Tracking everyday sleep

A research project in collaboration with KTH and Stockholms University

1. Introduction

1.1 Background

It is said that we on average spend about a third of our life sleeping. A good night's sleep is vital for every human being to survive and function properly. Experimental research has clearly shown the negative impacts of sleep deprivation.[1] However, there is none to little research showing how the variations in our sleep that arise in our daily life affects well-being and general performance. Therefore, Stockholm University (SU) is performing a study called “Sömn i vardagen” (everyday sleep) where they are going to study how length and quality of the sleep changes on a day to day basis as well as if there is a difference between young and older people. This will then be used to study how it affects mood and performance of the users participating.[2]

1.3 Purpose

The purpose of this report is to extend our knowledge about developing mobile applications, its requirements and what is key for achieving a good user experience. This will be achieved by working on a real-world mobile application with clear specifications from the client.

1.4 Goal

The goal of this project is split into two different areas, the first part of the goal is to learn the techniques used for developing mobile applications as well as how to design an application in order to maximize the user experience. In addition to this, these goals will be achieved by developing an application that is going to be used as an inspiration for the actual application used in the official study at SU. The researchers in the area can then use the data collected by the app in order to study user behaviour and draw meaningful conclusions that hopefully leads to a better understanding of the problem. Two different techniques will be used for developing two different working prototypes, these techniques are JQuery for developing an web application, additionally, an native application will be developed for the Android platform.

1.5 Benefits, ethics and sustainability

There are many possible benefits that may result from developing an application that can track a user's sleep and health. The United Nations has established 17 goals for sustainable development (SDG), one of which includes good health and well-being. By developing this application it can potentially lead to a more sustainable world since good health has direct impacts on other SDGs

[1] Ohlmann, K. K., O’Sullivan, M. I., Berryman, P., & Lukes, E. (2009). The Costs of Short Sleep. AAOHN Journal, 57(9), 381–387. https://doi.org/10.1177/216507990905700905

[2] Stressforskningsinstitutet, “Anslag till projekt om sömn i vardagen,” *Stressforskningsinstitutet*, 2019.

leading to a positive long term effect. While there are many areas of application that can be of benefit to society, there are also ways to abuse the technology. In a dystopian society, sleep tracking is used to control and surveil the people. This would be a grave infringement on the personal integrity of the people and could contribute to the power of a totalitarian government. Despite this potential abuse of the technology, contributing to the common person's understanding of sleep tracking can decrease the room for abuse, as people realize the power of the technology and consequently actively resist its abuse. An aspect of sustainability exists when considering the development and usage of sleep tracking systems. All forms of digitization inevitably lead to further dependency on electricity.

1.6 Methodology

In this report, the method consists of a field study researching the general public's view on sleep tracking, this will then be used to develop a paper prototype that will be used for gathering user feedback that will be considered while developing the functional prototypes.

1.7 Outline

In this report, there are x chapters.
Chapter one is an introduction to the thesis where the background is briefly explained and what problem will be researched and examined. Shortly the purpose, the goal, and the method are explained and also what connection it has to ethics and sustainability. Chapter two explains the design process including a field study and the development of the paper prototype. Chapter five contains discussions of the application's impact on the market as well as an analysis of the design choices.

2. Design process

2.1 Paper prototype

A low-fidelity paper prototype was created using Figma, shown in Fig. 1. The main screen of the prototype shows surveys represented as cards that the user has to complete, clicking on one of the surveys will enlarge it so the user can answer. The settings page will allow the user to set up and change their sleep schedule. The profile page will allow the user to see their profile and potentially statistics regarding their sleeping habit. Lastly, there is an information page where the user will be notified about vital information regarding the research study and the application.

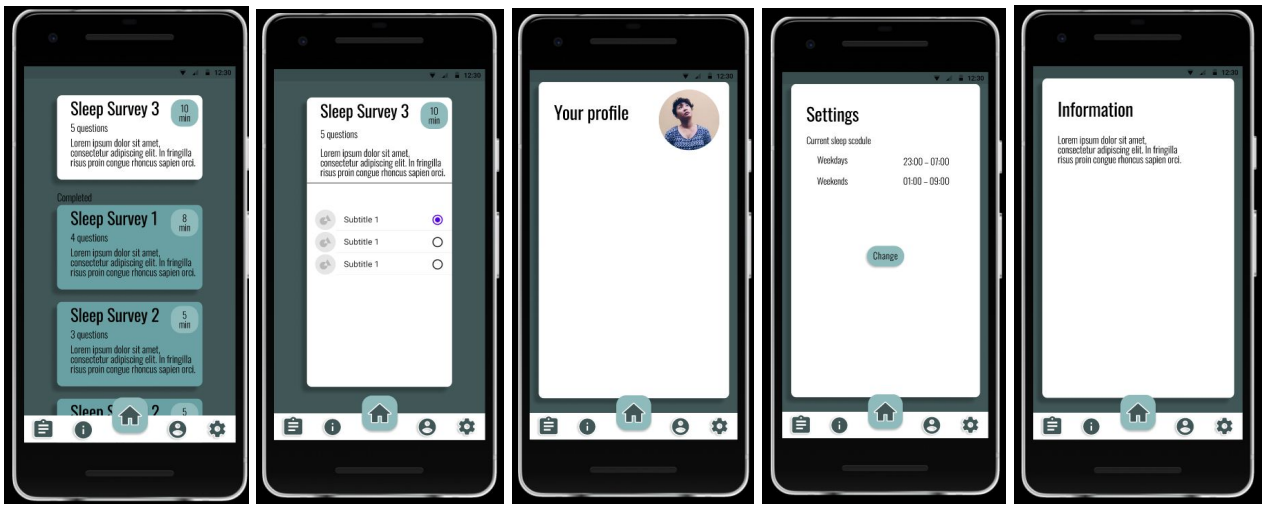

Fig 1. The different pages in the prototype

2.2 Field study

This chapter explains the field study, how it was performed and its results.

2.2.1 Survey

Since the chosen topic for this project was pre-determined by the research project, we chose to focus our field study on firstly, people's motivation for using sleep tracking apps and secondly, the usability and design of our prototype. For the first part we asked questions concerning their previous usage of sleep tracking apps and their attitude towards them. The outcome of this will have an effect on how we chose to design our application. If people in general have a bad attitude towards these kinds of applications, we might have to design and implement more functionality to make the users keep using our application. However, if their attitude is good, they might come back even with the basic functionality. We also added a question about people's attitude towards joining a research project by using a sleep tracking application, for the same reason.

The other part of the survey was more focused on the design of our prototype. We asked the participants to perform a simple task in the prototype, namly to change their wake up time and then rate the difficulty from 1-5, low numbers being easy and high numbers being difficult. They were also asked to rate the overall design from 1-5, where the higher the number represented how enjoyable they thought it was. Since our application will be used by a wide variety of ages it is important that it is simple to use by all ages.

2.2.2 Results of field study

The following section is a summary of our results from the survey. There were 18 answers in total and the largest age group were 18-29 (11 people). The other age groups that were represented in the answers were 30-39 (4 people), 65+ (2 people) and 40-49 (1 person).

The diagram below shows the answers to the first question about sleep tracking applications, seen in Fig. 2. There was an introduction and our definition of Sleep tracking application provided in this question.

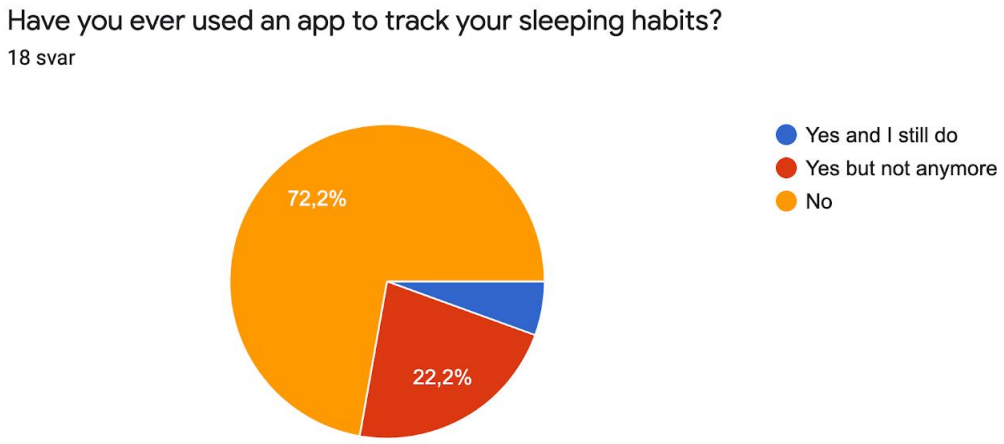

Fig 2. Answers to first question about sleep tracking applications

A majority of the persons answering this survey had never used a sleep tracking application. A more interesting result is that out of the 5 persons that had used these apps, 4 of them had stopped. The four people giving this answer were spread out over the age groups. …..This might be indicating that the apps available on the market today, are having a hard time keeping their users. The next question was directed to those people that have answered that they had stopped using these apps, asking them to write the reason why they stopped. We got the following answers:

1. “I did not think it helped me”
2. “Did not feel like it gave me anything”
3. “I am very forgetful and did not remember to use it and it was not very intuitive to use”
4. “Stressed me”

The two first answers concerns if the app is fulfilling its purpose for the user, which in these cases they did not feel like it did. They felt that the app did not help and give them anything.

For the third question, we wanted to look into their attitudes towards using a sleep tracking app for research purposes. The majority of the people we asked answered that they would be willing to participate in such study, only three answered that they would not. An interesting result is that everyone that stopped using these apps answered that they would be willing to participate.

The following graph displays the outcome of our questions about the design, see Fig. 3 and 4.

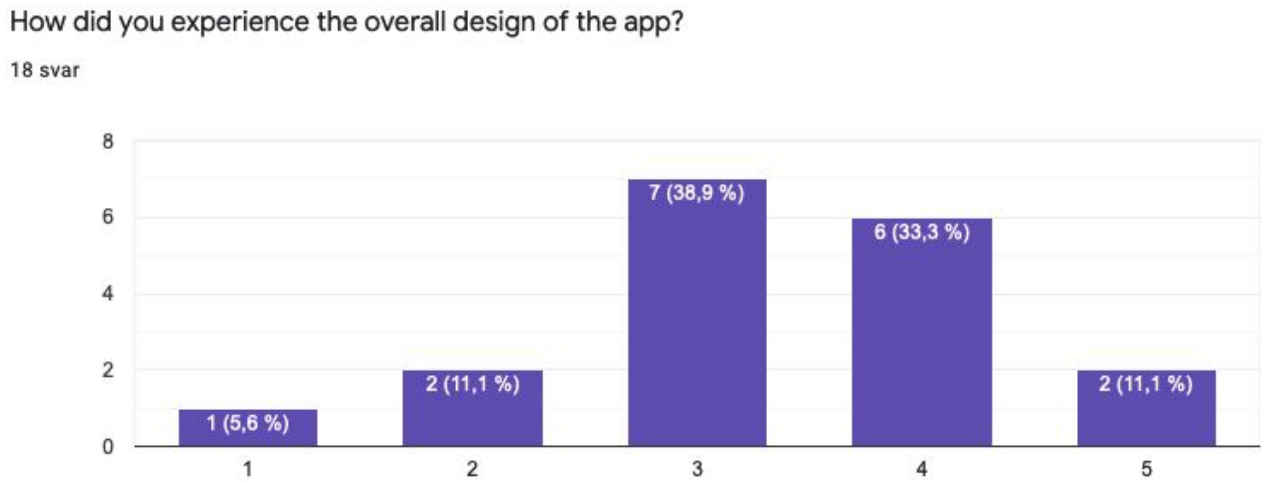

Fig 3. 1 represents terrible *and 5 represents* perfect.

What is interesting is that the average experience of the design was lower for people over 30 than under 30 with an average of 2.85/5 compared to 3.63/5. This might suggest that the current design is somewhat more catered towards the younger demographics which is something that needs to be considered and looked into since the application will be used by other demographics as well.

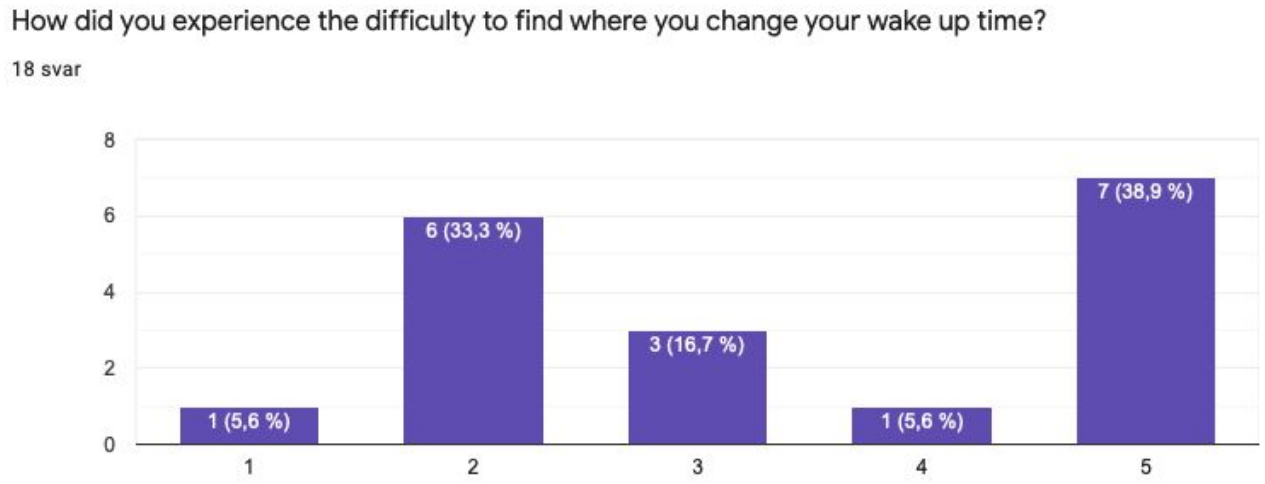

Fig 4. *1 represents* very easy *and 5 represents* very hard.

The results were pretty similar regarding the difficulty when navigating. However, it is important to mention that after the answers had come in it came to our attention that the prototype did not work for Iphone users, making these results unreliable.

Android Prototype

The Android prototype was implemented using the Android Studio IDE in the Kotlin programming language.

The implementation of the prototype was divided into two parts that were developed sequentially. The first part, that internally was referred to as the “main” phase”, concerned the development of the bottom navigation menu and the four pages that the menu leads to. The second part was referred to as the “task” phase and concerned the task that was assigned to the group regarding the research project. By dividing the prototype

Main phase

1.1 Home Screen

The app’s home screen consists of a navigation bar along with cards that represents the different cognitive tests and questionnaires. Clicking on the cards will take the user to the respective screen

Task phase

5. Discussion and analysis

This chapter includes discussions and analysis of the design process as well as the what impact the final application will have on the market.

5.1 Market impact

The problem that the application developed in this work tries to solve is hugely vital for ensuring good health and happiness amongst people as stated by Dement, W. C., and Vaughan, C in their work "*The promise of sleep: A pioneer in sleep medicine explores the vital connection between health, happiness, and a good night's sleep".*[3] However, the application alone does not bring any solution to this problem, in order for the application to be useful it requires researchers to distribute questionnaires to the users of the application as well as study the collected data together with how the users perform on the cognitive tasks.

There exists a plethora of different sleep tracking applications in the mobile ecosystem trying to solve the same problem but in different ways which can range from monitoring the users heart rate during the night to help the user establish a good sleep schedule. These applications can often belong to a wider business model in order for the developers to profit. Since the application developed in this work belongs to an academic research study it does not have the requirement of bringing in profits in order to be successful. There do exist similar sleep tracking applications intended for research purposes as for example the STF Sleep Research that is a custom app built for the Stanford Technology Analytics and Genomics in Sleep (STAGES) project to collect actigraph data for research. The app includes a date jiggle feature to ensure data is de-identified as well as the option to collect high resolution data.
However, the number of sleep trackers intended for scientific research is clearly lower than the number of profit based sleep tracking applications. In addition to this, a sleep application used for research in a scientific study does not have to compete with any other sleep tracking application since the applications used in a particular study is either chosen or completely developed by the researchers performing the study. Regarding the number of substitute products on the market it depends on how one interpret the questions, on one hand it exists a plethora of similar applications on the market, but since our application is specifically designed and developed with the research team's requirements in mind it can be argued for that does not exist substitute products on the market.

[3] Dement, W. C., & Vaughan, C. (1999). *The promise of sleep: A pioneer in sleep medicine explores the vital connection between health, happiness, and a good night's sleep.* Dell Publishing Co.

References:

[1] Ohlmann, K. K., O'Sullivan, M. I., Berryman, P., & Lukes, E. (2009). The Costs of Short Sleep. AAOHN Journal, 57(9), 381–387. https://doi.org/10.1177/216507990905700905

[2] Stressforskningsinstitutet, "Anslag till projekt om sömn i vardagen," *Stressforskningsinstitutet*, 2019. Available: https://www.stressforskning.su.se/om-oss/press-nyheter/nyheter/anslag-till-projekt-om-sömn-i-vardagen-1.460592 [Accessed: Jan. 26, 2021].

[3] Dement, W. C., & Vaughan, C. (1999). *The promise of sleep: A pioneer in sleep medicine explores the vital connection between health, happiness, and a good night's sleep.* Dell Publishing Co. [Accessed Feb. 24, 2021]