65]. Therefore, it exists a need to continue asking users the reasons for this demand and the conclusion was that they do not want to stop their social activity to report their drinking. Hence, this issue could be the cause for including a social focus in the system or to find less intrusive ways of self-reporting.

- Subjects believed that the app is lacking a BAC level chart showing progress, as well as BAC measurements in the summary of an event in the calendar. The essence of this complaint relies on 2 BCTs; the demand for 'feedback on performance' and 'self-monitoring'.
  Control Theory [13] posits that the BCTs; 'goal-setting', 'feedback/self-monitoring', 'action planning', and 'goal review' have synergistic effects. Interventions using a group of these techniques have been found to be more effective than interventions that used only one, which is what the system *'DropIt'* intends to include [15]. Blowing into the breathalyser, which corresponds to the 'self-monitoring' BCT, was observed to be really engaging for the user and probably the trigger for the demand on a more thorough 'feedback on performance'. Indeed, Susan Michie concludes in one of her articles that promoting self-monitoring is associated with improved out- comes in brief interventions [42].

- The BCTs 'Behaviour substitution' [2], 'Problem solving' [3], and 'Credible source'

[2]Behaviour substitution: Prompt substitution of the unwanted behaviour with a wanted or neutral behaviour.

[3]Problem solving: Analyze, or prompt the person to analyze, factors influencing the behavior

[4] were associated with great alcohol reduction [19, 44].
Fortuitously some subjects of the study claimed that there was a lack of medical advice on healthy drinking ('Credible source') and in fact, albeit it was mentioned in the UCD workshop too, the BCT wasn't included in the system. The system was implemented without this BCT due to the priority given to the included BCTs; 'self-monitoring', 'self-reporting', 'goal-setting', and 'feedback on performance', including 'biofeedback'. Furthermore, as C.Garnett et al. affirmed the total number of BCTs present in an intervention was not significantly associated with reduced consumption [19], meaning that a big amount of BCTs does not imply a success in alcohol consumption reduction. However, the 'Credible source' BCT was proved to be associated with a reduction of alcohol intake, hence it might need to be included in the mobile app.

- The BCT 'goal-setting' was barely used by the users. As they stated, this was because they wanted to have as a limit the recommended standard alcohol units by the Danish Health Board (7 for men and 14 for women) [61] or they did not want to reduce their alcohol consumption, just track it. Baring in mind the UX part, the functionality of changing the max. standard units weren't sufficiently visible and was inconsistent. The inconsistency arises from presenting this BCT inside of the gauge, while the gauge it's showing self-performance. Moreover, on the left upper corner the weekly goal in a number of std. units it's presented. Doubtless, the option to edit that goal should appear next to it, see Figure 7.2.

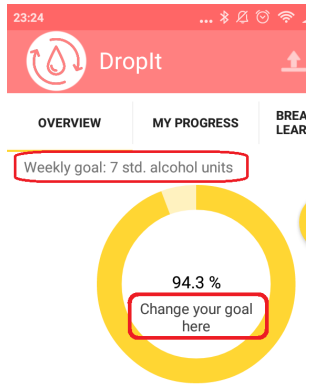


Figure 7.2: 'Goal-setting' BCT

and generate or select strategies that include overcoming barriers and/or increasing facilitators.

[4]Credible source: Present verbal or visual communication from a credible source in favour of or against the behaviour.

7.4.2 Favorable analysis

On the other hand, from the subjects' feedback, it is noticed that there are elements corresponding to the features that scored high on the UMACF questionnaire. The features that had the highest percentage of agreement in the *'Perceived Ease of Use'* (EE) were; *'learnability', 'feeling of skillfulness', and 'ease of use'* and the corresponding elements are:

- The gauge visualisation was clear and expressed where was the limit that shouldn't be exceeded. Although, usability wise is not the most appropriate because of the little information given compared to the pixels used in the screen. However, the goal in the *'Overview'* tab is to enhance the relevance of this visualisation, and not to collapse the view with excessive information.
- The use of tabs made the navigation fast and simple. Subjects affirmed that the app looked organised, hence it was easy to understand what the user is expected to do.
- The floating button got really good feedback from the user, being the simplest and easiest feature to use from the app.
- Subjects strongly believed that the BACTrack VIO was easy to connect with the app and easy to use and understand the results in the app. A subject said: *"The feature of giving extra information on the BAC level (i.e. 0.05 - Reduced inhibitions. You cannot drive) it's really useful!"*

Regarding *'Perceived Usefulness'* (HE), the feature the highest percentage of subjects agreed on was *'usefulness'*, in general. The corresponding elements that were thought to trigger this result were firstly, while it may appear redundant, the floating button and secondly the calendar.

Some users stated that, in a long-term usage, would be interesting and useful to learn how to drink in a healthier manner from previous days knowledge. Gazing at the summary of drinking events, the user can learn what to eat before drinking, and consequently what to drink, in order not to have a horrible hangover.

7.5 Other systems

In Table 2.2 in Chapter 2 it is shown a comparison of some features from the selected DBCIs; Drink Less app, Alcodroid Alcohol Tracker, The Alcohol Abuse Predictor, and Drinkaware. In Table 7.1 *DropIt* is added and compared to the related work.

DropIt included less BCT than the other systems. We chose to focus on (1) an infrequent used BCTs with evidence on effectiveness ('Self-monitoring and biofeedback' = 'BAC Calculation') and on (2) a very frequently used one ('Self-reporting and feedback on performance' = 'Hangover report') that satisfied users from the UCD,

as stated by C.Garnett et al. [19], and keep the number of other BCT low. It is found that a large amount of BCTs increases the complexity and reduced the overall usability, and therefore favourable to keep at a low level [19].

DropIt included the support of an external BAC measurement device, which none of the others did. The overall feedback from the device was good. Several users stated that - *"The breathalyser is so easy to use. Plus, I like the feedback on the BAC level"*. Furthermore, *DropIt* manage to achieve a usability of B, which is above average [33]. Unfortunately, the other systems did not report on the usability using SUS.

System	DropIt	Drink Less [20]	AlcoDroid Alcohol Tracker [15]	The Alcohol Abuse Predictor [15]	Drinkaware [3]
Number of BCTs	4	5	7	13	17
Available platforms	Android	iOS	Android	Android	Android / iOS
Score: Google Play Store / iTunes	4.3 / -	- / 3.9	4.3 / -	3.7 / -	4 /2.5
No. of ratings	7 / -	- / 36	5,169 / -	3 / -	1,870 / 59
BAC Calculation	Yes, accurate	No	Yes, not accurate	No	No
Hangover report	Yes	No - instead Mood, Productivity, Clarity and Sleep	No	No	No
Result	B in usability. High level of agreement in 'learnability', 'skillfulness', 'ease of use', and 'usefulness'	Help reduce hazardous and harmful drinking	Popular apps in the market for reducing alcohol consumption using BCTs	Evidence on reducing excessive alcohol consumption	Useful behaviour change tool in individuals who are already motivated

Table 7.1: *DropIt* comparison to other systems

7.6 Limitations

There are several points in the development and evaluation of *DropIt* and the project, that raises some concerns and needs to be addressed:

- As described in the *Recruitment section 5.1*, the subjects which collaborated in the study belong to a close network of the study coordinator and therefore, awareness should be raised on the positive bias of results.
- During the study, the app gave users the control of sending their data. This factor limits the recruited amount of subjects, as well as the gathered amount of data per subject. Although improved interpretations could have been drawn from a greater amount of data, this limitation is not thought to have caused a high impact on the quality of the data.

- Hardware resources were limited, meaning that only 4 breathalysers were purchased. This fact derives from the lack of knowledge regarding the number of subjects that would collaborate in the study, in combination with economic limitations. Its consequence was that only 4 out of 15 subjects could fully experience the usage of *DropIt*, and couldn't report on it.
- Data could have been biased by only receiving data from people that actually wanted to share their data. Possibly people that did not drink that much during weekends, was unwilling to share the data due to the fear of being judged as *'Boring/anti-social'*. The culture in the western world, especially Denmark, is centred around alcohol. If people do not drink at social events, they could receive comments on the reason for it: *'Are you pregnant, 'What's the matter, are you okay?'*. In the same way, sharing data showing low alcohol activity could bring up the same fear [7].
- Not developing the app for the operative system iOS, made the study be more reduced in the number of subjects and miss some feedback from users that are accustomed to other usability features.

CHAPTER 8

Conclusion

The data analysis showed that it is possible to understand and learn an individual's drinking pattern. These findings could be used in future BCTs; i.e., using machine learning methods to predict future drinking patterns, thus use the BCT 'Action planning' with a personalised knowledge of the user. In this way, the user would be guided towards a non-harmful alcohol consumption.

Additionally, the results from the questionnaires together with the feedback tell that, in general terms, the mobile application had an above average usability and subjects agreed in the existence of perceived ease of use and usefulness.
With the aim to improve and finalise an effective technological system, that at the same time satisfies the users' needs, the UC design process could be more focused on design details and the user.

For instance, instead of analysing the general design and functionality of 3 apps related to BC in alcohol consumption, the performed workshop could have guide participants into analysing BCTs. Each of the apps that were presented in the workshop had a certain number of BCTs and those could have been introduced to the participants in order to get more BC oriented opinions.

Furthermore, when targeting the usability focus area, participants could have been asked to open/install popular apps (i.e. Facebook) and analyse features such as; navigation, selection, reporting, adding, deleting, etc.

Moreover, self-monitoring could also be modified to be done in an automatised way. The use of wearables, such as BACTrack Skyn [1] and drunk user interfaces [37] to measure BAC level are emerging, which brings to light new ways of interaction with technology for BC. These methods will facilitate the self-recording, however simultaneously - Will they make the user less aware of their drinking, and reduce the effectiveness of BCIs compared to manually self-recording?

To sum up, automatic sensing might facilitate BCIs, however gathering a greater knowledge in behavioural change and good usability (i.e. The SUPR-Qm to measure usability[58]), in combination with UCD iterative processes would derive in implementing an effective DBCI for excessive alcohol intake.

[1] https://www.bactrack.com/pages/bactrack-skyn-wearable-alcohol-monitor

APPENDIX A

Acronyms

BC Behavioural Change
- BCI Behavioural Change Intervention
- BCT Behavioural Change Technique
- UCD User Centered Ddesign
- BAC Blood Alcohol Content
- AUDIT Alcohol Use Disorders Identification Test
- SUS System Usability Scale
- UMACF Unified Methodology for Assessment of Clinical Feasibility
- HE Health Expectancy
- EE Effort Expectancy
- SDK Software Development Kit
- TAS Transdermal Alcohol Sensor
- CACHET Copenhagen Center for Health Technology
- CAM Continuous Alcohol Monitoring
- WHO World Health Organization

APPENDIX B

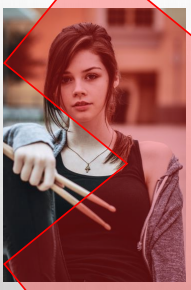
Documents

In the Appendix B documents regarding the design process and implementation of the system will be found.

B.1 User Centered Design

B.1.1 Personas and Scenarios

USER PERSONAS



LAURA JENSEN
17, Jutland

Bachelor in Environmental Management

Frustrations
- Family problems
- Drink to mitigate negative emotions

Goals
- Be aware of the amount of alcohol drunk over a period of time (progress)

Normally lonely drinkers

JACOB DAHL
19, Fyn

Bachelor in Chemical Engineering

Frustrations
- Lack of close relationships
- Drink to obtain social rewards

Goals
- Get reasons to stop drinking more than a certain amount (know the consequences)

USER PERSONAS

ANDERS BERG
21, Copenhagen

Master in Aquatic Science and Technology

Frustrations
- Introvert
- Drink to avoid social rejection

Goals
- Set up discrete alarms to know when you are over a certain limit

MARIE LARSEN
23, Copenhagen

Master in Business Management

Frustrations
- Not achieving to be the most popular friend
- Drink to enhance positive mood

Goals
- Stay motivated to reduce my alcohol intake

USER STORIES

- As a person that tries to **solve her personal problems with alcohol,** Laura needs to realise the **amount of alcohol she is drinking over time**
- As a person who **drinks to get social rewards** (e.g. hug from friends, smiles, etc.), Jacob needs a tool that while it keeps him in a social environment, also reduces his binge episodes by **giving him some knowledge about the consequences**
- As a person who **drinks to avoid social rejection,** Anders needs a tool that **discretely let him know when he is over his limitations.**
- As a person who **drinks to enhance positive mood,** Marie needs a technologic tool that **keeps her motivated to reduce her binge episodes**

SCENARIOS

1st SCENARIO

Is Friday, Jacob is meeting with his friends after class for some beers. He wants to be social/polite and he wants to easy communicate, so he drinks to comply with others and to get peer acceptance. He is going to end up drinking too much, way above the recommended by the Danish system.
Because he is wearing a BAC tracker connected to a mobile app, he can be informed objectively about his BAC along the evening, maybe he now he decides to stop drinking earlier or take his drinks more separately over the time.

SCENARIOS

2nd SCENARIO

Anders has been invited to a birthday party this weekend. He just knows 2 people out of 30. He wants the rest to accept him, meaning avoiding social rejection. In order to achieve this, he drinks without any limits, with the risk of going through an excessive alcohol intake.
But because he has a wearable tracking his alcohol content in blood and he previously set up some limitations, now he knows when is too much.

SCENARIOS

3rd SCENARIO

Marie loves music festivals. They usually last for days, long days. She is very active, doesn't like to miss a concert and she loves to give good vibes to the group. Unfortunately, in order to keep this enthusiastic mood she usually goes through binge episodes.
However, this year she is using an alcohol tracker which sends the data to an app. In this app she can see her BAC along the day and she can set up goals (e.g. Daily max nr. of beers = 3). This goals keep her motivated and engaged to reduce her alcohol intake and still have a nice time during Roskilde Festival.

RECOMMENDED ALCOHOL INTAKE (DENMARK)

Do not exceed 5 drinks (60g) on one occasion.

Low risk consumption: below 14 units/week for men and 7 units /week for women

High risk consumption: above 14 units/week for men and 7 units /week for women

No alcohol is safe for your health. Do not drink alcohol for the sake of your health.

If you are elderly, be especially careful with alcohol.

Children and young people under 16 should not drink alcohol. Young people between 16 and 18 years should drink as little as possible and stop before 5 drinks on the same occasion.

Reference: http://www.iard.org/policy-tables/drinking-guidelines-general-population/ [8]

B.1.2 Workshop Plan

User Centered Design

Workshop

25 February 2018

1 Workshop Plan

1.1 Introduction

1. Participants' Main Goal of Workshop: Prototype 3/4 screens of an app with the aim of **reduce alcohol consumption in young people**
2. My Main Goal of Workshop
   (a) Decide on the BCTs to use in the app (the ones that users find more effective)
   (b) Decide on the best features UX wise of an app
3. Agenda
   (a) Meet your partner
   (b) Debate
   (c) App Rating
   (d) Break
   (e) App analysis
   (f) Break
   (g) Prototyping

1.2 Definition of Activities

Meet your partner

1. Material: 10 sheets
2. How to: Fold a paper on half. Write on the upper part Name, Age, Gender and an embarrassing fact that could had happened to the person to your right. On the lower part write the same information about yourself. One by one, say out loud what you wrote about the one to your right. Then that person responds with the real information.

Debate

1. Material: 10 templates with 3 questions
2. Grab a piece of paper and write your answer to: Do you like drinking? Why? (Give 3 reasons)
3. Open question: What makes you buy the next drink? (Write your main reason)
4. Open question: In which situation usually happens for you? (Write down most typical

App rating

1. Material: 3 squared tiny pieces of paper per person, 2 x printed screenshots of 4 apps (The Alcodroid, The Alcohol Predictor, Drink Less, Leaf)
2. Grab a piece of paper and write your answer to: Do you like drinking? Why? (Give 3 reasons)
3. Open question: What makes you buy the next drink? (Write your main reason)
4. Open question: In which situation usually happens for you? (Write down the most typical)

Break

App analysis

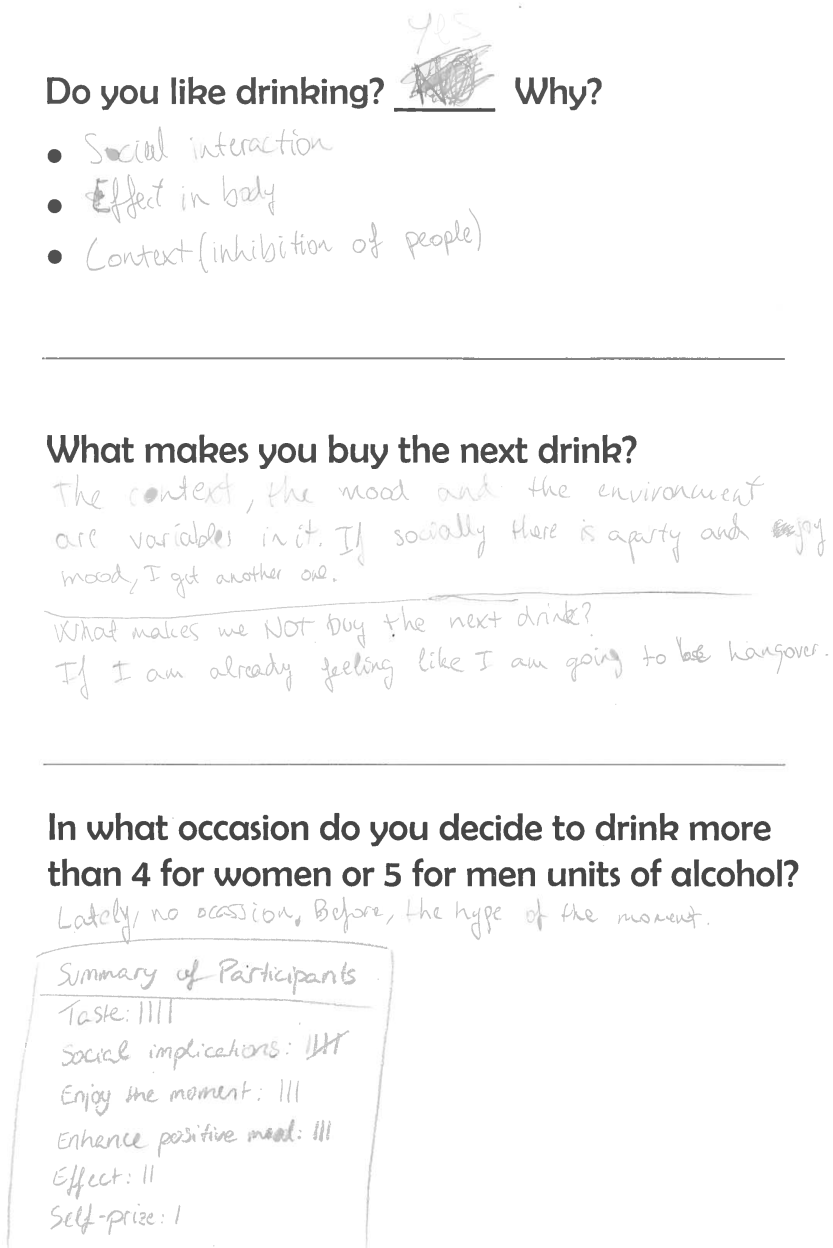
1. Material: 2 x printed screenshots of 4 apps (The Alcodroid, The Alcohol Predictor, Drink Less, Leaf)
2. 2 groups
3. Write underneath each screenshot which features you like and you don't

Break

Prototyping

1. Material: 2 x 5 printed templates of mobile phone frames)
2. 2 groups
3. Taking into account what you have written in the previous "App analysis" section and with the help of your imagination, design the main screenshots of an app that motivates users to reduce alcohol consumption.

B.1.3 Workshop: Task 1 - Debate



Do you like drinking? YES Why?

- Social interaction
- Effect in body
- Context (inhibition of people)

What makes you buy the next drink?

The context, the mood and the environment are variables in it. If socially there is a party and enjoy mood, I get another one.

What makes me NOT buy the next drink?
If I am already feeling like I am going to be hangover.

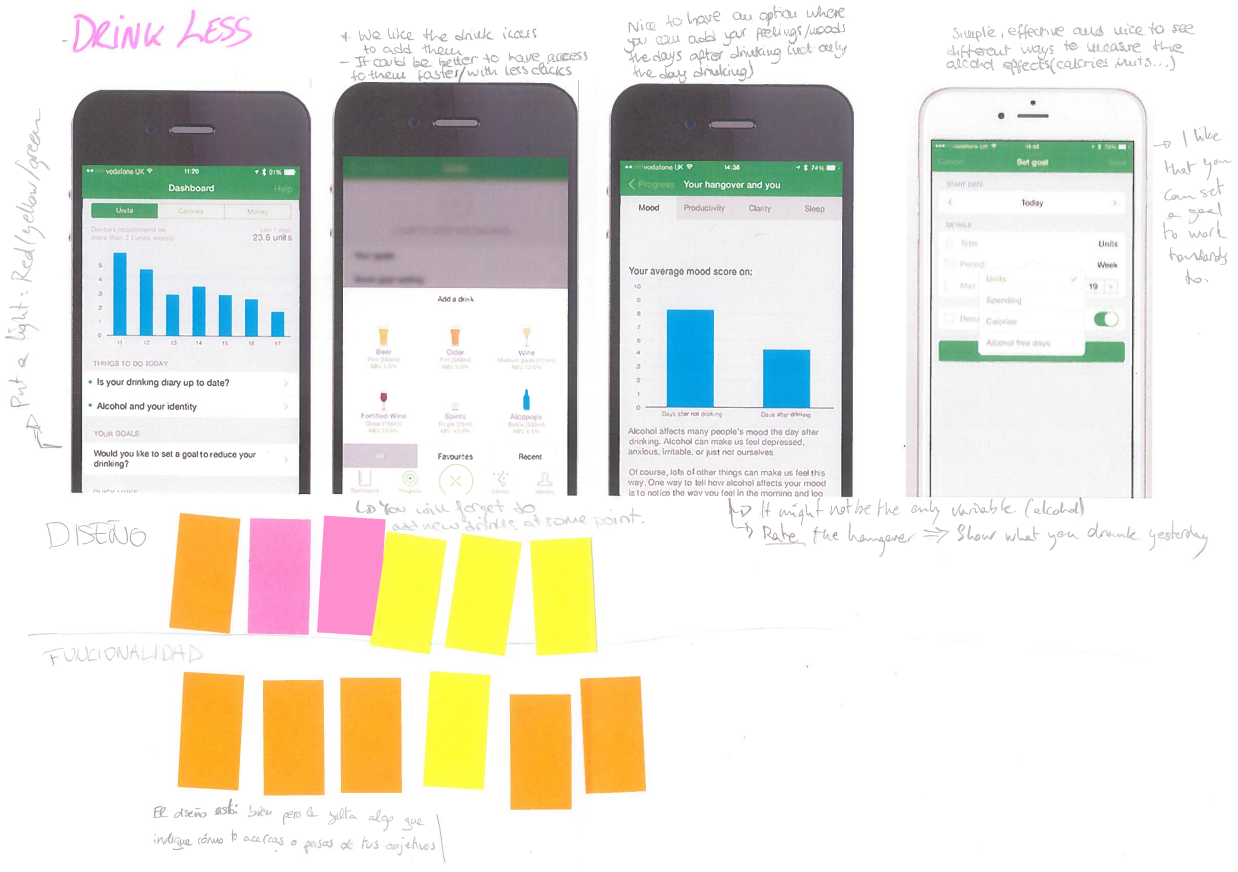
In what occasion do you decide to drink more than 4 for women or 5 for men units of alcohol?

Lately, no occasion. Before, the hype of the moment.

Summary of Participants

Taste: IIII
Social implications: IIII
Enjoy the moment: III
Enhance positive mood: III
Effect: II
Self-prize: I

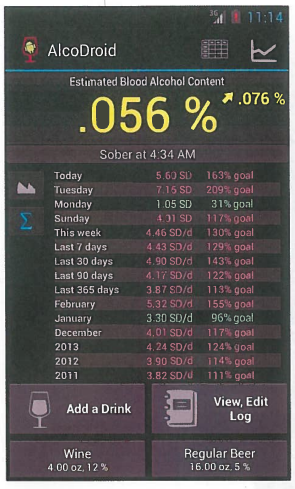
B.1.4 Workshop: Task 2 - App rating and analysis

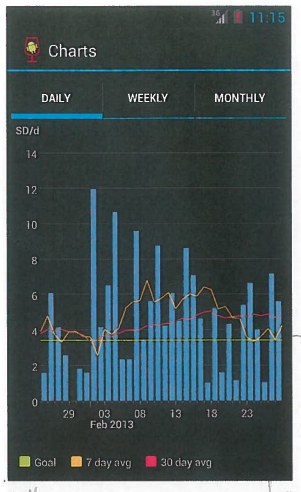


ALCODROID

no estoy tan interesado en el consumo puntual

This is too detailed for me





Se aprecia y entiende bien el consumo y metas visualmente

this doesn't give useful information Just give the % in the right!!

Database which tells how each beverage contributes to the goal

I like this to check progress

cuenta la escala de average 7 days and 30 days en el mismo gráfico

DISEÑO:

FUNCIONALIDAD:

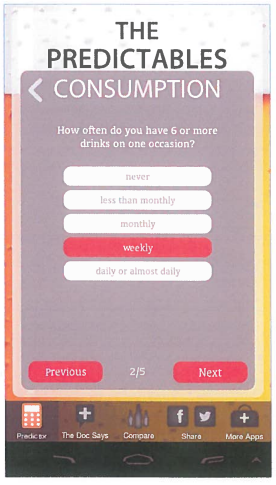
Precio ✓

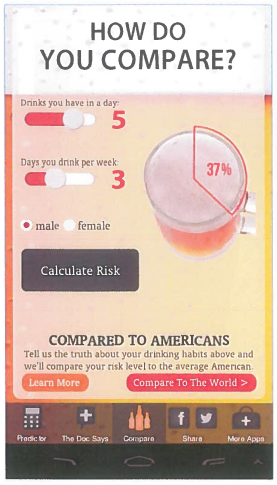
UPDATED BAC ✓

ESTIMATED SOBERTI ✓

* graphs help a lot with the visual understanding
* easy to add drinks

THE ALCOHOL PREDICTOR



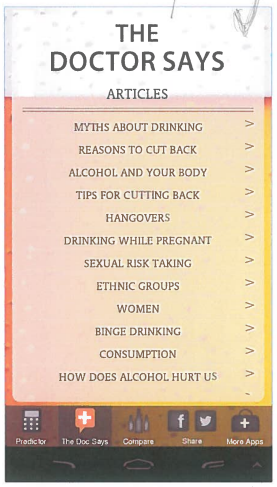


Risk of what?

Good to realize that you drink that much, but if you are below the average, you might not care

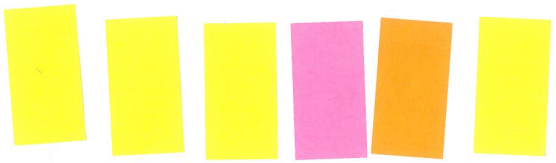
Useless yeah for help

specific for user

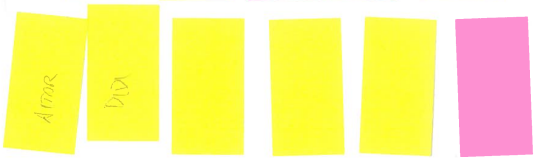


Demonstrated arguments about alcohol ⇒ seriously reasons to not drink too much (bad healthy consequence

DISEÑO:



FUNCIONALIDAD:

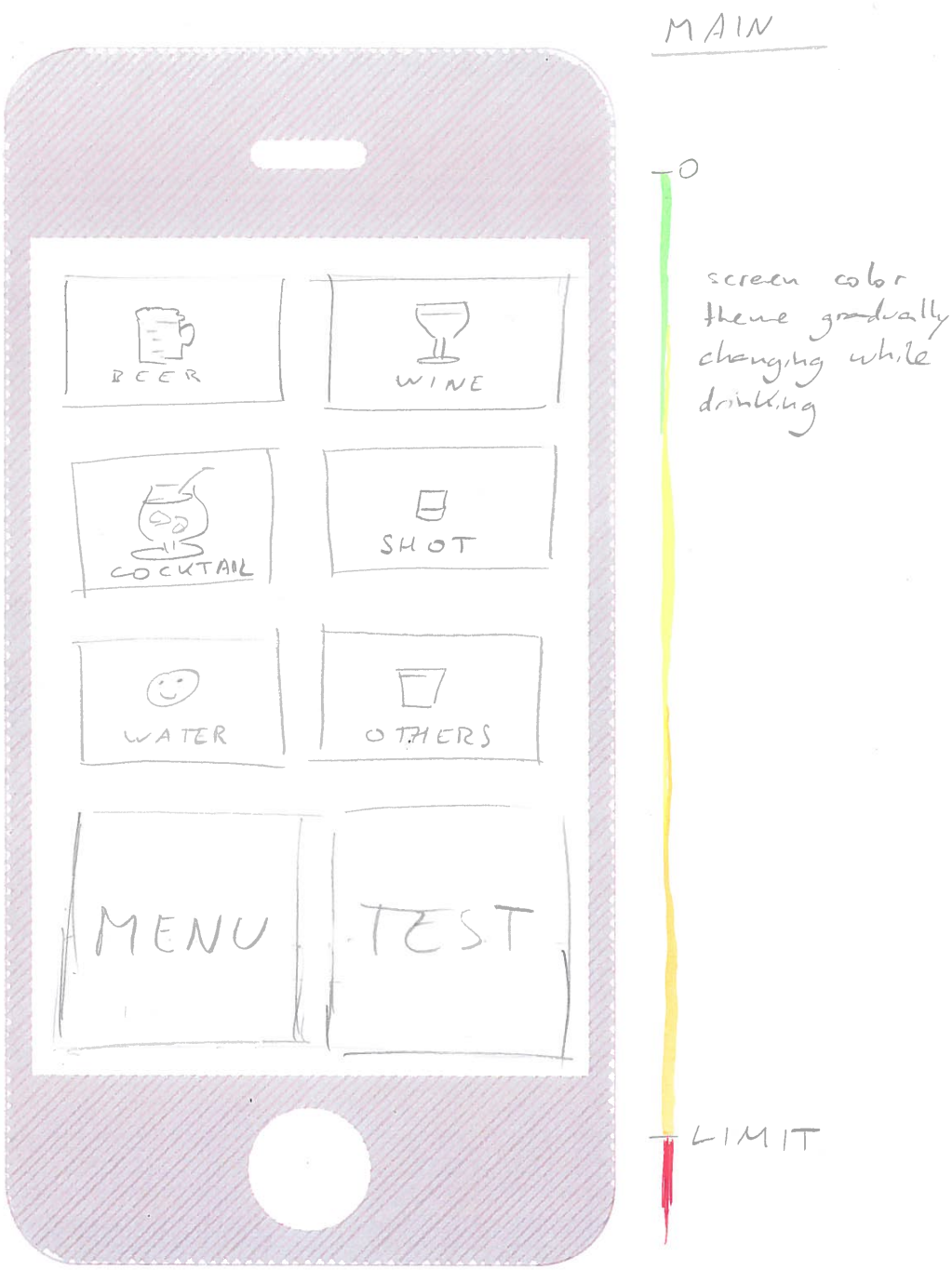


No hay challenge contra mí mismo.
No me importan los demás

No parece una aplicación que alguien que quiera consumir menos usaría. Los datos curiosos no ayudan a nada.
Me falta un tracking de tu progreso en tus objetivos

B.1.5 Workshop: Task 3 - Prototyping

B.1.5.1 Prototype Group 1



STORY

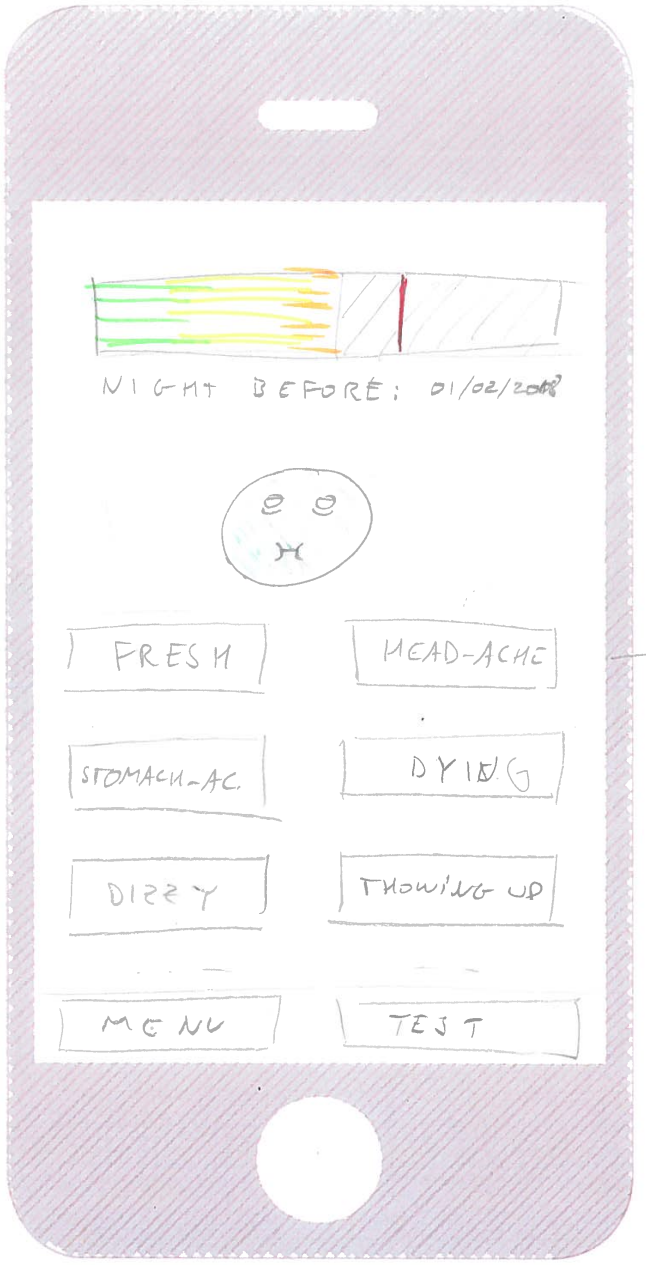
week graph

lunch/dinner you had

weekly goal

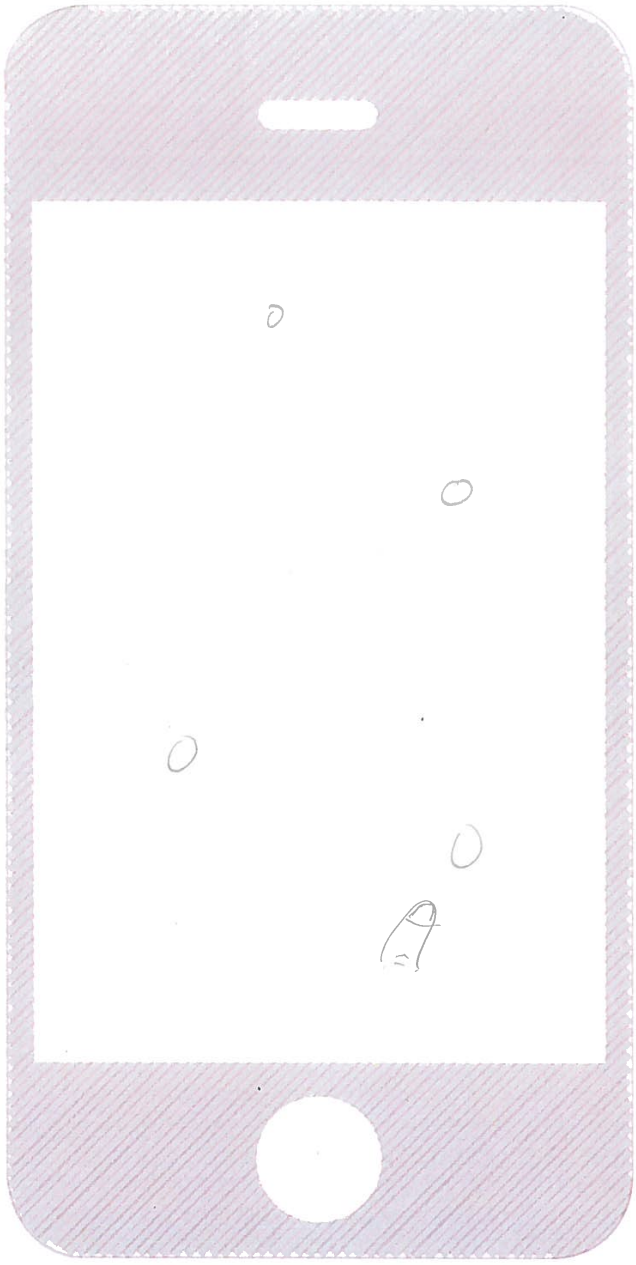
special day goal/objective

HANG-OVER



→ With the finger you should measure the %.

TESTING



- RANDOM GAMES:

1→ Topos (Wacamole)

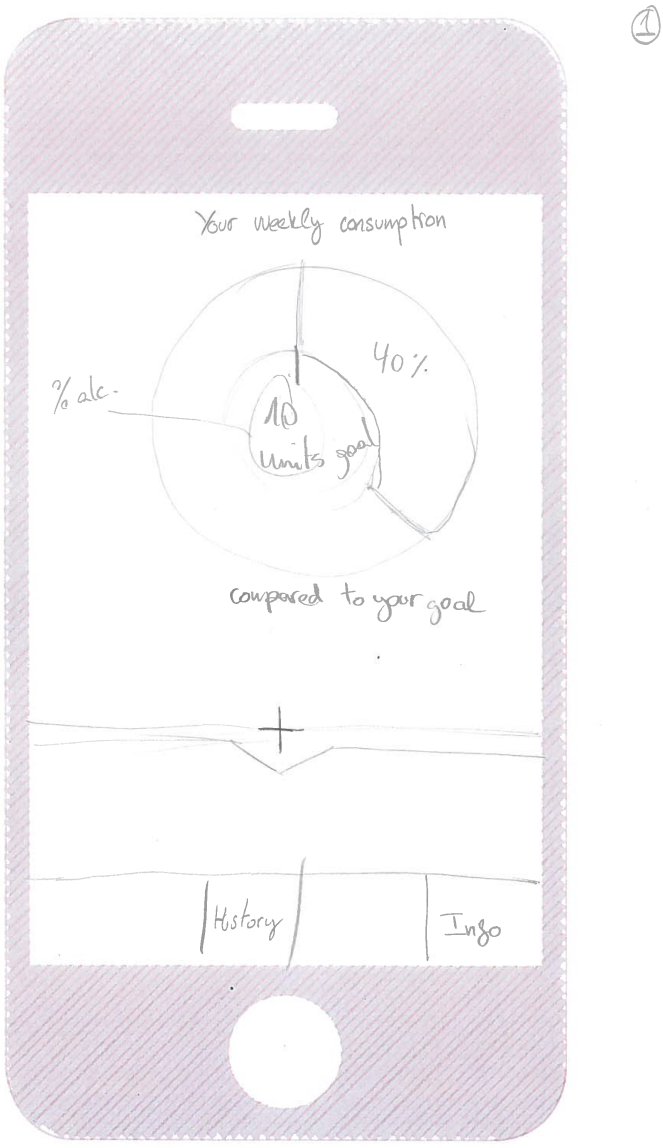
2- Follow the dot*

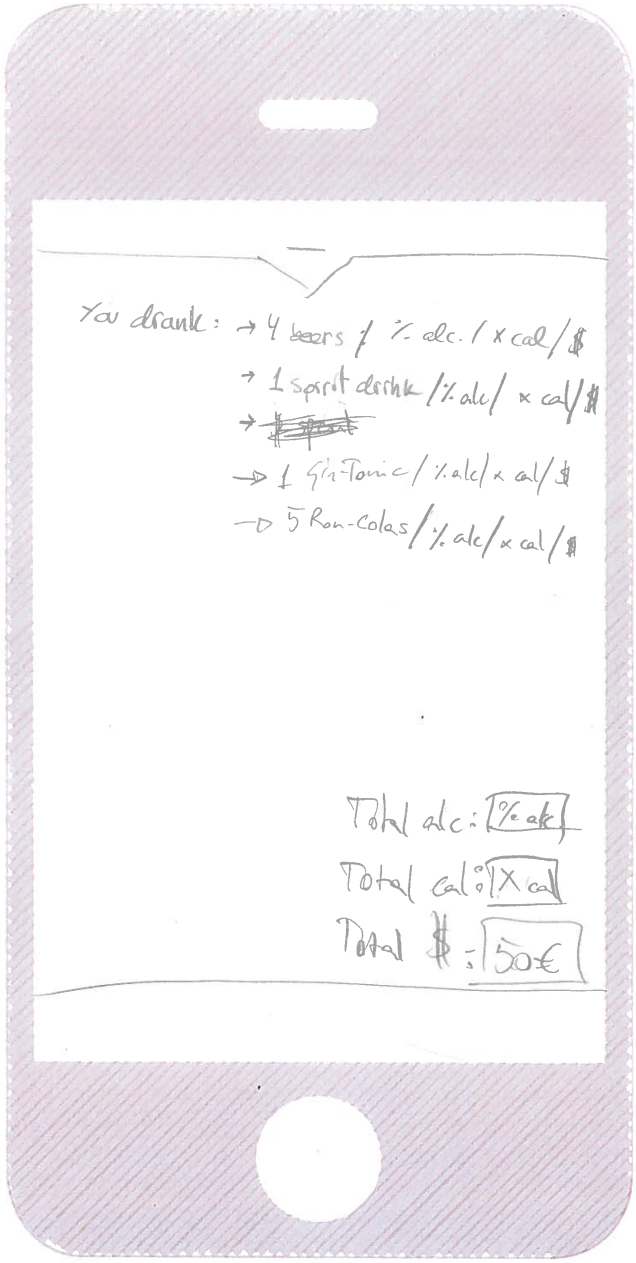
3- Tap the dots (Random appearing

* Moving dot, tap and follow it

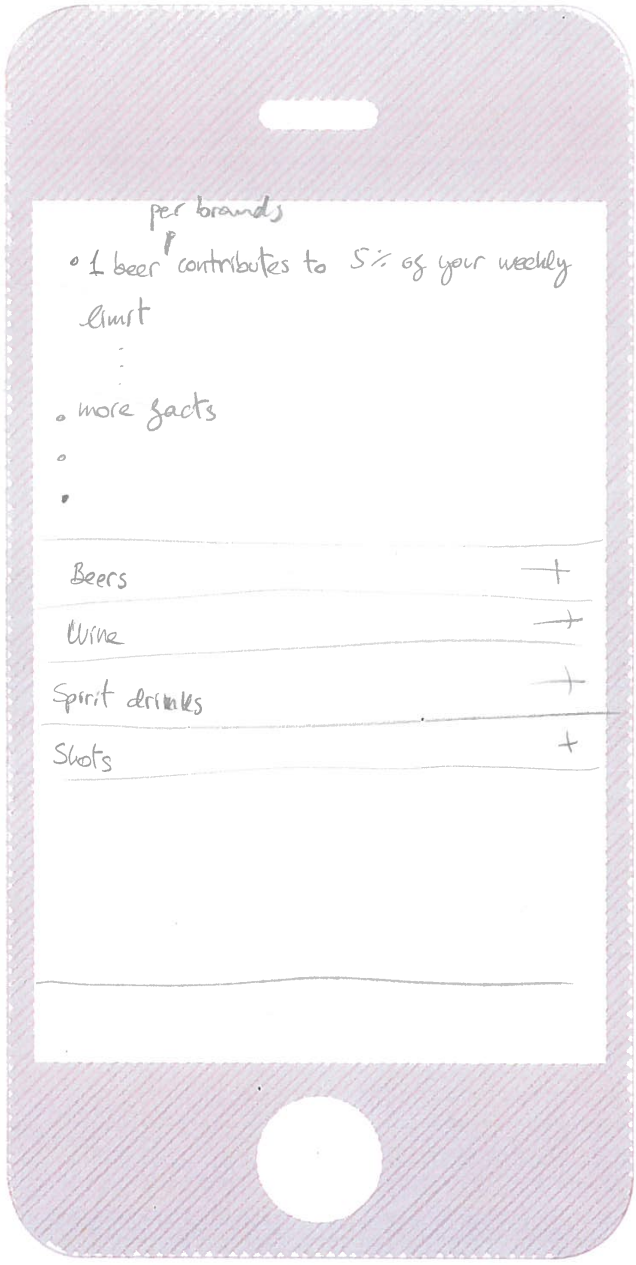
Show results with feedback depending on the performance

B.1.5.2 Prototype Group 2

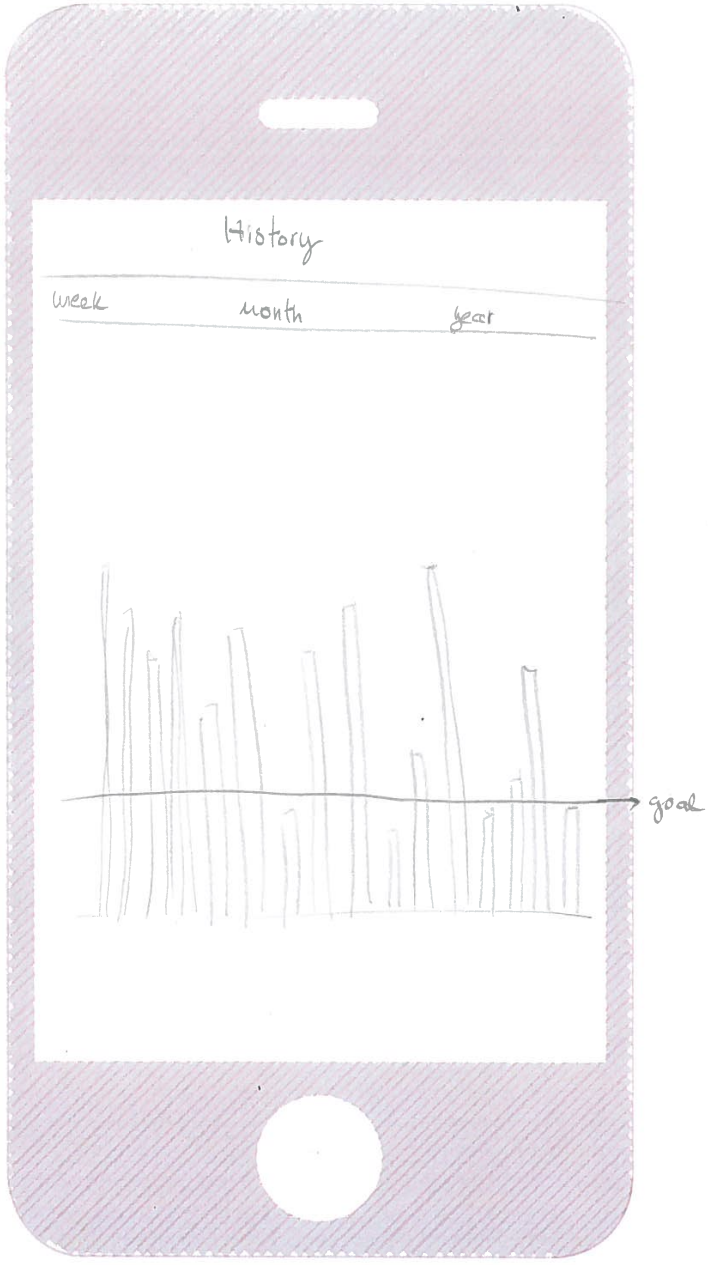



You drank :
→ 4 beers / % alc. / x cal / $
→ 1 spirit drink / % alc / x cal / $
→ ~~[illegible]~~
→ 1 Gin-Tonic / % alc / x cal / $
→ 5 Ron-Colas / % alc / x cal / $
Total alc : % alc
Total cal : X cal
Total $: 50€

Ingo



Color coding lo que puedes o no puedes tomar

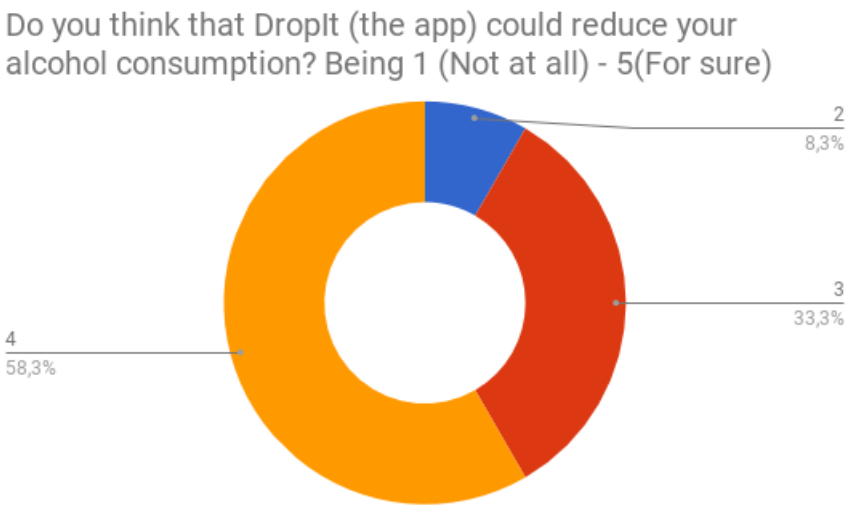

History
week
month
year
goal

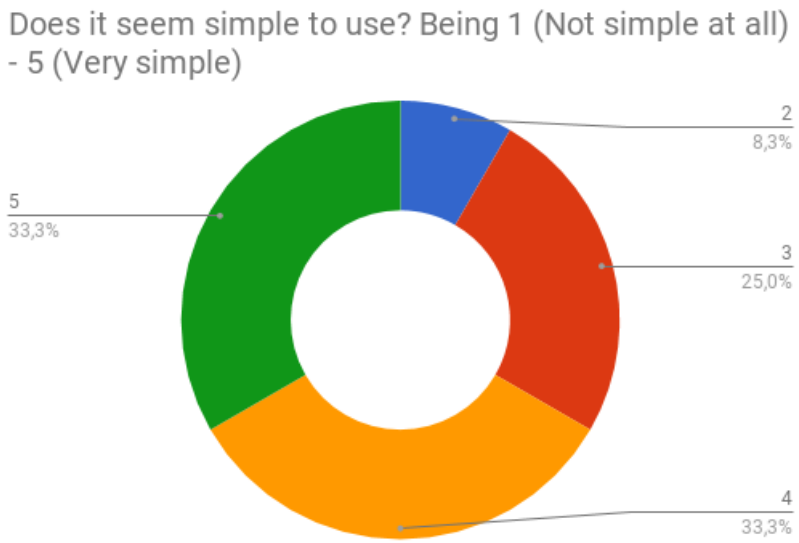
B.2 Feedback from Prototype in Marvel

In order to get feedback from the prototype done in Marvel, a questionnaire was built and published in the following link: https://goo.gl/forms/zvCQxOy1lcCF9Iko2

FEEDBACK ON PROTOTYPE: POP by Marvel

14 people giving feedback





Design

1. I don’t like that…

A more in-depth answer to "does it seem simple to use" I think it is fairly simple when you are sober while I think that there is both too much information and that the buttons are too small for when your motorical skills are effected. (but that might be due to it being first prototype)
I am a bit insecure what the "add drink" buttons represents (the shot class, is it champage or wine class...). Could be nice with a small text underneath maybe or maybe somehow indicated in the main plot... I dont like that the app is focused on a weekly basis. I am more focused on my drinking events (second part of main screen), I want to reduce drinking on daily basis when I am out etc. so I want that main plot to show the drinking event. I cant add a picture of my ugly face the next day together with the symptom list. I cant see what the 0.01/123 kcal/25 kr means.. put a label so I know that 0.01 is my BAC. Cant really see the difference between being at 100% and being 125% (25% above).
Sometimes it was a bit hard to read for me, maybe it would be better if you could scan it instead of photos. On the first screen I'd only show the circle and add an option to see more info on the other screen, I think it's a bit too much for one screen. When I click on a circle in scatter plot I understand that the chart is showing weekly consumption, but I don't get the monthly view - why is it there?
Sea tan suave los trazos y poco vistosa y colorida
Demasiados datos quizás en el círculo y al lado de las bebidas, aunque sí lo ponéis en tabla bien
El diseño de la gráfica de puntos, me parece confusa
No hay nada que me disguste especialmente

2. I like that…

I like the usage of graphical material to illustrate progress
There is the simple circular bar with 70% filled red, and when it reaches 100% everything is filled. The nice way to input my drinking so fast. There is only to/few tap buttons. The next-day symptom icons
Nice idea with scatterplot! In general I think the app is really cool and I'd definitely like to use it :)
interfaz novedosa y amigable
Original
el diseño, los iconos son suficiente intuitivos para que no haga falta utilizar texto.

Puedas establecer objetivos, estaría bien si se pone (que no lo vi) automáticamente maximo legal para conducir una vez introduces el pais por ejemplo. En cuánto tiempo se te pasa, trucos o remedios para disminuir ...
es muy intuitivo todo
Amigable
Se tenga que apuntar lo que se ha comido, pero me faltaría el cuándo.
La pantalla principal tenga a la vista los datos mas importantes sin tener que ir a otra pantalla
El boton del medio apetece apretarlo, la barra roja tambien esta chula

FUNCTIONALITY

1. I don't like that...

I cant send my data to my mail as a CSV file I cant see a graph for my drinking event, of my inputs. Based on my gender, age, and weight you could probably estimate what BAC I am currently on... .. and what next-day symptom I am probably going to have the next day if I continue. I cant add a name to the drinking event.
I didn't fully understand the screen shown when I click on circle on the home screen. What are the units and what is the number that I have to choose? (Design) > Maybe consider showing icons instead of a list it would be nicer.
No me queda claro si se puede poner un objetivo de reducción o de cantidad de alcohol por mes o algo así. También me costó entender exactamente qué significa la frase cuando clickeas en el ícono indicando que vas a tomar otro vaso... significa que si tomo otro vaso llegaría al 85% del tope de alcohol que yo especifiqué como límite? Por qué dice +1 drink? Abajo?
No tenga opción de poner una alerta
No entiendo muy bien el grafico de los circulos cada semana. Qué se supone que significan? respecto a qué tengo que comprar el tamaño del circulo?
No me resulta intuituva la grafica de las estadisticas w1, w2, w3..

2. I like that...

the fact that you can set a goal for the night.
I like the functionality of tracking my drinking, and see an overview of it. I like to see and re-collect my next-day symptoms
Same as my answer for the designs.
la aplicacion sea rápida y eficiente.
Puedas ver la cantidad de alcohol de cada bebida ingerida
Añadir nuevas consumiciones parece muy simple. Eso ayuda a que no te de pereza hacerlo
Que te vaya indicando en terminos de distintas bebidas la cantidad que puedes ingerir

EXTRA COMMENTS

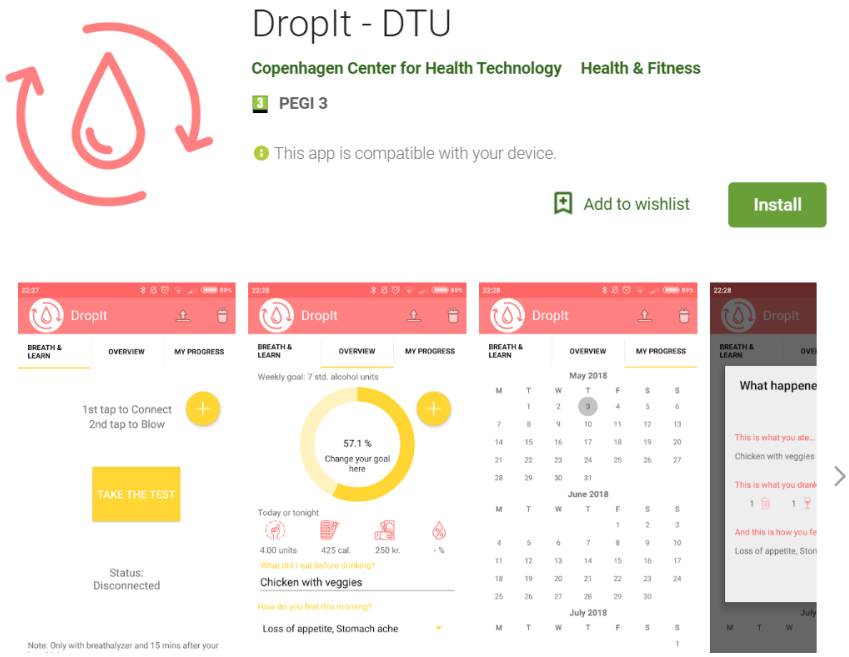
It would be nice if you could scan your bottle with your camera and it would know how much amount there is and percentage. For those who drink bottled beer.
I would like some comparison to the average person of my age and gender. So start the app by asking some details about me. Then in the "my progress" I would have a feeling if im above average or below in alcohol consumption (weekly). Would be nice to show that main circular plot, as it is now, but with some indication of past experience, something like: "70% of max, last time you went to 70% this fast (0-70% within 1 hour) you ended with 180% and with following symptoms next day: tired, nausia... (with the cool icons). But of course in a simpler way. Would be nice with a "call a taxi" feature in my event area in the main screen. If you have the number, then just code that the phone calls that number if you press the button. So the app becomes a app-to-go-to during drinking evenings. Which also means you could in a future scenario add: "need a friend to drink with" and it gives a list of your friends that are currently using DropIT and is registering above 0% BAC.
Cool app good job ;)
Muy buena idea e intención para concienciar a la gente del abuso en el cosumo del alcohol.
solo falta un breathalizer! ;)

Cuál es el ícono de la aplicación? No lo encuentro...
Me gusta la dinámica de la app, creo que sería buena idea poner un tab de "tu historia" para recordar aquellos días con mayor resaca y ver lo que tomaste. Todo el mundo querrá evitar 100% llegar al mismo punto.
A ver voy a intentar ir por partes y comentar todo lo que pueda. En cuanto a la pantalla principal esta bastante bien. La informacion principal esta ahi y es facil de ver. Añadir nuevas consumiciones es facil tambien. Lo unico de lo que no estoy seguro es de la parte de añadir comidas, no se como de importante es pero si es importante igual lo ponia debajo de la grafica? si es algo extra esta bien ahi. En la pantalla que sale al darle a la grafica circular, no pillo lo de BAC con el menu desplegable, que se supone que estoy eligiendo ahi? nivel de alcohol maximo para un evento? como se relaciona eso con la grafica de la pantalla principal? Luego en my progress, como ya te he dicho la grafica de los circulitos no la entiendo muy bien pero lo demas esta guay. El calendario no se por que tiene solo un dia verde y uno rojo, supongo que la idea es que los dias ok sean todos verdes y los que te pasas rojos no?
- I'd move drinking history in a third tab together with overview and my progress Frontpage may have a bit too much info. - I don't know what BAC stands for - Íf meal is free text, include weight. If meals are mapped towards a database make them search- and selectable similar to your dropdown - my first thought on the name is a rapper/r&b person dropping a microphone

B.3 Recruitment

Download “DropIt – DTU”
to track your alcohol consumption

- Go to PlayStore, type “DropIt – DTU” and download the app (Only available for Android users)
- Enter some basic personal data and off you go!
- Add your drinks with the big plus yellow button
- The Breath & Learn tab only works with an specific breathalyser... but you can still use the other features of the app



Developed by Andrea Quemada a DTU Master student

B.4 DropIt

This section provides a link to the mobile application in the Google Play Store:

https://play.google.com/store/apps/details?id=com.bactrack.backtrack_mobile.bactrackandroidsdkdemo&hl=en_US

APPENDIX C

Data

Appendix C will mainly contain documents relevant to the data used in the Mobile Application.

C.1 Standard Alcohol Units, Calories and Approximate Krones

Type of Drink	*Standard Units*	*Calories*	*Approximate krone*
Tuborg grön: 33 cl (4.6 % alc.)	1.012	37	40
Glass of wine: 17.5 cl (12 % alc.)	1.4	160	50
Spirit dark: 2.5 cl (40 % alc.)	0.6	106	100
Shot: 2 cl (40 % alc.)	0.5	60	30

APPENDIX D

Results

Appendix D contains documents relevant to the results of this project.

D.1 *'DropIt'* - The App

This section contains the source code for the mobile application *'DropIt'*, which was uploaded to *Github* and can be found in the following link:
https://github.com/andreaquemada/DropIt

D.2 Data Analysis - Jupyter Notebook

The Jupyter Notebook was used as a tool to analyse the data collected from the mobile application. The source code for the analysis of the data can be found in the following link to the *Github* website:
https://github.com/andreaquemada/DropIt/tree/master/Results

D.3 System Usability Scale Scores

Columna1	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10
Q1	2	3	4	3	4	5	4	3	4	3
Q2	1	2	1	1	1	3	1	2	1	1
Q3	5	4	4	4	5	2	4	4	4	5
Q4	1	1	1	1	1	3	1	1	1	1
Q5	4	3	5	5	4	4	3	5	3	4
Q6	1	1	2	1	1	3	1	2	2	2
Q7	5	5	5	5	5	3	5	4	5	5
Q8	1	4	3	1	2	4	4	3	1	1
Q9	5	3	5	4	5	3	4	4	4	5
Q10	1	1	2	1	1	2	1	1	2	1
Score	90	72,5	85	90	92,5	55	80	77,5	82,5	90
Total Score										

S11	S12	S13	S14	S15
4	5	2	2	4
3	2	3	2	2
4	4	1	4	4
1	1	4	1	3
5	4	2	4	4
1	2	4	1	2
4	4	1	3	4
1	2	4	3	2
5	4	2	3	4
1	1	3	3	1
87,5	82,5	25	65	75
				76,67

D.4 UMACF questionnaire's scores

							Scores	
Type	Question	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Total	Avg.
HE1	Usefulness				3	5	7	64	12,8
HE2	Adherence			3	3	3	6	57	11,4
HE3	Behaviour				3	8	4	61	12,2
HE4	Health				1	11	3	62	12,4
HE5	Efficiency			1	3	7	4	59	11,8
HE6	Productivity			3	2	6	4	56	11,2
HE7	Quality			4	5	4	2	49	9,8
HE8	Safety				2	9	4	62	12,4
EE1	Usability			1	4	5	5	59	11,8
EE2	Understandable			1	1	7	5	58	11,6
EE3	Learning			1		5	9	67	13,4
EE4	Easy		1			6	8	65	13
EE5	Skillful			2	2	2	9	63	12,6
EE6	Information		1	1	4	3	6	57	11,4
EE7	Interface			1	3	7	4	59	11,8
EE8	Pleasure			1	3	7	4	59	11,8
EE9	Features			3	7	5		47	9,4
SI1	Medical personal		6	1	4	3	1	37	7,4
SI2	Family		6	1	2	3	3	41	8,2
SI3	Peers		6	1	2	5	1	39	7,8
SI4	Country		5	2	5	3		36	7,2
FC1	Resources					1	14	74	14,8
FC2	Knowledge					4	11	71	14,2
FC3	Assistance				6	5	4	58	11,6
BI1	Intention		1	2	5	4	3	51	10,2
BI2	Prediction		2	2	6	2	3	47	9,4
BI3	Planning		1	3	3	5	3	51	10,2

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