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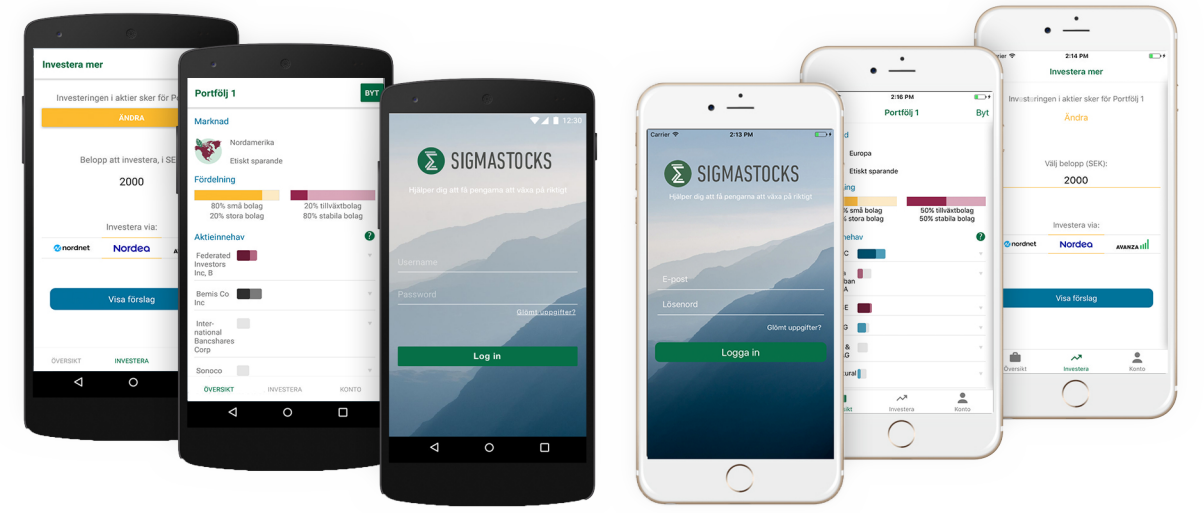

Mobile App for Monthly Stock Savings

Bachelor of Science Thesis in Computer Science and Engineering

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Cover: Two smartphones, one running Android and the other running iOS, with the mobile app of Sigmastocks launched. If nothing else is stated, images and figures in the report are created or captured by the authors.

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Abstract

This bachelor thesis documents the procedure of evaluating methods for usability and software development. To achieve this, the goal is to develop an app for Sigmastocks AB. Sigmastocks provides a service for choosing stocks that mathematically appear profitable, and has registered a demand for a mobile app in addition to their website. Since the application is strongly connected to Sigmastocks brand, a high-quality usability is one of the main focal points in this project. As a basis for this, a user requirement study was performed to identify possible desired functionality of the app.
The project also implements and evaluates the three usability methods: personas, cognitive walkthrough, and heuristic evaluation. The latter two methods are successfully used and concluded to be complementing each other very well. Heuristic evaluation provides a measurement on how well design rules have been implemented, and cognitive walkthrough provides information on what issues the design rules do not cover. The significance of design rules is a key evaluation of this project and concluded that they provide a secure foundation for usability. Personas are hardly incorporated in the development and thus cannot be properly evaluated.
The bachelor thesis further evaluates agile development and the software development framework Scrum in relation to a usability project. It was concluded to be a successful method. Usability requires user testing and usability assessments, for which the agile process can adapt to immediately.

Keywords: mobile app, stock savings, usability, user experience, cross-platform

Sammandrag

Denna rapport dokumenterar utvärderingen av utvärderingsmetoder inom interaktionsdesign och metoder inom mjukvarutveckling. För att uppnå rapportens syfte är målet att utveckla en mobilapp för företaget Sigmastocks. Sigmastocks är ett föreag som grundades i Göteborg och vars tjänst är att tillhandahålla en algoritm som matematiskt hjälper kunder att välja ut lönsamma aktier. Enligt grundarna är en mobilapp högt efterfrågad bland deras kunder. Eftersom appen är starkt kopplad till Sigmastocks varumärke är ett av projektets mål att uppnå hög användbarhet och användarvänlighet.

Som underlag till utvecklandet genomfördes en behovsundersökning för att få reda på vilken funktionalitet användarna anser vara mest önskvärda i appen. Projektet implementerar och utvärderar de tre utvärderingsmetoderna personas, kognitiv genomgång och heuristisk utvärdering. Doe senare två metoderna utfördes med framgång, och det avgjordes att de kompletterade varandra mycket väl. En heuristisk utvärdering kan mäta hur väl designregler har implementerats, och en kognitiv genomgång ger information om fel som inte täcks av dessa. Betydelsen av designregler är också en av de huvudsaklinga frågeställningarna i projektet och det har fastslagits att de ger en säker grund för användbarhet. Personas användes i mycket liten utsträckning under utvecklingen, och det kan därför inte avgöras vilket värde de tillför.

Rapporten beskriver och utvärderar sedan hur agil utveckling och metoden Scrum lämpar sig för utvecklingsprojekt inom interaktionsdesign. Slutsatsen är att de lämpar sig väl, då den iterativa processen tillåter ett frekvent testande av produktens användbarhet, samt möjligheten att anpassa utvecklingen efter den nya informationen.

Nyckelord: mobilapp, aktiesparande, användbarhet, användarupplevelse, multiplattform

Preface

We would like to thank the team of Sigmastocks, which has been a great asset and has provided support throughout the project. An extra thanks to Kristina Berndtsson and Anna Samuelsson, who tirelessly have worked on and provided assistance with the API. Also, a big thanks to Mai Thai and Nanna Stranne for the business and user knowledge provided, as well as a place to work from with access to copious amounts of coffee.

Our supervisor Morten Fjeld also deserves to be thanked for his refreshing insights and ideas.

To all who helped us in the tests and studies: thank you. The project would not have been possible without you.

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1

Introduction

The *Introduction* chapter starts by presenting the background of this bachelor thesis followed by its purpose and goal. It also presents the unconventional outline of this report to help the reader navigate.

1.1 Background of the Project

The Gothenburg-based company Sigmastocks provides a service for choosing stocks that mathematically seem profitable. The company is in a developing phase; as reported by co-founder M. Thai (personal communication, 2017-02-09) Sigmastocks currently has 2000 paying customers with an average monthly post-launch growth of 20% during 2016. The company aims to continue this trend, and thus has to accommodate the needs of both current and potential customers.

According to second co-founder, N. Stranne (personal communication, 2017-02-10), there is a strong demand for a more mobile oriented service, based on multiple inquiries to their customer service. The service Sigmastocks provides is today designed to be used mainly on a laptop or desktop computer. Since Sigmastocks currently has solely Swedish customers, and 81 percent of all Swedes own a smartphone (Findahl & Davidsson, 2016), an app is seen as a vital next step. To support as large a market as possible and simplify the maintenance, Sigmastocks requires this app to be available on both iOS and Android and to use a cross-platform framework.

Further, the intention of the app is to raise the quality of interactions with Sigmastocks. By improving the accessibility and portability of their service, users have the possibility to retrieve support for stock decision when it suits them. With a high level of usability, it will be possible to enjoy the potential benefits of the stock market with less effort and time required. Ultimately this might free time for the users that can be spend on other matters that are important to them. This is not necessary the intention of all technological services today. In his article “How Technology is Hijacking Your Mind”(Harris, 2016) Harris explains that many large technological companies compete to maximize users’ “time spent” on their site. In order to achieve

this, it is likely that companies consciously design their services to extend users time spent there for as long as possible. Together with an increasing "total time spent on mobile" in Sweden (Findahl & Davidsson, 2015), it is perhaps more relevant than ever to make sure that the users' time on mobile devices is instead **well** spent.

In the development of an app, several central concepts emerge. One is usability, that is, does the app provide necessary functionality in a satisfying way for the user (International Organization for Standardization, 1998)? Another is how the software should be developed, using methods of software engineering. This app should work on two operating systems (OS), but how can this be developed as well as designed for? These questions pave the way for the purpose of the project.

1.2 Purpose

The purpose of this project is to apply and evaluate methods for usability and software development of mobile applications. To achieve this, the target is to produce a mobile app for Sigmastocks, for which a requirement is that it should be cross-platform for iOS and Android. The co-founders Mai Thai and Nanna Stranne have furthermore stated that the target users are experienced Sigmastocks users and not novice users (personal communication, 2017-01-27), meaning, for example, introductions to the service is not a priority. It is to be developed using recent studies in software development, design rules, and mobile user interaction.

1.3 Problem Discussion

Four questions are posed, in order to a assess both the usability and software development aspects of the purpose. These, labeled Q1 to Q4, are introduced below.

As stated in the purpose, usability is a cornerstone of this project. A deep understanding of it in general, and for mobile apps in particular, is needed. Design rules is an umbrella term used in this project for design guidelines, design patterns and design principles. The project aims to evaluate the use of design rules in a usability project, something which is expressed in the first question:

Q1 : What significance do design rules provide in accordance to the development efficiency and quality of the final product?

In order to answer this, usability and design, and the combination of the two areas, will be studied. Design rules are to be applied in the app and its accompanying design sketches, and later evaluated to determine whether the contribute to the usability.

In addition to this, functionality that users desire and need has to be implemented. Prioritizing these functions is crucial, and has to account for less fundamental functionality being constructed on a basis of core functions. The requirements of Sigmastocks, too, must be taken into consideration. The combination of these factors leads to the second question:

Q2 : How can functionality be prioritized to match the needs of the users?

In order to solve this, research will be conducted on what functionality is desired by Sigmastocks' users, leading to the creation and prioritization of user stories.

The usability of the app needs to be further tested in order to properly evaluate the usability of the app. If any usability issues are found, these should be identified and resolved. Whether these test contribute to the usability of the app sparks the third question:

Q3 : How can the usability be verified and improved?

The development process itself is an important part of the purpose. While there exist several methods for software development, this project will use agile development. It must be assessed whether this makes for a good choice, leading to the fourth and final question:

Q4 : Is agile development a suitable method for applied user interface design projects?

A specific agile development method will be chosen and followed during the course of this project in order to answer this.

1.4 Limitations

Limitations are made regarding the questions, but also regarding the development of the mobile app.

Q2: Will be answered in the setting of complementing an existing website with a mobile app.
Q4: Scrum will be used as agile development framework.

The app is designed for touchscreen smartphones, as opposed to tablets, since this is the area where the functionality of Sigmastocks needs to be improved the most. The supported OSs are Android 6.0 and upwards, and iOS 10.0 and upwards. By selecting just a few recent OS versions, recently introduced technology and functionality can be used in the app. Testing will also become easier using more currently available and supported devices. The specific versions are based on what the users

of Sigmastocks use, as seen in Appendix D: approximately 80 percent of the Android phone users use Android 6.0 or later, and 87 percent of iPhone users use iOS 10.0 or later.

1.5 Outline of this Report

To better fit the project structure an unconventional outline is used, which is explained below.

Introduction describes the background and purpose of the project. *Theoretical Foundation* presents the theory needed to properly understand the report. *Method* explains how the project has been conducted, except from the design process of the app. The chapters *Requirement Study*, *Development Cycle One*, and *Development Cycle Two* concern three distinct phases of the project. The first phase consists of the gathering of requirements for the app, whereas the following two consist of its development, presented as two cycles. *Development Cycle One* is the development of the app, mainly using design rules, and the use of personas. *Development Cycle Two* begins with a heuristic evaluation and a cognitive walkthrough, which provide feedback used to improve the usability of the app. Thereafter, the chapter *Software Development Aspects* follows, which treats the chosen software development method and the written code.

The methods that are evaluated in accordance with the purpose each have their own "Outcome" and "Discussion" sections: "Outcome" describes the results and effects of the particular method or area, and "Discussion" is for the discussion and analysis of those results. This layout is chosen to keep fact and opinion separated, while maintaining a close connection between arguments and conclusion.

The report finishes with a final discussion and conclusions, which are presented in *Final Discussion* and *Conclusions* respectively.

2

Theoretical Foundation

This chapter introduces the framework of theories, facts, guidelines, and rules that should be taken into account when developing and designing a mobile app. Starting off with what makes mobile apps different from other software environments and general usability definitions, the chapter continues with presenting well defined methods for ensuring usability. Following this, agile development using Scrum is described, continued by a description of software and tools used for the development. The chapter ends with an introduction of some of the concepts of Sigmastocks.

2.1 Usability Theory

As ISO 9241 states: usability is the "extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use" (International Organization for Standardization, 1998, par. 3.1). In practice, it can be argued that usability enables the transition from counter-intuitive visualization to visualization that is self-evident (Krug, 2006).

In order to achieve a self-evident design, there are design rules which can be used. Design rules are defined in this project to include design principles, design patterns and design guidelines. Design principles are general principles and apply for various technologies and systems, whereas design guidelines are specific principles for a system (Dix, 2016). One of the main design principles is to eliminate excise (Cooper, Reimann & Cronin, 2007), where excise is described as the effort required from the user when conducting tasks that do not directly lead towards the goal (Cooper et al., 2007). Lastly, design patterns are best practices and solutions to common design problems based on heuristics and design principles (Hoober & Berkman, 2012).

2.1.1 Usability on a mobile platform

Mobile phones have several characteristics that separate them from, for example, computers. They have smaller screens, built in sensors and are used on-the-go in short time spans (Hoober & Berkman, 2012). Several specific design principles exist for these circumstances: for example, the progress should always be saved, and the amount of disturbance should be kept low but noticeable when needed. Due to the general nature of these principles, they should be tailored to the needs of the app (Hoober & Berkman, 2012; Neil, 2014). By implementing them, an app can be made more intuitive as well as interesting (Tidwell, 2011a).

Some common design problems, such as how to design a list, or how to create a login form, may arise in this project. Therefore design patterns can be applied since they are meant to address these situations. It is however important to remember that the design patterns are general and should be tailored to each specific case (Hoober & Berkman, 2012; Neil, 2014).

2.1.2 Theory of personas

A persona is a hypothetical user, with the traits, knowledge, and lifestyle of a target user (Banga & Weinhold, 2014). By creating personas, designers and developers can focus on the preferences of their representative target group, improving the user experience of the product (Friis Dam & Yu Siang, n.d.).

Since the personas are based on target users, actually identifying the needs of the target user is an important step in the creation process, which can be accomplished by identifying common denominators among the intended users. User data can then be collected from this group of people, either by quantitative methods such as surveys and online activity, or qualitative methods such as interviews. The users can then be separated into smaller groups based on their characteristics. Finally, a persona is created based on the average characteristics of each group(Brickey, 2010).

2.1.3 Theory of cognitive walkthrough

A cognitive walkthrough is performed to evaluate how easy it is, as a new user to learn a new interface (Spencer, 2000). The test is conducted by firstly defining a set of tasks along with action sequences on how to accomplish the tasks (Wilson, 2014). The user then conducts the tasks and the evaluator uses a form to write down the experiences of the user (Wilson, 2014).

An action sequence consists of actions that describe interactions between users and

the interface: the user performs a user action (UA) and the system display (SD) responds with appropriate feedback(Wilson, 2014). The problem reporting form is used to document the problems, successes, and design suggestion that may arise for each action. To simplify this procedure, the evaluator can for each action use the following four-question approach suggested by Wharton, Rieman, Lewis and Polson (1993, p. 9).

- Will the user try to achieve the right effect?
- Will the user notice that the correct action is available?
- Will the user associate the correct action with the effect they are trying to achieve?
- If the correct action is performed, will the user see that progress is being made toward solution of their task?

If there is a lack of subjects, or a lack of resources, the designers and developers themselves may role-play as users by using previously created personas (Wilson, 2014).

2.1.4 Theory of heuristic evaluation

A heuristic evaluation is described as an intuitive and cost-efficient way of finding usability problems (Nielsen & Molich, 1990). In this method, several evaluators use heuristic markers, or simply heuristics, to convey their judgments of an interface (Nielsen & Molich, 1990). While it is unlikely that any evaluator will find more than half of the usability problems, the majority of problems can be found by combining the opinions of several evaluators (Nielsen & Molich, 1990), with the majority of problems being found using five or more evaluators (Nielsen, 1994a). The evaluators knowledge of interfaces is also of importance, with specialists greatly outperforming novice evaluators in the identification and classification of problems (Nielsen & Jakob, 1992; de Lima Salgado & de Mattos Fortes, 2016).

Nielsen and Molich (1990) furthermore admit that heuristic evaluation has its drawbacks: for example, it is unlikely to lead to any large breakthrough in the design, and finding problems does not necessarily mean that there exist good ways to solve them.

2.2 Agile Development Theory

While theory of usability will facilitate the assessment of one part of the purpose, the use of software development methods is necessary for the second part. One of the research questions posed to provide an answer to this, Q4, regards the use of agile development. Opposed to plan-heavy development processes, agile development uses adaptive planning (Cline, 2015), meaning that the project itself becomes more specified over time. As specified in *The Agile Manifesto* (Fowler & Highsmith, 2001), agile development prioritizes, for example, collaboration and working software. In this context, working software means something that is actually real and tangible, as opposed to promises on what to come (J. Highsmith & Cockburn, 2001). Also, the timespan for releasing working software should be short, with frequent deliveries. This means that agile development is well suited for projects where the deadline is tight or customer demands might change during the project (J. Highsmith & Cockburn, 2001; Flora & Chande, 2013). According to a study conducted in 2016 by VersionOne, the by far most popular framework to implement for agile development is Scrum (VersionOne, 2017).

2.2.1 Scrum theory

According to Schwaber, one of the creators of Scrum (Schwaber, 2004), the main idea behind Scrum is the use of development iterations accompanied by daily inspections. This leads to an incremental development of the software, with each iteration creating a potentially shippable increment of the product, that is, a product with functions that can be delivered to the customer. This requires a team that assesses what it is capable of producing during one of these iterations, called a sprint.

What should be done during each new sprint is decided during a sprint planning meeting. During this meeting items are selected from the product backlog, which is composed by what product owner tells the development team is desired from the customer, as well as what the team believes it can be implemented during a sprint. This means that the goals have to be attainable to accomplish within one sprint, and larger goals may have to be broken down into smaller ones (Maximini, 2015). The tasks selected are compiled to a sprint backlog, and should have task-based information such as time estimates and persons assigned (Schwaber, 2004).

To ensure work is progressing, there are daily scrums: 15-minute meetings in which the developers are asked what they have done since the last meeting, what they plan to do, and if there are any obstacles in the way of this. This minimizes the risk involved of not completing the tasks needed for a potentially shippable product (Maximini, 2015).

In the end of each sprint, a sprint review is held, followed by a sprint retrospective.

In the review, the team presents for the product owner and any other potential stakeholders what has been done during the sprint. The goal is here to, together with the stakeholders, understand what the next step should be and how well the team has accomplished the sprint goals (Maximini, 2015). In the retrospective, the development team, together with the scrum master, assess what has worked well during the sprint, and what needs to be improved (Schwaber, 2004); this is done in order to improve not only the results but the cooperation within the development team (Maximini, 2015).

The product owner decides the requirements of the projects, and is responsible for that the goals of various stakeholders are represented. This implies that the product owner is the person in charge of the creation, organization, and prioritizing of the product backlog (Schwaber, 2004).

2.3 Sigmastocks' Service

In order to develop a mobile app for Sigmastocks, understanding their service is a necessity. The core of the service is a mathematical model that computes a stock portfolio, a set of stocks owned by an investor. Users have the ability to customize the selection criteria in regard to the size of the companies, focus on stability or rate of profit growth, geographical market and ethical selection; ethical selection excludes companies dealing in industries such as weapons and petroleum. The resulting portfolio is then diversified over different sectors (Sigmastocks AB, 2017). How a portfolio is visualized on the website is shown in Figure 2.1.

The Sigmastocks service provides two stock sub-portfolios: the user's *current holdings* portfolio and a *target* portfolio calculated by the model. When the user wants to purchase additional stocks, the model can be used to calculate which ones to buy; these will roughly be the highest ranked stocks in the target portfolio that is not yet in the current holdings portfolio. It should be emphasized that the current holdings must be reported by the user, since stocks are traded using a third-party brokerage firm.

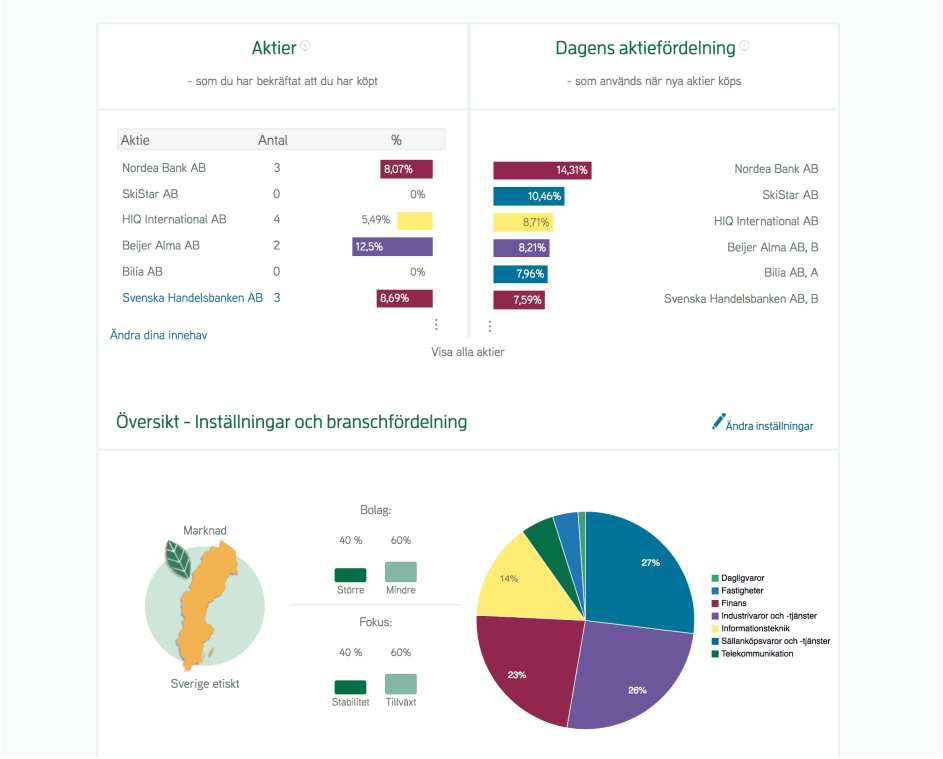


Figure 2.1: The visualization of one portfolio on Sigmastocks' current website, showing the current holdings in the top left, the target portfolio in the top right, and the settings of the portfolio together with the distribution between sectors below.

3

Method

Four main methods are used in this project: Scrum, personas, cognitive walkthrough, and heuristic evaluation. These are widely assumed to have certain benefits for ensuring efficient development and usability of the app (Affairs, 2013) and are evaluated in accordance with the research questions. This section motivates the choice of methods and briefly describes how they are used. The actual impact they have on this project is thoroughly discussed in Subsection 5.1.2, Subsection 6.1.2, Subsection 6.2.2 and Subsection 7.1.2.

3.1 Agile Development and Scrum

Agile development is indicated to be a good choice for this project, based on its description in Section 2.2. This correlates with the facts that Sigmastocks is rapidly developing, the project time frame is short, there is a wish of working software, and there is a possibility for frequent communication face-to-face both between the project group members and with Sigmastocks. Flora and Chande (2013) furthermore suggest that agile development is well suited for mobile app development, which strengthens this choice.

Scrum is chosen as the software development method for two main reasons. Firstly, the target of the project is to deliver an app to Sigmastocks, an app that shall support fundamental functionality of their service and provide a solid base for continued development. Scrum requires that a shippable increment of the product is produced in each sprint. If followed correctly, this would ensure that the final product is shippable when handed over to Sigmastocks. Secondly, the iterative nature of the development is assumed to provide adaptability to previously unknown requirements or expectations from the stakeholders Sigmastocks and Chalmers. Another possible consequence of this, is that the iterative nature disallows for a "full" technical requirements gathering at the beginning of the development. The drawback here is the possible lock-in effects of having made choices at an early stage that prevent a later discovered requirement to be accommodated. The sprint length is set to one week with a combined sprint planning, review and retrospect meeting each week.

Daily scrums are conducted with available developers and the scrum master. Scrum is further altered in the manner that no single person is appointed product owner. The responsibility of managing the product backlog has instead been solved by prioritizing it based on the requirement study and Sigmastocks' requirements. With this approach the maximization of value is largely determined by the users' desires and expectations of the app.

3.2 Methods for Usability

The application and evaluation of methods for usability is a main purpose of this project. The research question Q1 treats one method: the use of design rules. Design rules are chosen to be used as a foundation for the initial designs, providing empirical material that can be further analyzed. The outcome of incorporating design rules in each view is presented in Chapter 5. However, as Hoober states, design rules need to be adapted to each system (Hoober & Berkman, 2012). This calls for a method that addresses the specific users.

Sigmastocks has a broad range of customers and it is important to not design and develop a service for all of them. As mentioned by Cooper, designing for everyone will result in an unfocused goal and negatively affect existing and future users (Cooper et al., 2007). Personas can make it easier to design for a target user and for this reason two personas are created. The personas are created by the data from Google Analytics and are considered to be a helpful resource in order to find out the primary needs of Sigmastocks' end users. In addition to this, personas facilitates the design and development of the app and are thus a helpful hand when it comes to making product decisions.

However, lack of precision about the user can result in deficient personas, which can affect the clarity of how the service should behave. This could occur when the designers create personas that project their own goals, since the audience does not share the same knowledge as the designers. For validation and improvement of usability, which Q3 concerns, two additional methods are chosen. These two methods are cognitive walkthrough and heuristic evaluation, and the conduction of them are described in the following sections.

3.2.1 Conduction of heuristic evaluation

Due to its perceived straight-forward nature and low cost (Nielsen & Molich, 1990), heuristic evaluation is chosen as one of the ways to identify usability problems. How well the intuitiveness and cost-efficiency aspects apply to a usability project is to be evaluated in this report. The self-published heuristic evaluation guide by Jakob Nielsen (Nielsen, 1995) is used as the basis in this project. Five novice evaluators,

the number five chosen due to the probability of finding more than half of the problems as seen in in Subsection 2.1.4, are selected to perform the evaluation. Despite the value of specialists, novice evaluators are used in this project because of their availability. The term novice is the one presented by Botella, Alarcon and Peñalver (2014); the evaluators chosen do not hold a university degree, although they have all completed at least one course in human-computer interaction (HCI) (Botella et al., 2014).

The evaluators receive information and instructions, which can be seen in Appendix I. During the evaluation, a member of the project group is present to take notes on what the evaluators find. A set of commonly used heuristics, known as "the traditional usability heuristics of Nielsen and Molich" (de Lima Salgado & de Mattos Fortes, 2016, p. 388), is utilized in this project. This is due to their widespread use, including for mobile interface evaluations (de Lima Salgado & Freire, 2014).

3.2.2 Conduction of cognitive walkthrough

Sigmastocks co-founders N. Stranne and M. Thai have stressed the importance of the service to be simple to use (personal communication 2017-01-27). Since a cognitive walkthrough evaluates the efficiency of use and the learnability of an interface (Spencer, 2000), it is deemed a suitable method for achieving this goal and is chosen for this project. There is also a hypothesis that a cognitive walkthrough would complement a heuristic evaluation well, since the walkthrough provides feedback on the conduction of the tasks, while the heuristic evaluation assesses general heuristics (Nielsen, 1994b).

In order to have subjects that resemble the target group, it is reasonable to select subjects that are Sigmastocks' users. Sigmastocks cannot, however, disclose information about users' cities of residence. As a result, finding users that can be physically present is highly problematic. Instead, three subjects that have previous knowledge of Sigmastocks' service, albeit not users, are selected. A fourth person is that does not have the same knowledge of Sigmastocks is chosen based on his resemblance of the persona "Bengt" described in Appendix G. This person receives information about Sigmastocks' service as a preparation for the cognitive walkthrough. None of them has used the app before, and none is affiliated with the development of this project.

This is important since the purpose of a cognitive walkthrough is to validate how intuitive an interface is to a new user. If a designer or developer of the project instead were to roleplay as a persona, as mentioned in Subsection 2.1.3, previous knowledge would interfere with this goal.

Twelve tasks are created to cover all functionality of the app. While the three

most crucial tasks are selected for execution, the other tasks are left out due to a perceived lack of time. For the corresponding action-sequences, the four-question approach described in Subsection 2.1.3 is used. The issues found from these tasks are recorded by the instructor from the project group.

3.3 Gathering of requirements

In order to be able to identify and prioritize which functionality that should be implemented in the app, methods for requirement gathering are chosen. An analysis of the website traffic is combined with customer interviews. These two methods are hereafter called the requirement study. They are chosen in order to provide information about current behaviour and desired functionality,

3.3.1 Analyzing website traffic

Sigmastocks uses the tool Google Analytics (https://www.google.com/analytics/) to obtain data about the most frequently visited pages, operating system, et cetera. Data collected by Google Analytics over a one-month period is analyzed to help determine requirements for the app.

In order to analyze the most used functionality of Sigmastocks' website, its most visited pages are examined. The results can identify common goals of the users when using the website, which during the development phase can help with the prioritization of user stories.

3.3.2 Conducting customer interviews

The purpose of the interviews is to find out what the customers desire in a Sigmastocks mobile app. By conducting the interviews it can be uncovered what functionality, both existing and new, the customers desire in the app. Information about the customers' needs are gathered by interviewing the customers.

Telephone interviews are chosen as method over web surveys, since interviews are known to have less non-responses (Strandell & Westling, 2015). With A publication by Statistics Sweden (SCB) says that the participation will be higher if the interviewer conveys how the results of the study will benefit the participant, and also if the interviewer states that the participation would be of great help since most people are inclined to help (Japec et al., 1997). This is taken advantage of when formulating the introduction of the telephone calls.

A list of 50 current users are provided by Sigmastocks and the selection of user is conducted as follows: filter users that have been registered for at least three months, sort them by email and select the first 50. The reason for this is that these users have more experience of the service and are assumed to be able to provide deeper insights on many of the interview questions. Email address is deemed less biased than the other available parameters such as name, start date of membership and date of birth. This is not an entirely random sample but is the best option that can be provided.

In order to ask relevant questions, the wished outcome of the interviews related to its purpose is determined. The three main wished outcomes are as follows:

- Being able to tell what functionality is desired by the customers
- Being able to prioritize between different functionality
- Point out potential new functionality

The questions should preferably ask about a specific time rather than in general, this forces the subjects to answer truthfully (Rob Fitzpatrick, 2013). The number of questions are limited in order to keep total time of the interview as short as possible. This is to keep their commitment throughout the whole interview. A long list of questions responding to different purposes with the interview is filtered into 11 final questions, which are to bee seen in Section E.3

3.4 React Native

Using a cross-platform framework is, as mentioned in Section 1.2, a demand from Sigmastocks. A comparison, which can be seen in Appendix C, is made to determine which cross-platform framework to use. React Native is chosen, in short, based on its large online community, well documented examples, good performance compared to, for example, web-view based frameworks, and personal recommendations. This choice is not without risks being taken; it is a new framework, released in 2015 (Occhino, 2015; Witte & von Weitershausen, 2015), and could therefore contain large numbers of bugs not yet discovered and lack solutions to common code-based issues.

4

Requirement Study

The purpose of the requirement study is to be able to identify and prioritize which functionality is desired and to be implemented in the app, but also to back up decisions on operating system and device support. The study examines the requirements and desires of the users and with the result as a basis, the functionality can thereafter be prioritized. The study is divided into the two areas *Website Traffic*, which examines the historic website traffic, and *Customer Interviews*, where phone interviews with Sigmastocks' current customers are held.

4.1 Outcome of Website Traffic

In the website analysis, statistics about the various goal pages are obtained. This statistic, color coded by category, can be seen in Table 4.1. To provide a better overview, only the first level of each path is displayed.

Table 4.1: Page view data of the most visited paths of https://www.sigmastocks.com/, in total 218 134 visits, during the period 2017-01-15 to 2017-02-14. Note how the percentage of pageviews and percentage of exits vary substantially. The time is measured in (minutes:seconds).

Path[1]	**Category**	**Page views**	**Exits**	**Avg. time**
Portfolio details	Portfolio operations	27.24%	10.43%	00:44
How to	Information acquiring	6.79%	12.49%	00:37
Blog	Promotional content	5.00%	34.83%	00:25
Prices	Information acquiring	4.82%	14.27%	00:30
FAQ	Information acquiring	3.46%	20.28%	01:10
Profile settings	User administration	3.19%	8.63%	00:26
Modify stock holdings	Portfolio operations	2.51%	1.44%	00:21

As can be seen here, portfolio operations are the most visited pages, with functionality such as an overview of a portfolio, rebalancing, and stock trading. Information

[1]The real paths have been replaced with labels, by Sigmastocks' request

acquiring is also popular, with pages where questions about the service are answered. These pages are often visited for a relatively long sessions, which probably is because they contain much information. The blog stands out with its high exit percentage, which may be because there is not enough reason for a user coming from, for example, a promotional link on Facebook to continue to the rest of the site. Despite this, it is a relatively popular feature. Viewing and changing user information also seems to be a somewhat common goal.

4.1.1 User data

Data about the users of Sigmastocks' service are collected and analyzed, in order to be able to create accurate personas and user stories. In Figure 4.1 the distribution between different mobile devices is shown, in where phones hold a large majority over tablets. The usage of iOS is more than 70 percent of the mobile usage and OSs apart from Android and iOS constitute less than one percent of the total traffic.

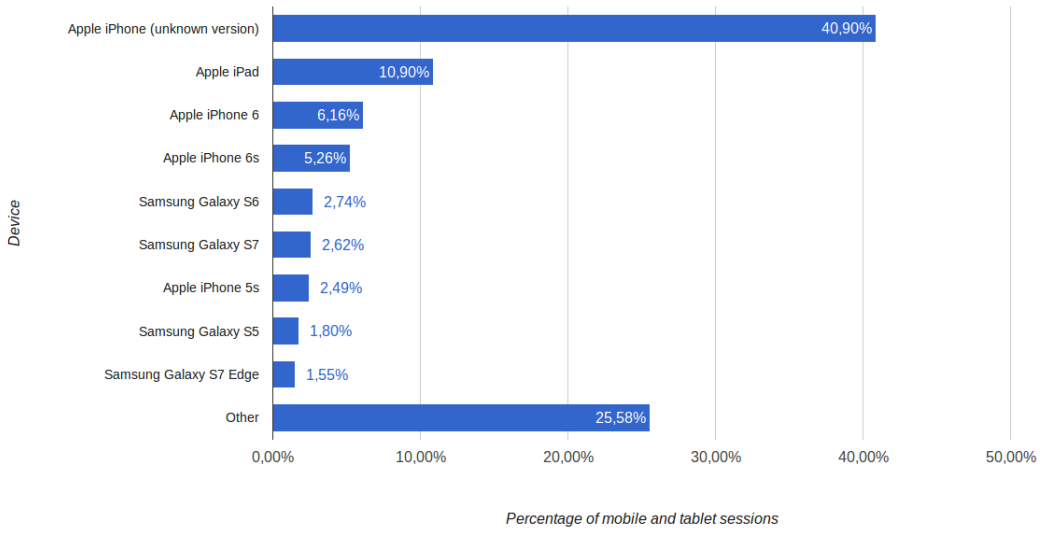


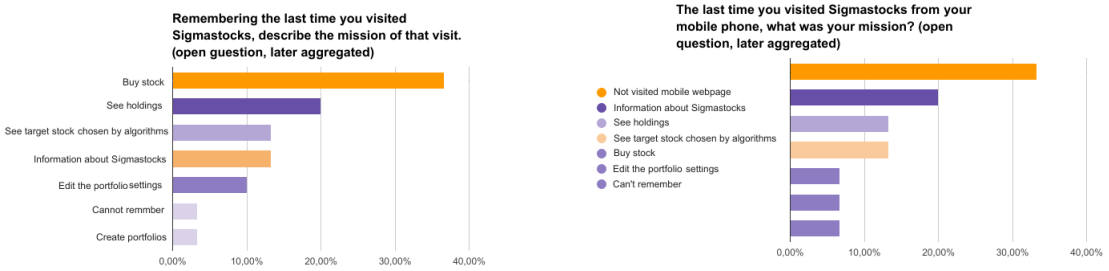
Figure 4.1: Percentage of sessions of https://sigmastocks.com/ by mobile and tablet device during the period 2017-01-15 to 2017-02-14.

Apart from using iOS, it can also be stated that the majority of users are between 25 and 45 years old. The most common flow for a user is to log in and view a specific portfolio, which goes well along with the high percentage of views of User portfolios.

The entirety of the information gathered from the website traffic study can be seen in Appendix D.

4.2 Outcome of Customer Interviews

In the customer interviews, the most commonly reported desired functionality is the ability to get an overview of a portfolio and to invest in more stocks. This correlates to the habits and intentions of the users when visiting Sigmastocks, as seen in Figure 4.2a and Figure 4.2b. Further desired functionality is the ability to see the stocks selected by Sigmastocks' algorithm, and the acquiring of information about the service.



(a) Question 4 **(b)** Question 5

Figure 4.2: The answers to Question 4 and Question 5 asked in the interview conducted on Sigmastocks' customers, shown in percent.

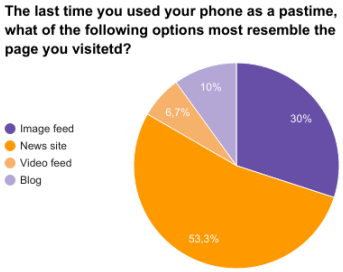
In order for functionality to be prioritized, questions about main features are asked. As seen in Figure 4.3a, an overview of a portfolio is deemed more probable to have as goal when opening the app, more so than the combined abilities to acquire information about Sigmastocks and to edit a portfolio. Purchasing and selling stocks is also seen as more important than editing the settings of a portfolio, which in turn is more important than the creation and deletion of portfolios.

(a) Question 6 **(b)** Question 9

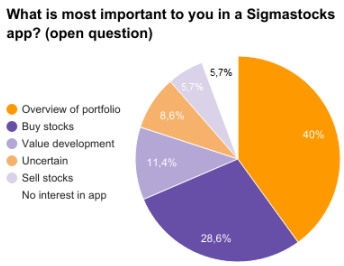
Figure 4.3: The answers to Question 6 and Question 9 asked in the interview conducted on Sigmastocks' customers, shown in percent.

Figure 4.3b concerns what the users see as the most important information to be displayed in a portfolio overview. Viewing the user's own holdings is a prerequisite; apart from that the corresponding target portfolio is seen as most important. An

interesting note is that close to find the value development of the portfolio most interesting, even though this feature is not available in the existing service. As shown in Figure 4.4b, it is also seen as the third most important feature of a potential app.



(a) Question 2



(b) Question 1

Figure 4.4: The answers of Question 1 and Question 2 in the interview made with Sigmastocks' customers, shown in percent.

One of the most frequently reported reasons to visit the website of Sigmastocks, as seen in Figure 4.2a, is to acquire information about Sigmastocks. On the website, this can be accomplished by the means of four kinds of media: animated videos through-out the site, a blog, a text-intensive Frequently Asked Questions (FAQ) page, and a less text-intensive "how it works" page. In order to determine which of these would be most suitable to adapt in the app, it is asked how the users spend their pastime while using their mobile phones. As seen in Figure 4.4a, sites with the structure similar to news sites are in a clear majority, with image feeds as the second most common answer. This can implicate that users may prefer text-based objective information with accompanying pictures.

Potential new functionality asked for is the ability to log in via a third party or fingerprint and not via their Sigmastocks credentials. Many also state that they want a simple connection to the mobile apps of their bank for stock trading. There are the commonly desired ability to to see the value development of ones portfolio which would require new implementations in Sigmastocks' back-end and probably affect the strategic decisions about Sigmastocks' service. All answers of the customer interviews are to be seen in Appendix F.

4.3 Discussion of Requirement Study

In the introduction of this report, the question Q2 was introduced: "How can functionality be prioritized to match the needs of the users?" This question will be discussed here. The two ways examined are the analysis of user data from an existing service and interviews with intended users.

Although the information analyzed in Section 4.1 provides some notion of how current users interact with the service, it is not sufficient on its own to back up the prioritization of functionality. This conclusion is based on that frequent use of a certain website function does not necessarily imply desirability of the same function in a mobile app. There is also no guarantee that the visitors of the website are customers of its service, excluding them from the target group of the app. The method is perhaps thus mainly suitable when the service to be created is intended to be similar to the existing service and all visitors are target users for the new service. Furthermore, it lacks concrete details about how the user interacts with each web page. Despite this, the study shows some important statistics: there is a high rate of mobile devices visiting the website, confirming the need of a service fit for mobile use, and statistics about mobile OSs of the visitors can be used to determine how an app should be developed.

The interviews held are qualitative rather than quantitative, in the sense that each question is designed to provide a result for a specific purpose. The respondents were often very committed in providing detailed responses, leading to high-quality data. However, the number of participants in the interviews is vastly lower than what can be analyzed in, for example, a website traffic study. While the number of participants in the interviews, thirty, thus can be seen as low, their answers point in the same direction as the website study.

The number 30 was chosen because a rule of thumb for the Central Limit Theorem is that 30 data points is sufficient to extract a distribution to represent the population (Blomqvist, 2014). This theorem was never used due to the lack of numeric answers, but nevertheless seen as a guide on the size of a sufficient sample. Out of the 50 customers picked out for the interviews only 32 had to be contacted in order to get 30 answers, two being nonresponses.

The two methods complement each other well. The strength in the data about the existing service, that is website traffic, is that it has the potential to cover a large spectrum of users. One of its weaknesses is that the collection of data is done generically, and is not, except from a few cases such as conversion rate (The number of visitors becoming customers), customized to a specific purpose. The information based on the interviews, on the other hand, is tailored for this specific situation and can thus be seen as more valid. The sample is however small compared to that of the website traffic study, meaning that generalization can be seen as difficult. By combining the two, both questions of a quantitative nature, such as the distribution of visitors' OSs, and qualitative, such as the reason for visiting the web site, can be answered.

There are some sources of error in the methods. For example, the sample used in the interviews was not entirely random, even though their answers show consistency with data collected from other sources. There is however a possibility of subjects misinterpreting questions and therefore responding inaccurately. This is a serious issue, but it is hard to detect with no such examples found. Despite this, as seen in

Figure F.11 in Appendix F, the number of people who chose to respond is very high. A comparison can be made with Statistics Sweden's annual study; they currently face problems due to their survey has non-responses rising from 15 percent to 40 percent, far above the level of this study at 6.3 percent (Strandell & Westling, 2015). The result is thus still assumed to be a sensible generalization of all Sigmastocks customers.

4.4 Result of Requirement Study

The result of the requirement study is the following prioritization of functionality to implement:

- Overview of a portfolio
  - A view of the holdings
  - Distribution of small versus large companies
  - Focus on stability or rate of profit growth
  - If the portfolio setting ethical is applied or not
  - Distribution of the industries the companies operate in
  - The geographical market of the portfolio
- View of the stocks of the target portfolio, as calculated by Sigmastocks' algorithms
- The ability to purchase stocks
- Information about Sigmastocks, such as the FAQ-page on Sigmastocks' website
- The ability to sell stocks
- Push notifications reminding about monthly investment
- The ability to edit portfolio settings
- Creation and deletion of portfolios

This adheres to data collected from the website traffic study and the customer interviews. An exception is made for the ability to view the development of the stocks in a portfolio; even though this feature was highly requested, Sigmastocks does not at the moment provide any support for it to be implemented. The information is instead passed over to the company to act strategically upon.

The prioritization above has been negotiated with Sigmastocks, with the resulting final prioritized product backlog visible in Appendix H. The negotiation primarily makes sure that Sigmastocks' core functionality is high prioritized. It also ensures that the interviews have greater influence on the product backlog than the website traffic, since they reflect the target users better.

5

Development Cycle One

The first development cycle consists of the creation of personas together with the development of the first iteration of the app. The creation of personas starts simultaneously as the customer interviews, while the development of the first version of the app, taking four weeks to complete, starts afterwards. Section 5.1 presents the outcome and discussion regarding the use of personas, while the later sections describe the design processes of the app and their corresponding outcomes. In this cycle, design rules are taken into great consideration, providing the foundation for several design decisions.

5.1 Personas

Two personas, Emilia and Bengt, are created. Their personal information and individual traits are based primarily on data collected from Google Analytics as well as assumptions based on customer information provided by Sigmastocks.

5.1.1 Outcome of personas

One significant discovery from Google Analytics is that a majority of the customers are between 25 and 38 years old, as seen in Figure 5.1. Since there are customers of both genders, the decision was made to create two personas Bengt Sturesson, a man of age 38, and Emilia Eriksson, a woman of age 31, which are further described in Appendix G.

Furthermore M. Thai states that the most common use for Sigmastocks' service is long-term investments, such as saving money for retirement or for the future of their children (personal communication, 2017-05-11). The assumption that a large amount of Sigmastocks' users have children and a stable income is made, based on this information. Thus both created personas are parents and full-time employees. M. Thai also states that many of the customers use the service because they themselves do not have enough time to spend on the stock investment process.

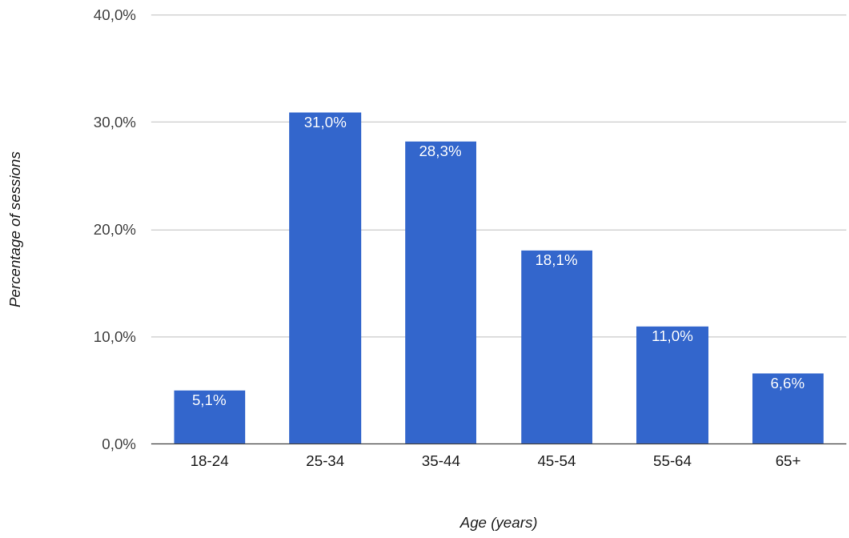


Figure 5.1: Distribution of the ages among Sigmastocks' customers, based on data retrieved from Google Analytics. Note that data for users below 18 years of age is unavailable, and that all users at and above the age of 65 are grouped together.

(personal communication, 2017-05-11). Therefore another common denominator for Bengt and Emilia is that they live quite stressful lives. Lastly both personas have in common that they are customers of Sigmastocks, because this is the target group for the app.

The service of Sigmastocks offers customers to create unlimited number of portfolios within the same market. Yet the Chief Technology Officer (CTO) of Sigmastocks stated that approximately 91 percent of the users have between zero to three portfolios (Kristina Berndtsson, personal communication, 2017-03-23). For this reason, Emilia has one portfolio while Bengt has three.

5.1.2 Discussion of personas

The personas are not as applicable as first assumed, and are used under very few occasions during the project. The aim with the personas are, however, to influence design decisions and possibly ease the selection of user test subjects.However, by conducting the interviews from Chapter 4 before creating the personas, it would have been possible to create improved personas based on this qualitative study in addition to the quantitative data gathered from Google Analytics. With this in mind, the question sheet for the interviews could have been altered to include questions to influence the design of personas. For example, questions regarding the interviewees' work situation or interests could have been posed. The group had not come to the above insight at time of creation of personas, leading to personas based only on quantitative data and assumptions. A conclusion is therefore that valu-

able aspects of the personas should be determined before the gathering of data for their creation, in order to determine which qualitative and quantitative information acquiring methods to use.

Although personas were not as helpful as expected during the design phase of the application, they did assist the selection of one test subject of the cognitive walk-through and also contributed to the design of the screen *switching between porfolios*, see Section 5.5.

5.2 Navigation and Design Guidelines of the App

Concerning the overall design of the application, each view in the app should use the same basic layout, colors, and stylistic elements. This is referred to as the Visual Framework pattern (Tidwell, 2011a). Using the Visual Framework pattern decreases the amount of effort needed to use the app, by not demanding from the user to interpret new layouts when changing views (Tidwell, 2011a).

Tidwell also state that an efficient design helps enhance the branding of the company (Tidwell, 2011a). Sigmastocks already has a branding profile, which is used in their communication channels. The colors and fonts used by the company are thus considered when creating the design guidelines for the app.

5.2.1 Navigation

The navigation needs to be designed to allow the goal to be achieved by the user with as little excise as possible. The navigation should also make it easy to determine the users current location as well as whether the goal of the navigation have been achieved (Hoober & Berkman, 2012).

Due to the fact that the user must be logged in to use the features of the app, the first view to be displayed is the login page. Once logged in, the app rarely has any hierarchy except for the dependency between the overview of a portfolio and the portfolio selection screen. Since two thirds of the users only have one portfolio (Kristina Berndtsson, personal communication, 2017-03-23), the portfolio selection screen is mostly hidden. The app would also, for the same reason, benefit of having a pre-selected portfolio.

When designing the navigation, two main sketches were made as seen in Figure 5.2. After reasoning how the navigation would be used in different cases, tab navigation is considered the most suitable option. It works well, since there are few peer items, and provides a good overview of the navigation options (Neil, 2014). The tabs change color depending on if they are active, providing instant feedback about the

current location. Back arrows are provided for navigation within the tab, to enable safe exploration (Tidwell, 2011a).

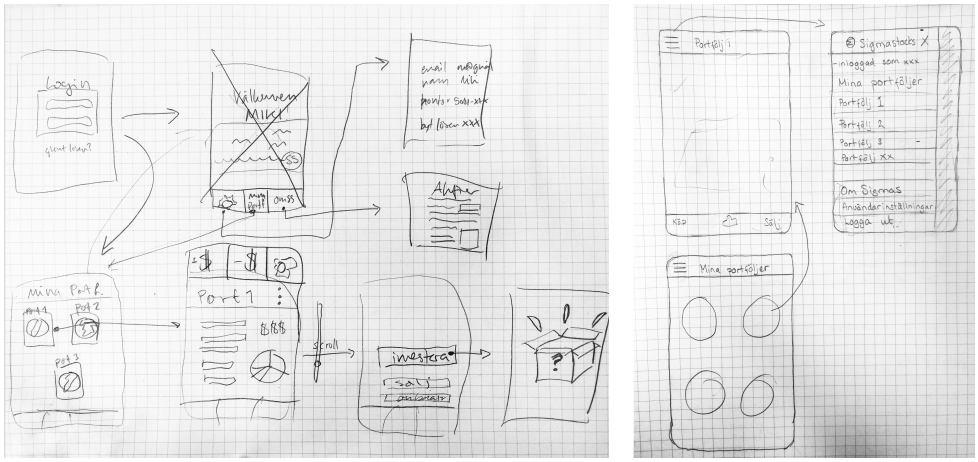


Figure 5.2: The two main sketches for the navigation within the app. The sketch to the left shows the flow and views with a tab bar while the sketch to the right shows an option with a drawer navigation.

5.2.2 Design guidelines

The green color of Sigmastocks has the most central place within the branding of the company, and is consequently chosen as the main color of the app. To incorporate green in all views, it is used in the top navigation bar aswell as in the tab bar. This color is highly saturated, and in order not to tire the eyes of the user (Tidwell, 2011a), white is chosen as the accent color for the bars. Regarding the other colors, the Sigmastocks' color palette consists of blue, dark purple and mustard yellow. To provide balance between the colors in the app, a mixture between warm and cold colors should be used (Tidwell, 2011a). This, together with the statement that cool colors give a respectful impression (Tidwell, 2011a), leads to the decision to choose the warm color yellow and the cold color blue as accent to the green.

Figure 5.3: A button designed according to Sigmastocks' brand

Another main branding feature of Sigmastocks is their buttons. They are colored blue, with rounded corners and white text, as displayed in Figure 5.4. Since they contrast well against the background and are easy to touch because of their big size, this design of buttons are also suitable for the app and thus prioritized over the general iOS or Android design guidelines.

5.3 Login View

As stated in *Mobile User Experience* (Mendoza, 2014), the login view is one of the most important parts of the app. In the case of Sigmastocks, the only current available login functionality is using an email address and a password. The first time a user wants to log in, both email address and password has to be provided. This is not much information, and a login screen should consist of just a few input fields. Two text fields with input hints, and a large button, is enough (Mendoza, 2014; Neil, 2014).

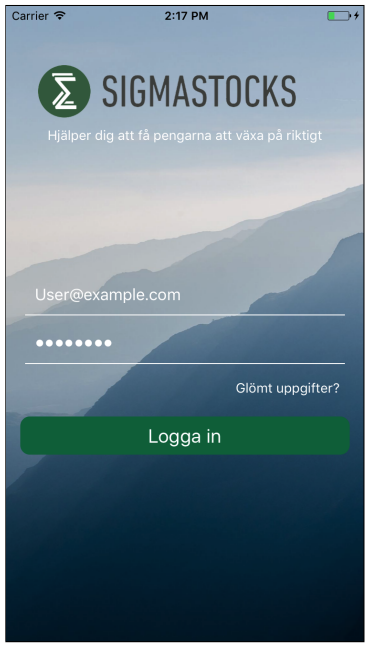


Figure 5.4: The login view of the app

Since a mobile phone is generally personal the display of passwords and storage of user data can be managed differently from that of a computer. In *Designing Mobile Interfaces* (Hoober & Berkman, 2012), it is suggested that the password should not be masked if it is not on the screen for an extended amount of time, which will reduce error rates without compromising the security to a large extent. However, in the app only the last letter is unmasked. This still allows the user to see what is typed in, while reducing the risk of someone else seeing the password, and still reduces the error rate in the same manner as showing the entire password. Another of Hoober's principles that is grounded on the assumption that a mobile phone is personal, is to preserve data whenever possible. This is made in the login screen, where the default value of the input fields are the input given during the previous session.

Since the login action requires time for back-end processing, a graphical loading symbol, known as a spinner, is shown during this period. Once finished with processing, more feedback is given corresponding to the result. If the login is successful the view is changed to allow access to the rest of the app. If unsuccessful, OS-dependent feedback is shown. For Android a toast, a small pop up that disappears after a set time (Google Inc., n.d.-c), is shown. For iOS a pop up is used instead, based on Hoober's design principle about making something clearly visible when interrupting the intended flow (Hoober & Berkman, 2012).

5.4 View One Portfolio

In this view, information of a specific portfolio is presented. The view consists of two sections, as seen in Figure 5.5; the settings of the portfolio is shown at the top, with a list is used for showing stock items below. These items can be expanded to reveal more information and to modify the held quantity of that stock, as seen in Figure 5.6. Since there is a possibility of all stocks not fitting in one screen, it is necessary that the scene is scrollable (Hoober & Berkman, 2012).

As can be seen under "Fördelning" in Figure 5.5, text is added to the bars describing the distribution of stocks, in order to give a fail-safe method for the user to understand the data (Transtutors, n.d.). In order to have continuity with Sigmastocks' website, the market of the portfolio and whether or not the portfolio has the ethical setting enabled are presented in the same way as in the website, which is as a map with or without a leaf added. In addition to the image, text-based information about this is added next to this image.

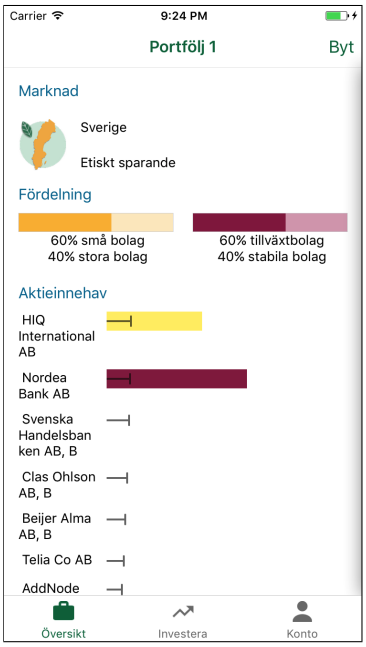


Figure 5.5: Screenshot of the scene "View one portfolio". Portfolio settings are shown at the top, followed by a visualization of current holdings and target portfolio.

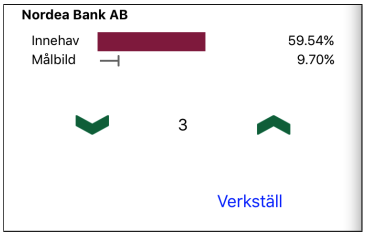


Figure 5.6: Screenshot of the scene "View one portfolio", when a stock item is tapped.

5.4.1 Visualize individual stocks

The performance of the portfolio in the context of Sigmastocks' service could be defined as how well the current holdings portfolio coheres with the calculated target portfolio of the model. Each stock is rendered on screen as a graphical component showing its name, quantity held, and a bullet graph that visualizes its performance as defined previously. Generally the height of a mobile phone screen is substantially larger than its width, so to fit as many stocks on screen at the same time as possible, the bars have to be horizontal. However, there is a possibility to rotate the phone and thus the scene. It is still rather likely that not all stocks will fit even using vertical bars, and continuing with horizontal bars is seen as the best solution. This will also make the user experience continuity between the portrait and landscape modes, since all information will be similar in both variations of the scene.

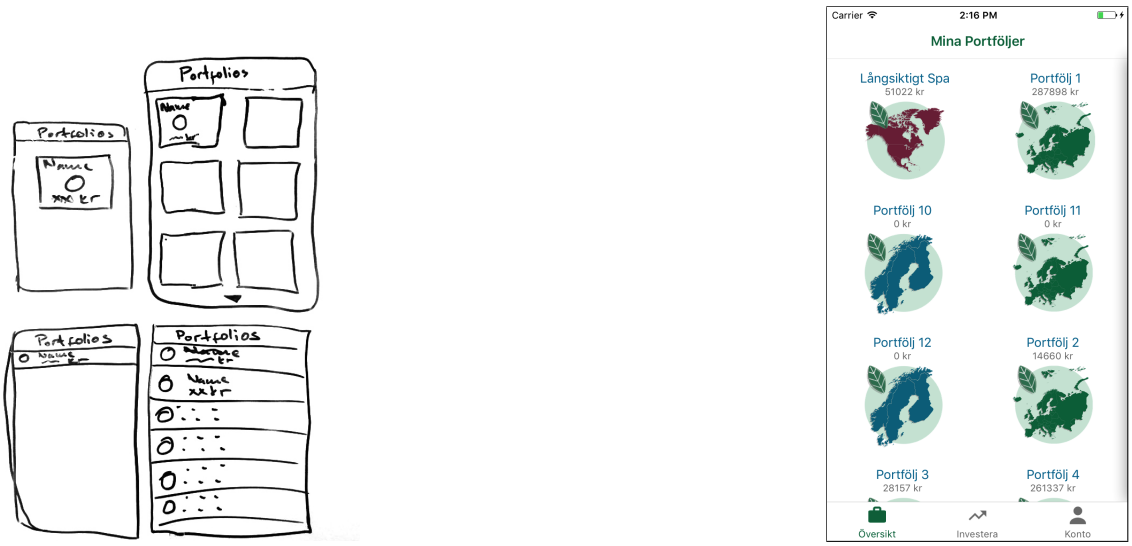
5.4.2 Stock details and quantity modification

An overview of all stocks should be supplied, the scene should allow the user to drill down into details about each stock. The detailed view should also allow for modifications of a particular stock, such as adjusting the held quantity. Stocks are listed as expandable views, in order to take advantage of the Shneiderman's Mantra. This mantra implies a drill down architecture: "Overview first, zoom and filter, details on demand" (Ware, 2013). While this guideline might not solve all problems, it is commonly referenced in the information visualization community and can provide a base on what to strive towards (Craft & Cairns, 2005).

To modify the held quantity the user is presented with two options, either to manually edit the held quantity by pressing the text input field displaying the quantity or by using the arrow buttons on its sides. Pressing the arrows will increment or decrement the current text input by one. Until now the users quantity has not yet been modified on the server, but this is done once the user presses the apply button. But first a confirmation message will be displayed to prevent user errors and limit user confusion (Hoober & Berkman, 2012).

5.5 Switching Between Portfolios

The main purpose of the "switching between portfolio" screen is to provide an overview and selection screen of the portfolios of a user. Visible in the view are the main features of each portfolio: its name, total value, geographical market, and ethical setting. The latter two use the same visual representation as on the website, which is as images, in order to adhere to Sigmastocks' brand.



(a) **(b)**

Figure 5.7: The development of the "switching between portfolios" view. (a) shows the two proposals for visualizing the portfolios, either as a grid or as a list. To the left is the view when a user only has a single portfolio, and to the right when there are several. (b) shows the implemented version of the view.

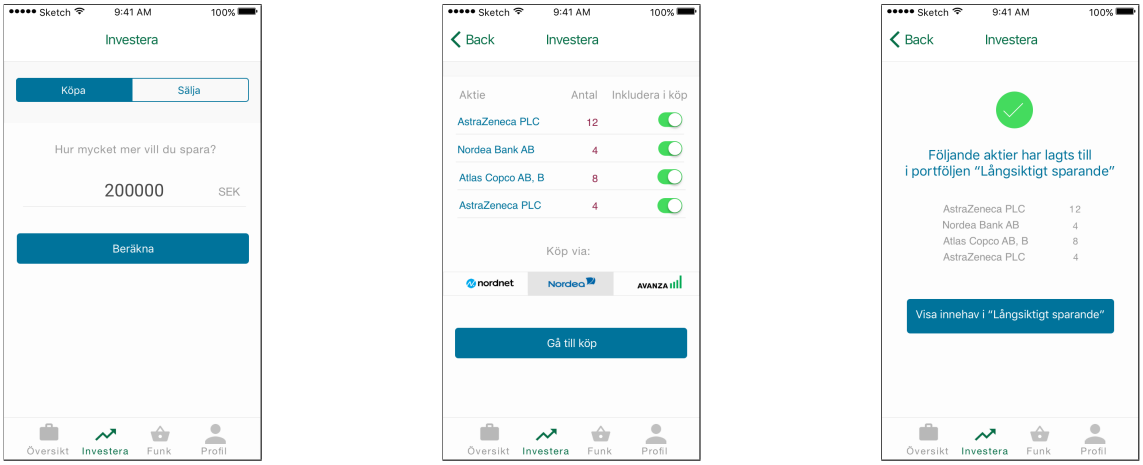
Since each user has an unknown amount of portfolios, different design patterns for showing these are evaluated. In order to display the key features described above, the four design patterns Thumbnail List, Fisheye List, Grid, and Carousel are considered. This as they contain both images and labels (Hoober & Berkman, 2012). Given that each user may have many portfolios, finding a certain portfolio could be difficult when using the Carousel pattern; this pattern is therefore discarded. The

Fisheye List is also discarded, since there is no additional detailed information that needs to be made visible in this view.

As a consequence, sketches are made for the remaining two patterns, visible in fig. 5.7a. Because the number of portfolios can vary, the chosen design has to work for cases ranging from zero to a large amount of portfolios. Specifically, one and three portfolios are used as reference, since these are the number of portfolios the personas have. A list would look empty with only one or three portfolios present, while a grid would be able to occupy the space of the screen more evenly. Consequently the Grid pattern is chosen, with the implemented design shown in Figure 5.7b.

5.6 Stock Trade Flow

An essential part of Sigmastocks' service is to trade stocks using a third-part stock broker. This presents several challenges for designing the trade flow, such as how to gather necessary input, and how to present the entire flow. Furthermore, how to solve the integration of stock brokers that cooperate with Sigmastocks, to enable actual trade, is a key issue.



(a) **(b)** **(c)**

Figure 5.8: The three views visualizing the sketch investment flow. Input for calculations is provided in (a), whereas (b) displays calculated stocks and (c) shows a confirmation.

The trade flow mainly consists of three different user actions: the input of necessary information for the calculation of stocks, the review the calculations given by Sigmastocks, and the trade through the stock broker. As recommended in *Mobile Design Pattern Gallery*, long forms are preferably split up into different views rather than displaying everything in a scroll view (Neil, 2014) This extensive trade flow can be resembled to a long form, and is divided into three views: the first view displays the input necessary for the calculation, that is, the amount to invest and the stock broker to use. The second view presents the calculations, in which each stock can

be either included or excluded. The third step of the process is dependent on the integration with the stock broker, for which the desired navigation is to open its app directly. This is assumed to be possible when creating the prototypes. The final view is added to provide sufficient feedback regarding the trade.

A recurrent used pattern in the trade flow is Good Defaults, which encourages use of default values where the input can be predicted (Tidwell, 2011b). Good Defaults are applied to the first two steps in the stock trade flow, such as a pre-selected portfolio to invest in, and the inclusion of all calculated stocks.

In the implementation of the stock trade flow, some minor changes from the paper prototypes are made. Since buying stocks has higher priority than selling them, this feature is implemented first. This leads to the options visible for selling stocks being removed. For this reason the specific flow of buying stock will be referenced as investment flow and the sketches can be seen in Figure 5.8.

5.7 User Page

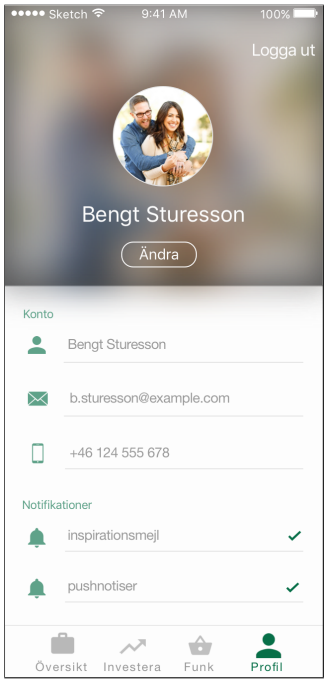


Figure 5.9: The digital sketch of the user page, with information related to the account of the persona "Bengt".

A profile page is necessary, since all functionality in the app is connected to and dependent on a specific user. Furthermore, apps requiring a user to sign in should provide a page for user settings (Tidwell, 2011b). On this page, icons are used instead of labels to describe each text field. This as icons both can help users better understand an interface (Cooper et al., 2007), and recognize adjacent items faster (Cooper et al., 2007).

In the Android version, a floating action button is used for the primary action, which is the editing of settings. While the Android design guidelines strive toward a more graphical interface ('Introduction - Material design - Material design guidelines', n.d.), the iOS design guidelines instead use words for describing the actions of system buttons ('Buttons - UI Controls - iOS Human Interface Guidelines', n.d.). Thus the edit settings in iOS is represented by a button with the word "Ändra" (Modify). For the reason that user page is not included in the core functionality of Sigmastocks, only a sketch for this view, seen in Figure 5.9, is made during this first cycle.

6

Development Cycle Two

This chapter describes the second development cycle, which lasts for three weeks and consists of usability tests and changes made by examining their results. In Section 6.1 and Section 6.2 the outcome of the tests is described and discussed, with the process leading to the improvements described in Section 6.3. After this cycle the app is considered ready to be handed over to Sigmastocks.

6.1 Cognitive Walkthrough

As one of the two selected methods for testing usability, a cognitive walkthrough is conducted during the second development cycle. At the time of conduction, the app tested is the product of the first development cycle, described in Chapter 5, alongside the paper prototype for the investment flow. However, when the last walkthrough is to be conducted, the investment flow has been implemented and is then used instead. The reason for this change is to find errors in the implemented version that might not exist in the sketches, since further iterations of the investment flow would build on the version actually implemented. Three tasks are examined during the walkthrough: one concerning the view and interpretation of the current holdings versus those of the target portfolio (named T1), one regarding the change of stocks in another portfolio than the currently shown (T2), and one about the investment of stocks (T3). The entire list of the questions, together with the raw results, can be seen in Appendix K.

6.1.1 Outcome of the cognitive walkthrough

The result of the cognitive walkthrough performed is feedback regarding different issues of the interface. Related to T1, issues concerning interpretation of the current holdings versus the target holdings appeared. It is perceived difficult to understand that the stocks are all pressable, and thus, several subjects can not distinct what belongs to the target portfolio and what belongs to the current portfolio. The subject

with no experience of Sigmastocks' website also finds the colors of the different bullet graphs highly confusing.

Regarding T2, one issue observed in three of the four walkthroughs is the difficulty of finding the button for switching portfolio. This decreases the efficiency in the app significantly. There are also complaints about not knowing if the holdings actually are updated. Overall, too little feedback is given about what and where something happened.

This issue is also observed in T3. For example, it is unclear in which portfolio any investments are made, and the button labels are seen as confusing. In the implemented version of the investment flow, the placeholder in the amount input field is mistaken for an actual pre-filled value.

6.1.2 Discussion about cognitive walkthrough

The cognitive walkthrough is proved to have a direct effect concerning the usability of the app: its resulting feedback identifies several task-based issues, such as the lack of feedback when the users update their portfolio holdings, which can then be resolved.

While preparing the cognitive walkthrough, the selection of subjects had greater effect on the resulting feedback than initially expected. The subject who has no previous experiences of Sigmastocks, yet is similar to the persona Bengt, provided feedback regarding the colors in the portfolio overview. It is difficult to assess if the colors are a real issue or if a user familiar with Sigmastocks' service would, on the contrary, have found them simplifying the interface. To prevent sources of errors like this one, it is important to select subjects that share key characteristics with the personas, and thus the target group; in our case, that would be selecting people with previous experience of Sigmastocks.

As stated in Subsection 2.1.3, one option is to let team members act as the personas and perform the given tasks. Doing this would have enabled a more time efficient walkthrough, by removing the necessity of finding and scheduling suitable subjects. However, it would not measure the learnability, since the team member, despite the acting, already would be familiar with the interface. An example of this is the aforementioned button for switching the active portfolio. Since all team members know exactly where it is located, it would not have been evaluated as hard to find. In general, similar efficiency issues like this one might have been left undiscovered if the cognitive walkthrough would have used subjects already familiar with the interface.

Another interesting observation to make is that the feedback rarely concerned designs created with the aid of design rules. Instead, the feedback was likely to regard design

choices that had been made on presumptions, such as the location of the button for switching portfolio. This signals that design rules do provide a secure foundation on which designs can be developed, and that user testing mainly benefits design not covered by design rules.

A limitation of a cognitive walkthrough is that it exclusively evaluates specific tasks. This means that the tasks have to be designed to ensure that all necessary features are evaluated. In the case of this project, it was concluded that there would have been sufficient time to assess some of the left out tasks. Assessing them would provide a broader basis where usability issues could have been found, leading to the possibility to further improve the usability. One possible action to prevent choosing too few tasks is to measure the time it takes to carry out the walkthrough as well as identify possible stages where issues can be found. With this information in hand, it would be easier to determine if additional tasks have to be created in order to fully cover everything of importance.

Note that understanding a user interface is not the same as interacting with it. There is diverse data displayed in the app, and consequently the question about if users actually comprehend the data is of importance. One of the questions asked to each user is whether the meaning of the action is clear, but not if the meaning of the view itself is clear and comprehensible. Thus, if there is visualization of specific data, this has to be taken into account when creating the questions.

6.2 Heuristic Evaluation

Not only a cognitive walkthrough was conducted to find usability problems in this project, but also a heuristic evaluation. The evaluation evaluated the paper prototypes made, see Appendix M, and the version of the app as it was after development cycle one. This provided feedback not only on current issues, but also on future design proposals.

6.2.1 Outcome of heuristic evaluation

The evaluation time slot ranges from one to two hours depending on when the evaluators believe that all existing usability problems have been found. During this time slot, the evaluators test the interface of the app and accompanying design sketches. The results are written down by the project team member, with details such as in which view the problem is found, if it is for the app, the design sketch, or both, and the experienced severity of the problem. The evaluators are instructed to traverse the system at least twice, in order to properly understand it and identify as many problems as possible.

The results from the evaluations are combined and compiled, as visible in Table J.1 and Table J.2 in Appendix J. From the feedback, user stories are made and put in a backlog. The priorities of these stories are determined both by the sum of severity scores of each problem, as well as estimated time to complete and how much value it would create if completed. As an example, one of the most severe issues found is a crash-inducing bug on the login page. A limitation in this process is that only the interface of the app, not its functions, is tested.

6.2.2 Discussion about heuristic evaluation

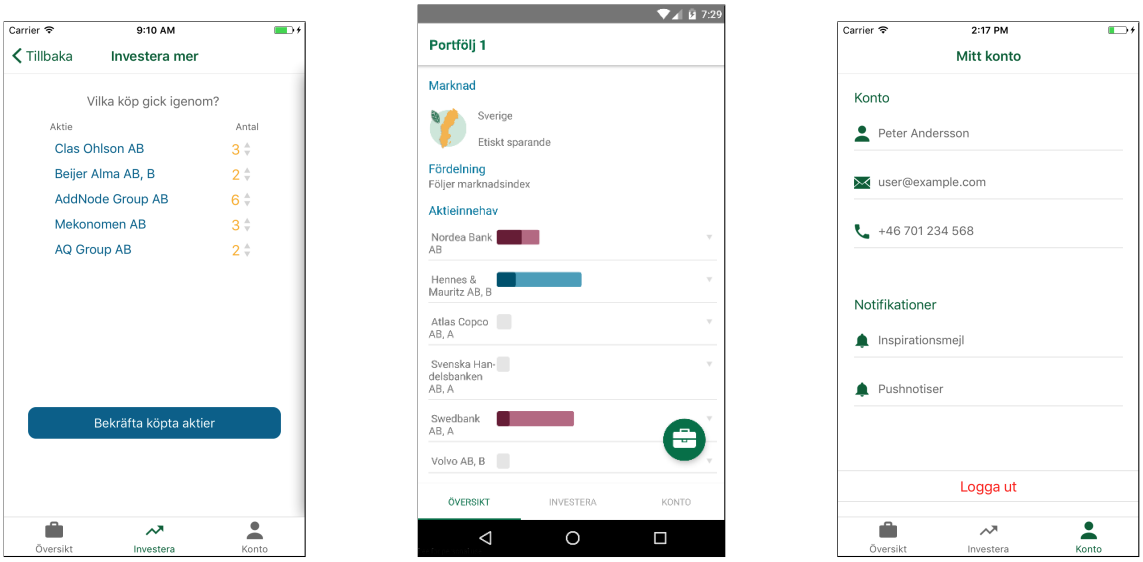
The absence of usability experts among the evaluators is seen as a major problem, due to the difficulties using novice evaluators (Nielsen & Jakob, 1992). It is possible that this could have been solved by contacting the supervisor of the project, to see if he knew any experts at the human-computer interaction department who might be willing to participate. However, since Nielsen and Jakob (1992), show that enough novice evaluators still can identify many problems, this approach is seen as somewhat satisfactory. As they further state, more problems may have been identified using more evaluators, but because of the diminishing returns it is not certain that the feedback provided would be worth the additional time spent.

While many problems are indeed found, many problems are only discovered by one or two evaluators, which is consistent with the findings of Nielsen and Jakob (1992). This makes it difficult to judge how severe a problem is; if one evaluator rates it as very severe, but the others do not identify the problem at all, it is experienced difficult to asses if the sum, mean, or median of recorded severity scores should be used. In the end, the sum is used, which makes the problems discovered by multiple evaluators stand out more. It is believed that this reflects the actual severity of the problem, since severe problems should be discovered by several evaluators.

Several of the problems discovered by multiple evaluators are also assigned different heuristic categories, which in turn is consistent with the findings of de Lima Salgado and de Mattos Fortes (de Lima Salgado & de Mattos Fortes, 2016). While this in the end does not affect the following prioritization, it shows that there is a risk for inconsistent answers when using novice evaluators. Despite the problems surrounding the fact that only novice evaluators are used, many problems regarding the interface are found and can later be corrected. It is however a clear possibility that some issues are left undiscovered. Despite this, and while a heuristic evaluation takes time to prepare, conduct, and analyze, it is believed that the feedback given is valuable enough to justify its use.

6.3 The App Version Two

After the usability tests, which mainly used the sketches Appendix L, improvements are made to the app. Since the feedback primarily concerns the investment flow and the display of holdings, these interfaces are where the most changes are made. A short explanation of all the views and their functionality can be found in Appendix M.



(a) (b) (c)

Figure 6.1: Screenshots of the three views mostly changed due to the feedback in the user testing. (a) and (c) is show the iOS version, while (b) shows an Android-specific screen. (a) displays an added view in the investment flow, providing the possibility to select accepted purchases. (b) displays the overview of one portfolio, with improved visualization of the holdings and a floating action button for changing portfolio. (c) displays the implemented user page, with information about the account and an option for logging out.

6.3.1 Investment flow

Much of the feedback from the tests concerns the investment flow, specifically the visibility of information and the lack of possibility to regret purchases. Some issues are already addressed in the implemented version, such as display the name of the portfolio in which the investments are made. Other minor changes, like more accurate text on the buttons used for navigation in the flow, are made thanks to the feedback. Due to the placeholder being mistakenly interpreted as a real value, it is changed into a real default value which implements the Good Defaults pattern. The view in fig. 6.1a is also added in response to the feedback, giving the user an option to select approved purchases. The desired and probable flow is that all purchases pass, and thus the values given in the previous step are used as Good Defaults.

The initial idea for the third step in the investment flow, which is the purchase of stocks through a stock broker, relies on the availability of opening the apps of the banks. Since this is found to be unsupported, displaying the websites of the banks remains the only viable choice. This can be done in multiple ways. Due to the size of the screen, presenting the view of the bank together with the calculations from Sigmastocks is evaluated as unfeasible to display. As a result, a solution in implemented, for which a new view of the website of the bank is presented. This solution is designed to have the stocks and amount pre-selected in the website of the bank, simplifying the purchase process. Although this functionality is currently not supported by the banks, it is believed possible to implement it for Nordea in the near future, due to the bank's coming release of an open API (https://nordeaopenbanking.com/). If this, however, continues to be unsupported, a separate buy button for each stock item is to be added. This button would open the web page of the trade of that particular stock, for the specified bank.

6.3.2 Displaying holdings

In the usability evaluations, the bars representing holdings are often seen as difficult to comprehend. While the bars themselves are not seen as bad representation of the data, determining which bar represents what data is deemed more complicated.

To assist the interpretation of the bars a help dialog is implemented. The dialog explains what the two different bars represent and how to interpret them, and is available by pressing the green button with a question mark shown in Figure 6.2. The bullet graphs are replaced with new bars, which will have to be evaluated in further tests together with sketches for other suggestions, in order to determine if they increase usability.

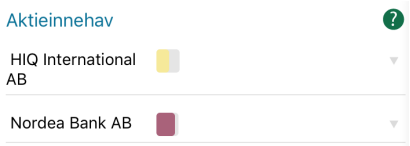


Figure 6.2: The enhanced bars visualizing holding and target. A button for opening a help dialog, explaining how to interpret the bars, is located in the top right.

The usability tests of the app also reveal that it is not intuitive to expand the stock items. To resolve this issue, the grey separating bar is added between each stock item to clarify that they are indeed separate items. A grey downwards facing arrow is added for each stock item, as seen in Figure 6.2, to symbolize that more content is available.

6.3.3 Response to other feedback

Furthermore, the cognitive walkthrough revealed a difficulty in locating the button for switching the active portfolio. An alternative is, on Android, to use a floating action button, similar to the one found on the Android version of the user page.

An implementation of this is seen in Figure 6.1b. Its larger size and more central position is assumed to increased visibility. However, since it is not clear if users will understand its function, the floating action button is not implemented in the final version of the app.

Something that is implemented, on the other hand, is the user page. The implemented version does not contain a profile picture, as this information can not be retrieved from the user. Instead, it only contains basic account information, notification settings, and a logout button, as seen in Figure 6.1c.

6.4 Ideas About Future Improvements

Even though the final app is ready for delivery to Sigmastocks, there are still unimplemented user stories. They concern both functionality prioritized as less important, but also feedback derived from the user evaluations. Thus, some potential future improvements are explained in this chapter. The app will also have to be tested in greater scale, before it is made publicly available.

Regarding the login view, there are some important enhancements to be made. The last character in the password is currently not masked, but in a demonstration for example it could be beneficial to fully mask the password for security reasons (Hoober & Berkman, 2012). As an intermediate solution, Hoober and Berkman suggest the addition of a checkbox for the option to mask the password (Hoober & Berkman, 2012), which also was a proposed solution given as feedback in the heuristic evaluation. The view could further be improved with a possibility to log in using connected accounts, such as Facebook, which would would decrease the required input. Fingerprint recognition is another option, which would give the app an advantage over the web service.

The investment flow is another area for possible improvement, especially regarding the integration with the banks. A solution, if they do not support the auto selection of multiple stocks, is to take advantage of several devices. When using two devices, one can display the website of the bank and one can display the app of Sigmastocks. When pressing the buy button for each stocks, the view in the other device is updated with corresponding stock and values. This would remove excise, since the user continuously can confirm what the recommendation are, without having to go to a previous view in the app, as well as not having to navigate between views for each purchase.

7

Software Development Aspects

Some of the software aspects in the development cycles concern Scrum, the framework chosen for agile development. Others concern how the software is implemented. This chapter presents the outcome of and discussion about these aspects.

7.1 Scrum

This section will present gathered data and results from the process of incorporating Scrum in the project. The purpose is to provide an introductory discussion regarding Q4: Is agile development a suitable method for applied user interface design projects? Where the initial hypothesis is that the answer is yes.

7.1.1 Outcome of Scrum

This is a summary of the Scrum retrospectives held each new sprint. In total, 42 feedback points where recorded in weekly journals using the *start, stop, continue* technique. In this technique, feedback is categorized as something that the team should start doing, something that is not working well and should be stopped, or something that is working well and should be continued.

Many points allow for generalization and are grouped based on subject as seen in Table 7.1. **Communication** includes feedback regarding communication between developers, but also for ensuring that the ongoing work is transparent and accessible at all times. **Take initiative** includes feedback that highlights the importance of individuals taking initiative. **Workload distribution** includes feedback that highlights the benefits of distributing workload.

Additionally, several times during the project it was reported in the teams communication channels that the assigned tasks would not be completed within the estimated time.

Table 7.1: Feedback points recorded during the course of the project, by category

	Begin	**Continue**	**Stop**
Communication	8	5	0
Take initiative	4	2	0
Workload distribution	4	4	0
Other	6	5	4

During the project, user stories where divided into smaller tasks to be assigned to developer during the weekly sprint planning meetings. The distribution and management of tasks was handled using a Trello board, which is a collaborative notice board where tasks may be assigned to users.

7.1.2 Discussion about Scrum

For this project Scrum provided the ability to adapt the development to the new information. The sprint planning and daily scrums allowed for efficient communication and distribution of the workload. The rest of this section will be devoted to discuss some experiences of using Scrum.

Time estimation is hard: A frequent issue was that of estimating the time each user story will take to implement. Often, time was underestimated due to unforeseen obstacles that arose during development. Because of this, user stories was not always finished before deadline. This breaks the requirement of producing a new increment each sprint. Still, it was built incrementally which ensured that at any given time, a working increment of the app was available.

Communication: As mentioned, an effect of incorrect time estimates, several tasks were completed after their deadlines. In some cases, however rarely, the fact that a developer would not be able to finish a task before the set deadline was not communicated clearly to the rest of the team. Had communication been more clear, the group could have adapted to this information and reallocated resources accordingly. Communicating proactively is a necessity for the teams ability to adapt. Realizing this, it was decided to incorporate daily scrums. This improved communication by offering a quick status check with all available developers that day.

Individual initiatives: Scrum lacks a role for delegating tasks. When finished with a task prior to deadline, the developer must actively seek work and support other developers that struggle. This increases the probability of reaching sprint goals. Taking initiative in this manner was a quality frequently asked for, and later praised, in the scrum retrospective. Just like **Communication** this became easier when incorporating daily scrums.

Backlog management: A common feedback raised regarding items in the backlog was that they lacked a detailed description. Backlog items need to clearly state what sub tasks must be completed before the whole task is considered done. The lack of an designated Product Owner became apparent here, since the developers had to work this out by themselves, taking time from actual implementation. Thorough and comprehensible task descriptions would likely improve time estimation and streamline development, since developers would then know what is expected from them.

One of the common denominators for these experiences and issues, is that they are not specific to applied user interface design projects. With this information it is not possible to disprove that the answer to Q4 is: yes.

7.2 Code

A large part of the project is the implementation of the design. In this section, a part of the actual programming will be discussed.

7.2.1 Outcome of the structure of the code

The code structured proposed in the system design document of Appendix B is followed. A part of this can be seen in Figure 7.1. Separation of concerns is a major point in this architectural design; all screens are kept separate, with index files and custom styles of their own.

Figure 7.1: A part of the folder structure used in the project.

Only a few artifacts are made specific for each operating system, with one example visible in Figure 7.2. Here a message is displayed in a toast if, on Android, and in

a text box, if not.

```
_showFeedbackMessage = (message, isError) => {
    if(Platform.OS == 'android') {
        ToastAndroid.show(message, ToastAndroid.SHORT);
    } else {
        if(isError){
            this.setState({resetMessage: message});
```

Figure 7.2: The way a message is shown, depending on OS.

In order not to call on the server for each operation which needs a portfolio, data is stored locally, made possible by the asynchronous storage solution AsyncStorage. Since AsyncStorage only can store text strings, other objects are converted and parsed using JavaScript Object Notation (JSON) as seen in Figure 7.3.

```
export const getActivePortfolio = async () => {
    const json =  JSON.parse(await AsyncStorage.getItem(
      asyncStorageKeys.activePortfolio));
    return json ? json[0] : null;
}
```

Figure 7.3: How a locally stored active portfolio is parsed and fetched.

The code is developed on personal computers and synchronized with a private repository on GitHub (https://github.com/). It is tested mostly on emulators for iOS and Android.

7.2.2 Discussion about the structure of the code

The structure mostly worked well. It enabled easy import of separate screens for navigation, but also led to some confusion during the development. For example, since there were one index.js file for each screen, which simplified the import of components, it could be difficult to immediately understand which index.js was currently open in the editor. The design also was seen as somewhat arbitrary, especially where subcomponents should go and what they should be named. An alternative option could be to have the separation in another way: for example, storing all screens in one folder with different names for each file, and styles in another folder. In hindsight, this could probably have made the development easier, with less folders to keep track on, but could also have weakened the separation of concerns. Furthermore, the system design document could have been further updated during the project; while only one person was responsible for this document and it was not seen as a priority to update it further, doing so could have removed some of the uncertainty.

The local storage, being asynchronous, demanded that some things such as portfolios had to be waited on when before performing parsing or other actions related to them, as seen by the “await” keyword in Figure 7.3. This partly negated the upsides of asynchronous storage, but it was still seen as a good option for storing objects locally.

It was made clear later on that the app should have been tested more using real devices instead of emulators. The emulators were in some case faster than their real counterparts, making the developers assume the app was more optimized than it really was. The choice was one of convenience; it was easy to test on different devices using an emulator, and it also provided a premier debugging environment. A mix of developing on emulators, but still performing the pull request tests on real devices, could alleviate this issue. This has the potential to combine the ease and speed of developing for emulators, while continuously ensuring that the app works on real devices. An issue in this group was that only half of the developers could emulate as well as test the app on iOS devices, since Apple does not support this on Windows or Linux.

The app in the end is very dependent on a connection with the servers of Sigmastocks. This led to a rather difficult situation before a demonstration, when their servers went offline. However, this is a problem that is difficult to solve; since the service is dependent on recent stock market data, an app without access to this would not be able to provide an adequate experience. Perhaps the algorithms could be incorporated in the app for an offline mode, but stock market data would still need continuous updates.

8

Final Discussion

In Section 1.3, four initial questions are introduced. In this chapter, a summarizing discussion about the combined use of methods is presented, focused on how they concern these questions.

8.1 [Q1]: What significance do design rules provide in accordance to the development efficiency and quality of the final product?

As stated in Subsection 6.1.2 design rules provide a foundation from which designs can be developed. The rules are however limited to standardized actions, while a system always will be unique. This means that a function that is to be implemented might not fall into any of the standardized rules covered in theory, and hence instead be designed based on presumptions made by the developers. As further stated in Subsection 6.1.2, feedback from user testing rarely concerns designs created with design rules, but designs created on presumptions. Therefore, user testing, such as cognitive walkthrough, is necessary in addition to design rules. This is in line with the claim of Neil and Hoober (Hoober & Berkman, 2012), that design patterns and principles have to be tailored to each unique situation in order to ensure the usability of a system.

The benefit of design rules is that they are efficient. It is a quick way to grant some usability, as opposed to usability evaluation methods which require vastly more resources to deliver design insights. Design rules can therefore be seen as a powerful starting point, to preferably be complemented with usability evaluation methods.

However, this discussion is based only on a single usability project which does not alone provide sufficient information to draw general conclusions. Only a handful of all existent design rules were used and there is likely. In order to really be able to answer Q1, further studies would have to be conducted. Some in which comparisons

to projects which do not use rules are made.

8.2 [Q2]: How can functionality be prioritized to match the needs of the users?

The functionality to implement was prioritized in accordance to the requirement study. By doing this, it is believed that the functionality in the app could reflect the actual needs of the user. When analyzing the study, it was shown that the analysis of user traffic data from Sigmastocks' existing services and the interviews complemented each other well. Data on website traffic show which functionality is most used, and interviews show what is most desirable. These to are not necessarily the same, since what is desired in an additional service might not be the same the desires of the existing service. Users might have different purposes for using the two systems, and might wish for new functionality in the new service.

From this case study it can be concluded that analyzing data of an existing service in combination with interviewing the target users provided a solid understanding of the requirements of the additional service. Customer interviews can identify what a customer desires, but these desires might not be applicable to all customers since not all are interviewed. Taken both data from the existing service and interviews with target users into account will help paint the bigger picture. This method can therefore be recommended for similar projects where an existing service and an existing customer base already exist.

Since the data from the requirement study was considered to be sufficient in order to prioritize functionality, the fictive personas were less incorporated in the design process. As stated in Subsection 2.1.2, a persona is merely a hypothesis of a target user. It is self-evident that, if this hypothesis is false, that is, it does not match any real users, the design will be customized for users that do not exist, and hence risk not accommodating the real users. This advocated for the usage of collected user data over personas. However, if the personas are based on the collected data, this would not cause contradicting designs. Hence, is can not be accurately determined whether or not user data is better than personas.

Moreover, personas can be created as a representation of certain target users that the system is meant to satisfy. It is plausible that a company wants to appeal to groups such as young women or rich elderly. In such a case, a tailored persona might help the design to be focused at certain users, as opposed to data about all users. However, in this project the target users are experienced Sigmastocks customers, a description which does not provide any common characteristics of the people in the group. It is important to underline that no adequate conclusions can be justified about personas since the method was not thoroughly tested.

8.3 [Q3]: How can the usability be verified and improved?

One hypothesis from the beginning of the project was that cognitive walkthrough and heuristic evaluation are suitable methods for evaluating the usability, particularly in combination. As mentioned in previous discussions, they two methods yielded different types of feedback. Problems related to certain tasks, such as how efficient they were to perform, were found in the cognitive walkthrough but not in the heuristic evaluation. At the same time, the heuristic evaluation highlighted usability errors, such as incoherent design, which is not given as feedback in a cognitive walkthrough. The heuristic evaluation also identified errors only visible through stress testing, for example a crash-inducing bug on the login page. This was not found in the cognitive walkthrough, since a user generally would press the login button only once. As both methods contributed with feedback regarding usability issues, but from different perspectives, it was advantageous to incorporate them both as methods for evaluating usability.

One important aspect when creating an evaluation is the choice of evaluators. To ensure usability, it is a necessity to use evaluators from outside the development group. Since the developers and designers already know how the design is constructed, issues regarding, for example the efficiency in finding elements, are likely to be left undiscovered. This was the case in this project, as none of the team members had experienced any problems in finding the button for switching the active portfolio. Another example is if the feedback given is sufficient and located in a logical place, since the development group already would know where to look for the feedback.

When important design choices are to be made, testing a paper prototype is beneficial in the way that it can identify issues in an early stage. This can prevent time wasting as a result of the implementation and later reconstruction of a lacking design, as well as provide verification that the design is usable. On the other hand, testing the implemented version is necessary since it can show some issues, such as long response times and possible bugs, that the prototype cannot. These aspects affect the efficiency and satisfaction when tasks are being performed, and thus have a great impact on the usability.

In order to improve usability, potential issues must first be *identified*. Both methods contributed to the improvement of the usability of the app by doing this. However, neither could suggest and verify a potential solution directly. Instead, any improvement made would need to be verified with yet another evaluation. Also, as Nielsen and Molich (1990) states about heurisitc evaluation, finding problems does not necessarily mean that there exist good ways to solve them.

Regarding the verification of the usability, efficiency and effectiveness could be verified using the cognitive walkthrough. However, when only the two, for this project,

chosen evaluation methods are used, there is no way to verify the satisfaction. This concerns both the satisfaction when performing certain tasks, as well as for with the overall functionality. The two methods only evaluate what has already been created and do not test whether there is redundant or missing functionality, something that decreases the satisfaction.

To address that aspect of usability, another method must be added. This method preferably lets a target user evaluate the app. This evaluation would be performed during a period long enough to find minor issues that are not discovered directly or only appear after a certain amount of use. After the evaluation period, questions regarding satisfaction could be asked in order to find issues and completely verify the usability.

8.4 [Q4]: Is agile development a suitable method for applied user interface design projects?

During the project, usability testing was incorporated as a part of the agile process. Since its purpose is to identify usability issues that are unknown at the moment, it is difficult to plan for potential adjustments beforehand. The adaptive planning made it simple to adjust the development to the test results. Adaptive planning is a general trait and cornerstone of agile development, which proved to be valuable for this project regarding usability testing. In combination with the failure of disproving Q4 in Subsection 7.1.1 the answer to the question, in context of this project is yes. The result is however not sufficient to generalize, because an agile method was tested in only this project. Arguably there might be issues that this project did not encounter.

With the short sprint length used in the Scrum process of this project it would not have been suitable to implement and verify usability with these methods every sprint. Out of the two methods, Cognitive walkthrough is probably the most suitable to schedule regularly. A suggested rule of thumb is that as soon as a new functionality has been implemented and can be transferd to a task, A cognitive walkthrough test can be held. Also time estimation of a cognitive walkthrough is easier than heuristic evaluation since tasks are determined at forehand while heuristic evaluation testers roam the interface without the same structure. Both methods where successfully incorporated in the agile process and provided useful feedback. It can be said about cognitive walkthrough and heuristic evaluation that they both benefit from regular scheduling. This is because new functionality might have to be tested more than once until high usability can be verified, due to the lack of a method that can grant solutions to identified probles. The frequent delivery aspect of agile methods might serve well as a way for this. For instance, when using Scrum the previously identified usability issues may be redesigned and tested the upcoming sprint.

9

Conclusions

This final chapter delivers an extract of the conclusions that can be drawn from this bachelor thesis. It is structured as answers to the four introductory questions.

The target of the project is reached: a cross-platform mobile app is created and delivers the most important functionality with respect to the requirement study and demands from Sigmastocks. The company is satisfied with the result and the system is deemed to have good usability. Further the four questions of the project will be answered.

Q1 :What significance do established design rules provide in accordance to the development efficiency and quality of the final product?

The value of the design rules is that developers have a reliable starting point for designing their GUI in a way the users can understand. They are efficient, but still need some adaptation in order to achieve good usability. The needed adaptations can preferably be assessed with usability evaluation methods.

Q2 : How is functionality prioritized to match the needs of the users?

If an additional service is developed for an existing one, data collected about the existing service can provide useful information about the users. Customized information about what the users demand can better be assessed through interviews with the current users. It can not be said from this study whether or not personas is a good method to assess the needs of the users.

Q3 : How can the usability be verified and improved?

The two usability evaluation methods cognitive walkthrough and heuristic evaluation are deemed especially valuable together. They provide information about if the users can actually use the system and how the design is aligned with industry standards. However, they do not provide information about whether or not the system meets the demands of the users.

Cognitive walkthrough is a suitable method for verifying and later improving the

usability of an app. It can beneficially be conducted multiple times throughout the development with different tasks as soon as a new task is implemented, with subjects preferably resembling the target group for more accurate feedback. In the creation of the tasks, one should have in mind if pure functionality and user flows is to be tested, or rather assess how the visualized data is interpreted.

Heuristic evaluation was also deemed suitable since it verifies that design rules have been taken into account. This in turn signals that the system has basic usability. The evaluation is of value since it provides insight from experts in usability, and also therefore communicate in a way that designers easily can interpret and use in further designs.

Q4 : Is agile development a suitable method for applied user interface design projects?

Agile development provided the ability to quickly adapt to new information from usability testing. By ensuring that each increment of the app was a working piece of software, it ensured that the target of this project was fulfilled. In Subsection 7.1.1 no unique disadvantages of utilizing Scrum in an applied user interface design projects was identified. From this it is concluded that agile development was a suitable method for this project, but that it is not possible to answer for applied user interface design projects in general.

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A

Glossary

Asynchronous - operations allowing for other operations being executed before the first is finished

AsyncStorage - An asynchronous key-value storage system that is global in the app (Facebook Inc., n.d.)

API - Application Programming Interface, a service which enables, for example, an app to communicate with a server

The App - The mobile app developed during the course of this project

Closed question - A question with a number of answering options

Design guidelines - Are guidelines for design that are specific for a certain system (Dix, 2016)

Design patterns - Are general solutions to common problems in design(Rouse, 2007)

Design principles - Are general principles when constructing design that may apply across different technologies and systems(Dix, 2016)

Design rules - Umbrella term for design patterns, design guidelines and design principles

Development phase - The period of the project during which code was written

Ethical (in regard to Sigmastocks) - An option for not selection companies dealing in businesses Sigmastocks deem unethical, such as weapons and petroleum

Floating Action Button (Android) - A button shaped like a circled icon floating above the interface (Google Inc., n.d.-a)

Focal Point - The first things your eyes are drawn to when a new interface appears. (Tidwell, 2011b)

Git - A version control system focused on managing software created by several developers

GitHub - A website for hosting git repositories

GUI - Graphical user interface

IEEE - Institute of Electrical and Electronics Engineers, an association of engineering professionals

ISO - International Organization for Standardization, an organization which creates standards

JSON - Is a data-interchange format ('JSON', n.d.)

Login - [noun] An object related to the act of logging in

Log in - [verb] The act of logging in

Logout - [noun] An object related to the act of logging out

Log out - [verb] The act of logging out

Minimum viable product - A product with just enough functionality, in regard to provided requirements, to be deemed viable by the customer

Mobile app - A software application to be used on a mobile phone

Non-responses - Subjects of a survey that choose not to participate

Open question - A question without predefined answering alternatives

Pull request - A method for reviewing code that is to be merged with existing code. A developer creates a pull request with the new changes, and others can review and approve or reject them.

Security token - Information stored in a bit string (Butterfield & Ngondi, 2016b).

Shippable - Something that can be shipped to a customer

Spinner - Animated spinning symbol that signalizes that content is loading.

System design document - Specification how the software is developed, and how the architecture is laid out.

Toast (Android) - A notice popup window, only shown for a short while

User story - A potential or requested feature, with motivation given from the viewpoint of the person who requests or would request it

Validity - To what extent a measuring method correlates with what it's intended to measure

View - A portion of the app visible on the screen of the phone

B

System Design Document

Template partly taken from the department of Computer Science, Florida State University ('System Design Document Template', n.d.).

B.1 History

2017-02-23: Version 0.1, written by Erik Öhrn.
2017-02-27: Version 0.2, revised by Erik Öhrn.
2017-03-01: Version 0.3, revised by Erik Öhrn.

B.2 Introduction

The purpose of a system design document is to specify how the software will be developed, and how the architecture will be laid out. Since the team members are new to the development of applications by the means of React Native, this document aims to ease the co-development and ensure that there will be a cohesive source code.

B.3 Proposed Software Architecture

B.3.1 Overview

The app is to be designed using React Native (https://facebook.github.io/react-native/) for cross-platform development. This framework was chosen due to its availability for both iOS and Android, as well as being used in well known apps such as Facebook

and Messenger (Patterson, 2016). As Patterson, 2016, of Network World states, React Native has been shown to provide native UI elements for both operating systems, which in turn leads to that the project group can focus on the user experience on a whole.

The API provided by Sigmastocks will be used to handle communication with their servers.

The app is to be structured in different sections. This will be further discussed in subsection B.3.2.

B.3.2 Subsystem decomposition

There are many models for data architecture, such as three-tier layering, model-view-controller, et cetera. In React Native, the style, markup, and logic of a component is often coupled, resulting in encapsulated single files for varying functionality.

The code will be structured by feature, in a manner presented by Alexis Mangin (Mangin, n.d.). The general structure is presented below:

```
> android
> src
    > components
        > [e.g. buttons, notifications, etc.]
        [Global components]
    > data
        > users
    > scenes
        > [e.g. Home, Sign in, etc]
    > services
        > [e.g. api]
   App.js
   store.js
> ios
[other files]
```

Since the code is divided by functionality, each folder may need several files related to that functionality. For example, the Home scene might have subfolders such as components and services, with functionality-dependent code. The rules for each folder is defined as follows:

> A component can define nested components or services. It cannot use or define scenes. A scene can define nested components, scenes or services. A service can define nested services. It cannot use or define components or scenes. A data entity is standalone. Nested entities can only use other entities that are defined by a parent entity. (Mangin, n.d.)

B.4 Glossary

- Component: a JavaScript class based on React.Component
- Data: a bridge between the API and the client. Handles network calls
- Scene: a page in the application
- Service: a self-contained module

C

Technical Aspects

Here various technical theory is explained. To understand cross-platform application development, an overview of mobile operating systems in general and iOS and Android in particular is presented first. One cross-platform framework, React Native, is then described, followed by a section on how an app can communicate with a server using an Application Programming Interface.

C.1 Mobile Operating Systems

The two most common operating systems are iOS, produced by Apple Inc., and Android, produced by Google, Inc. (International Data Corporation, 2016). The distribution in Sweden is fairly even. According to a report by the Internet Foundation In Sweden, the market share among smartphones in Sweden for Android is 46%, and for iOS 51% (Findahl & Davidsson, 2016). As for the customers of Sigmastocks, 99.3% is using either of these mobile operating systems(as seen in Figure D.2) and thus only these two systems will be further examined.

C.1.1 iOS

iOS is the most popular mobile operating system of visitors of www.sigmastocks.com, making up about 70% of the mobile traffic according to the requirement study in Chapter 4. Its app development uses the programming language Swift (http://www.apple.com/se/swift/). While the language is open-source, developing iOS apps using the iOS Software Development Kit (SDK) and Xcode requires the use of a computer running Mac OS (Apple Inc., 2017). This means that not everyone can develop for iOS; in this team three out of six had the required equipment. However, the fact that the Apple ecosystem is relatively restrained has its upsides. There are very few devices needed to test for and ensure the app displays correctly on. Assuming the various iterations of the iPhone are the intended targets, there have been 15 different versions since the first release in 2007 (https://support.apple.

com/en-us/HT201296). This number is considerably reduced for the target group of Sigmastocks, according to the requirement study in Chapter 4. 87% of the customers with iPhones either has IOS 10.0 or a more modern version, see Appendix D. This reduces the intended targets to 10 different devices of iPhones ('iOS 10 is compatible with these devices', n.d.).

C.1.2 Android

Android is the second most popular mobile operating system of Sigmastocks visitors, with about 29% of all mobile traffic. Development for Android apps is done in the programming language Java, using the Android SDK. The development, using for example Google's Android Studio, is very open; it can take place on a computer running either Windows, Mac OS, or a Linux distribution (Google Inc., n.d.-a). Furthermore, all members of the project group has previous knowledge of Java development.

When it comes to different devices, there is a plethora of various configurations: more than 14000 according to Google (Google Inc., n.d.-b). While not all of these are smartphones, as some are tablets, smartwatches, et cetera, the number of devices available is staggering. A much smaller number is used by the visitors of www.sigmastocks.com according to the requirement study, but there are still many different configurations to take into account. This means that an app developed for Android may have to take into account how the screen size may vary, as well as the resolution, storage capabilities, processing power, input methods and so on.

C.2 Cross-platform

In conclusion, iOS is an attractive platform to develop apps on, but has drawbacks due to the locked ecosystem that would make it difficult to develop for the team. Android is an attractive development platform because of its accessibility, but less attractive due to the variety of devices. Also, developing solely for iOS would lock out close to a third of the visitors of www.sigmastocks.com, and thus potential app users, which could have negative business impact.

Instead of choosing just one of these sets of users there is the possibility of creating an app that runs on both iOS and Android. This was a criteria of success given by Sigmastocks for this project. Developing for both system can take plenty of time, resources, and money in demand, and getting enough equipment to both code and test the software on could be expensive (Goadrich & Rogers, 2011). To combat this, there exist some ways of developing for both at the same time, called cross-platform development.

Although developing two separate apps likely could provide better experiences for the respective iOS and Android users(Abed, n.d.), cross-platform was selected due to it's ability for the developers to focus on a single source code and design. It's believed that this will lead to a faster implementation of the app, compared to developing for both iOS and Android separately. A few of the cross-platform frameworks available are PhoneGap (http://phonegap.com/), React Native (https://facebook.github.io/react-native/), and Xamarin (https://www.xamarin.com/).

PhoneGap is similar to web development, and uses HTML, CSS and JavaScript to create apps that can run on iOS, Android, and Windows Phone. This can thus be called a webview app (Eisenman, 2016). This method makes it possible to use the app across several different operating system, but has its drawbacks. For example, performance can be limited compared to compiled native code (Charland & Leroux, 2011). Another way is to use a framework to compile native code for both operating systems, using the same code base; Xamarin and React Native both use this method. Based on the belief that performance is of high importance, the native cross-platform frameworks were chosen in favour of PhoneGap.

Xamarin uses C# in its app development process, in order to create apps for iOS, Android, and Windows Phone. While no-one in the group has developed in C# before, it's very similar to Java (Cabrera, 2002). No-one had previously used the Integrated Development Environments (IDEs) provided by Xamarin, but from content provided by the website of Xamarin, it's believed that there are well developed tools for developing a native UI. Xamarin and also seems to scale well when datasets grow large (Furuskog & Wemyss, 2016), which could prove beneficial for, for example, sorting stocks. However, based on information gathered from colleagues, documentation as well as community support of Xamarin could be limited.

React Native uses code written in JavaScript, in combination with markup language, to compile executable code for both iOS and Android. While this might seem similar to a web app, in that the code is being able to execute on both operating system, React Native creates Objective-C code for iOS devices and Java code for Android devices when compiling (Eisenman, 2016). Many of the members have previous knowledge of JavaScript and various markup languages, such as Extensible Markup Language (XML).

Several colleagues of the project group members recommended React Native in favour of Xamarin, due to a large online community and well documented examples. Based on these arguments, it is believed that React Native will be the best way for the project group to create an app for both iOS and Android, and this framework will thus be described in further detail.

C.2.1 React Native

The technology of React Native is a fairly recent framework, with support for first iOS and later Android being released in 2015 (Occhino, 2015)(Witte & von Weitershausen, 2015). This means that React Native is still in its infancy, with many best-practices left to assess and discover (Charland & Leroux, 2011), which could prove to be a severe difficulty during development of the apps. This could also mean that the community for React Native hasn't grown as large as the ones for iOS or Android development, respectively, which could make troubleshooting difficult.

However, this method of developing mobile apps have some important advantages to developers: developing using React Native is possible on both MacOS, Linux, and Windows, even though a computer running MacOS is required to compile and test code for iOS (Facebook Inc., 2016). While this still requires some people on the development team to use Mac computers, every developer can still develop and use the same code base for the project (to some extent; in some instances, native source code is still required (Eisenman, 2016)).

The performance of React Native can be superior to that of web apps, partly made possible due to how React Native handles the Document Object Model (DOM). A DOM is a way to represent data in markup language, structured as a tree (Butterfield & Ngondi, 2016a). This can become slow when the amount of components grow large (Paul & Nalwaya, 2016); however, by providing a Virtual DOM (VDOM), React Native speeds up this process by only updating the parts of the DOM that have been affected by an app interaction.

D

Collection of Website Traffic Data

This appendix presents the statistics given by Google Analytics. Due to copyright reasons, the user flows are not presented. The data was collected in the time period of 2017-01-15 to 2017-02-14.

D.1 Most Visited Pages

The most visited paths can be seen in Table D.1, along with accompanying statistics such as the percentage of pageviews.

Table D.1: The ten most visited paths of Sigmastocks' web site. Note how the percentage of pageviews and percentage of exits, users exiting the session from this page, vary substantially.

Page path level 1[2]	**% Pageviews**	**% Exit**	**Avg. time on page**
Portfolio details	27.24%	10.43%	00:44
/	14.30%	14.46%	00:22
User portfolios	9.78%	1.24%	00:06
Log in	8.03%	5.78%	00:11
How to	6.79%	12.49%	00:37
Blog	5.00%	34.83%	00:25
Prices	4.82%	14.27%	00:30
FAQ	3.46%	20.28%	01:10
Profile settings	3.19%	8.63%	00:26
Modify stock holdings	2.51%	1.44%	00:21

The pages are classified in accordance to the following categories:

- Portfolio operations

  Portfolio details: detailed views of the portfolio, with functionality such as rebalancing, and buying and selling stocks. There is no possibility to deduce

[2]The real paths have been replaced with labels by Sigmastocks' request

what the users do while on that site by using this data, since no such tracking methods have been implemented in the website. This path is followed by an id number for a specific portfolio.

Modify stock holdings: site for managing the contents of a portfolio.

User portfolios: an overview of a customer's portfolios.

- User administration

  Log in: consists mainly of the sign-in page.

  Profile settings: consists mainly of the ability to edit user settings, as well as the confirmations after creating a new user or editing the settings.

- Information acquiring

  How to: a how-to-page.

  Price: a price list.

  FAQ: frequently asked questions.

- Promotional content

  Blog: the various blog entries written by Sigmastocks.

These can be sorted by percentage share of page views, as seen in Table D.2.

Table D.2: The pages from Table D.1, sorted by category, sorted by the percentage of pageviews.

Category	**% Pageviews**
Portfolio operations	29,75%
Information acquiring	15,07%
Promotional content	5,00%
User administration	3,19%

D.2 Device Statistics

Statistics about the most common mobile devices can be found in Figure D.1. As can be seen, various versions of Apple iPhone are most common, with the shown Android Phones all having a very small percentage. However, since there are so many version of Android phones, they still add up to close to one third of all sessions, as seen in Figure D.2.

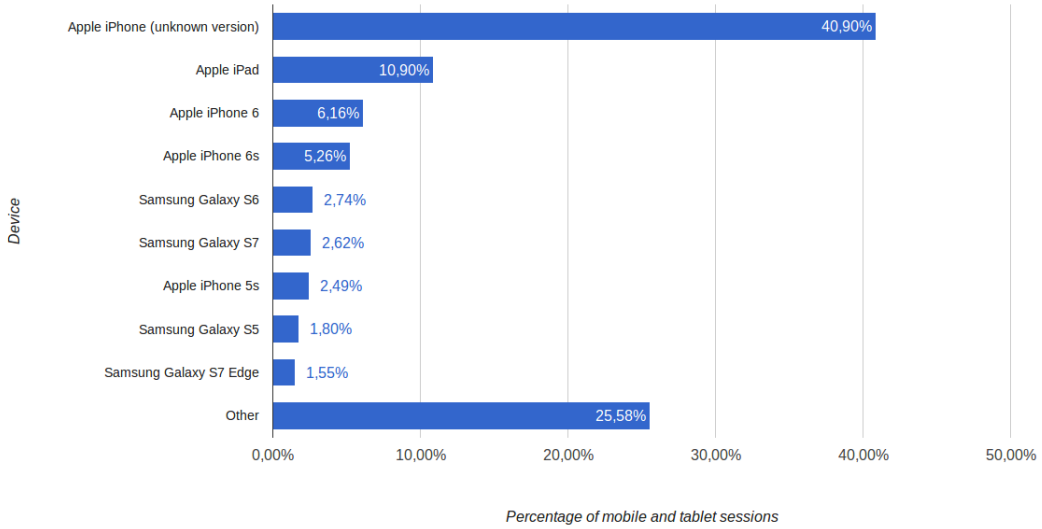

Figure D.1: Percentage of sessions of https://sigmastocks.com/ by mobile and tablet device during the period 2017-01-15 to 2017-02-14.

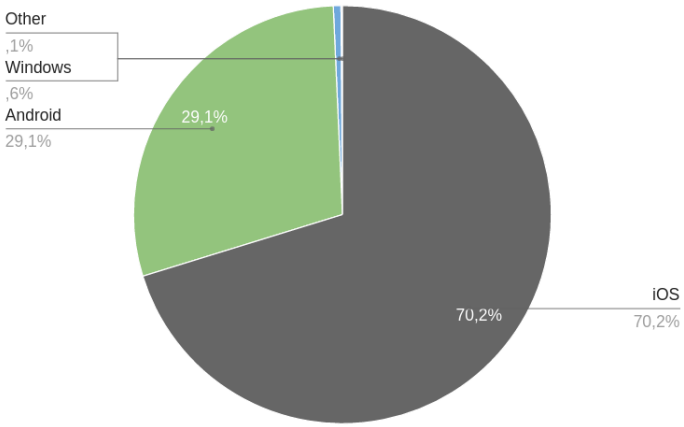

Figure D.2: Percentage of sessions of https://sigmastocks.com/ by mobile and tablet OS during the period 2017-01-15 to 2017-02-14.

The versions of the OSs were also analyzed, with the results visible in Table D.3 and Table D.4. At least 87 percent of the iOS sessions use iOS 10.0 and upwards, and at least 80 percent of Android sessions use Android 6.0 and upwards.

D.3 User Statistics

Statistics about user age were collected, and can be seen in Figure D.3. As can be seen, the website is most popular among adults in their upper twenties to mid thirties, but it should be noted that the bars are not equally measured in years. For

Table D.3: Percentage of iOS sessions of https://sigmastocks.com/ during the period 2017-01-15 to 2017-02-14 by version, sorted by most recent version.

iOS version	Percentage of sessions
10.2.1	35,53%
10.2	32,25%
10.1.1	10,29%
10.1	0,94%
10.0.2	6,50%
10.0.1	1,55%
9.3.5	5,13%
9.3.4	0,80%
9.3.2	1,54%
9.2.1	0,74%
Other	4,73%

Table D.4: Percentage of Android sessions of https://sigmastocks.com/ during the period 2017-01-15 to 2017-02-14 by version, sorted by most recent version.

Android version	Percentage of sessions
7.1.1	4,79%
7.0	6,64%
6.0.1	58,59%
6.0	10,61%
5.1.1	5,12%
5.0.2	1,92%
5.0.1	3,79%
5.0	3,25%
4.4.4	1,00%
4.4.2	2,10%
Other	2,19%

example, Google Analytics did not reveal data for users under 18 years of age, and there is a single group for all visitors above the age of 64 (“65+”).

The data Google collects about users regarding interests are shown in Figure D.4, Figure D.5, and Figure D.6.

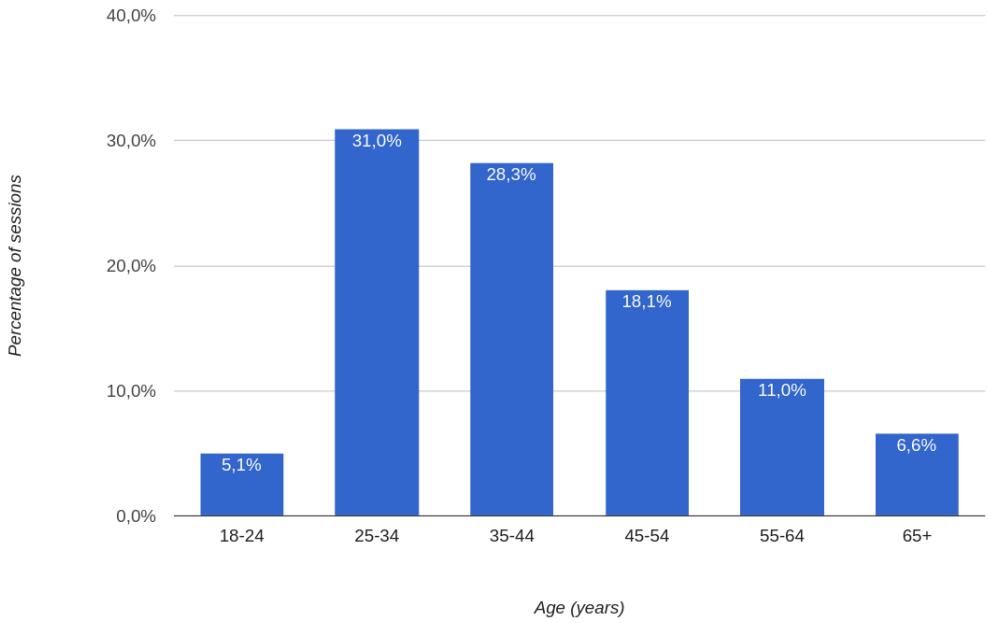

Figure D.3: The age distribution of the adult users of http://sigmastocks.com/ during the period 2017-01-15 to 2017-02-14. Note that the data only shows users of 18 years of age or older.

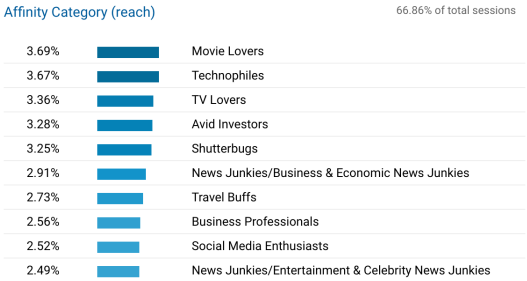

Figure D.4: Distribution of the interests among the users in affinity category.

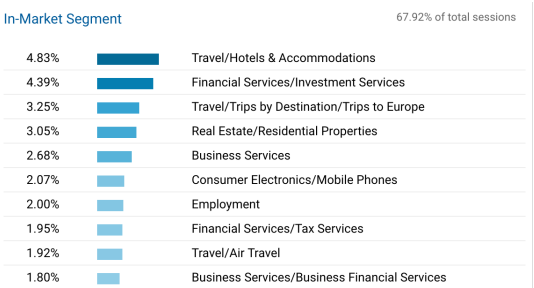

Figure D.5: Distribution of the interests among the users in in-market segment.

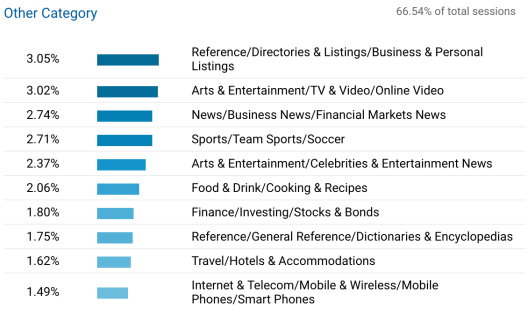

Figure D.6: Distribution of the interests among the users in other category.

E

Interview Questions

Since the interview was held in Swedish, the questions and their purposes are given in Swedish as well as in English further down. Apart from the questions chosen as the final ones, several more were created. They, together with a short explanation about why they were dismissed, are also presented in this appendix. If there are no explanation about the dismissal, the questions were not considered those of highest importance and were left out due to the length of the survey.

E.1 Final Questions and Their Purposes - Swedish

Question 1 Vad hade varit viktigast för dig att ha i en Sigmastocksapp? Det kan både vara funktionalitet som finns på hemsidan idag, eller om du kommer på något annat.

Purpose Skapa oss en opåverkad bild, före vi har fått dem att tänka i vissa banor, om vad de efterfrågar.

Question 2 Senast du använde mobilen som tidsfördriv, vilken typ av sida var du inne på? Videoklipp, bildflöde, blogg eller nyhetssida.

Purpose Få reda på vad de gör när de fördriver tid på mobilen, för att avgöra om de har störst nytta av Academy, Bloggen, Så går det till, om Sigmastocks eller FAQ.

Question 3 Vilken typ av bankärende gör du bara på datorn och inte på mobilen?

Purpose Har de förtroende för att köpa aktier via mobil?

Question 4 Om du tänker tillbaka på när du senast var inne på Sigmastocks,

beskriv vad du gjorde under det besöket?

Purpose Veta vad de använder tjänsten till och vad de värderar högst

Question 5 När du senast var inne på Sigmastocks i mobilen, vad var du ute efter då?

Purpose Ta reda på varför de som varit inne på mobilsidan använde Sigmastocks via mobilen

Question 6 Om du nu går in på Sigmastocks app; Vad av följande alternativ vill du helst göra? Överblicka ditt innehav, ändra i sparande eller få information kring aktiesparande?

Purpose Prioritera funktioner

Question 7 Vill du i appen helst kunna ändra portföljerna eller kunna köpa och sälja aktier?

Purpose Vad är viktigast för deras sparande?

Question 8 Vill du i appen helst kunna ändra portfölj-inställningarna eller kunna skapa och ta bort portföljer? (portföljintsällningar s̄tora/små företag, etiskt, månadsspararbelopp et cetera.)

Purpose Vad är viktigast kring hantering av portföljer?

Question 9 Vad tycker du är mest intressant i översikten av din portfölj, (förutom innehavet)

Purpose Vad vill de veta om sin portfölj? (vi antar att de vill kunna överskåda den)

Question 10 Vad skulle du föredra för att komma ihåg att månadsspara: din nuvarande metod, bli påmind via notiser på mobilen eller båda två?

Purpose Borde vi skapa notiser för månadsspar?

Question 11 Är det något mer du vill kunna göra i appen eller något annat vi borde ha frågat?

Purpose Täcka upp det vi missat

E.2 Dismissed Questions - Swedish

Purpose Veta vad de använder tjänsten till och vad de värderar högst (Behandlad)

Question Vad tycker du är det bästa med Sigmastocks tjänst?

Purpose Vad vill de veta om sin portfölj? (vi antar att de vill kunna överskåda den)(Behandlad)

Question Senast du var inne och kollade på din portfölj, vilken information var du ute efter då?

Question Vad minns du om din portfölj? Alt: bransch, aktier, fördelning, belopp

Purpose Veta om de har förtroende att köpa aktier från mobilen och om Sigmastocks nuvarande mobilanpassning är tillräckligt bra för aktieköp

Question Har du köpt aktier på mobilen ngn gång? (Denna fråga kommer bara visa på de som har förtroende, och inte säkert på de som inte har det, då de kan ha haft någon annan anledning till att de inte har köpt aktier)

Question Om ja på föregående, var det via Sigmastocks?

Question Gör du ibland bankärenden på mobilen?

Question Köper du aktier vid sidan om Sigmastocks tjänst?

Question Har du gjort det via mobilen någon gång?

Question Om ja på föregående, hur tyckte du om det?

Purpose Borde vi skapa notiser (för ex. månadsspar)?(Behandlad)

Question Vilka appar får du notiser ifrån som du har nytta av?

Purpose Ta reda på varför de som varit inne på mobilsidan använde Sigmastocks via mobilen

Question Vilka tjänster saknar du på mobilsidan?

Purpose Ta reda på om de försökt använda Sigmastocks via mobilen

Question Har du varit inne på Sigmastocks via mobilen?

Question Vad tycker du om den mobilanpassade sidan?

Purpose Vill de kunna ändra portföljinställningar och i så fall vad?

Question Har du ändrat dina inställningar i en portfölj någon gång förutom när du skapade den?

Question I så fall, vad har du ändrat?

Purpose Få reda på om de vill ha hjälp att veta när börsen är öppen

Question Vet du när börsen stänger idag?

Question Har du någonsin försökt handla aktier när börsen varit stängd?

Purpose Vill de kunna investera mer (vi antar eventuellt det.)

Question När investerade du senast i nya aktier med hjälp av Sigmastocks?

Purpose Vill de kunna sälja av?

Question När sålde du senast aktier?

Purpose Vill de kunna ta bort en portfölj?

Question Har du tagit bort en portfölj du skapat hos Sigmastocks?

Question I så fall hur många?

Purpose Vill de kunna skapa ny portfölj?

Question Hur många portföljer har du? (Kan ses hos Sigmastocks data)

Question Har du funderat på att göra en till portfölj?

Purpose Vilka användaruppgifter borde vara med?

Question Vill du kunna se: mail,telefon,lösen, kontokort, gjorda betalnigar?

Question Vill du kunna ändra dem?

Purpose Är Academy intressant att ha med?

Question Har du varit inne på Academy? Vad gav det dig?

Question Om nej, varför?

Purpose Är Bloggen intressant att ha med?

Question Följer du någon blogg?

Question Har du varit inne på Bloggen? Vad gav det dig?

Purpose Vill de kunna läsa Så går det till?

Question Läste du instruktionsmanualen till det senaste du köpte?

Question Vet du hur man " Första gången: Skapa portföljen "

Question Vet du hur man " En gång och/eller kontinuerligt: Köpa aktierna "

Question Vet du hur man " En gång per år: Sälja av för att köpa nytt "

Purpose Ska vi i appen berätta vad Sigmastocks är?

Question Vad gör Sigmastocks?

Purpose Borde FAQ vara med?

Question Vet du. . . .[insert vanliga frågor]....?

Purpose Ta reda på om kontakt till Sigmastocks borde vara med

Question Har du själv tagit kontakt med Sigmastocks via mail eller telefon?

Purpose Borde Användarvillkor vara med?

Question Har du läst användarvillkoren?

Question Känns det mer tryggt om du kan läsa användarvillkor?

Purpose Få reda på mobilvanor

Question Vilka appar har du varit inne på idag?

Question Vad gjorde du på den senaste du var inne på?

Question Om du tar upp din mobil och kollar vilka appar som är öppna, vilka är det?

E.3 Final Questions and Their Purposes - English

Question 1 What would be the most important functionality, in your opinion, to have in a Sigmastocks app? It can be both existing functions on the website and other functions you might think of.

Purpose Create a unaffected picture of their wishes, before we make them think in special directions.

Question 2 The last time you used your phone as a pastime, what of the following options most resemble the page you visited? Video feed, image feed, blog or news site.

Purpose To find out what they do when they spend time on their mobile, to determine whether they get the most use from the information given by Academy, the blog, how it works, about Sigmastocks or FAQ.

Question 3 What type of bank errand do you only do on a computer, and not on your phone?

Purpose Determine if they have confidence in buying stocks from the mobile.

Question 4 Remembering the last time you visited Sigmastocks, describe the mission of that visit.

Purpose Know what they are using the service for and what they value the most.

Question 5 When you last visited Sigmastocks from your phone, what was your mission?

Purpose Find out why they used Sigmastocks from their mobile.

Question 6 If you now open the Sigmastocks app; what out of the following options would be most inclined to do? Overview your holdings, make a change in the holdings or get information about saving in stocks?

Purpose Prioritize between functionality.

Question 7 Would you in the app rather edit the portfolios or be able to buy and sell stocks?

Purpose Find out what is of most importance for their saving.

Question 8 Would you in the app rather edit the settings of a portfolio or create and remove portfolios?

Purpose Find out what is of most importance regarding the management of the portfolios.

Question 9 What do you find most interesting in the overview of your portfolio, except the holdings?

Purpose Find out what they want to know about their portfolio. We assume they want to overview the holdings.

Question 10 What would you prefer as a monthly reminder to invest: Your current method, push notifications or both?

Purpose Find out if we should create push notifications for the monthly savings?

Question 11 Is there anything else you want to be able to do in the app or something else we should have asked?

Purpose Cover what we missed.

E.4 Dismissed Questions - English

Purpose To find out what they use the service for and what they value most. (Purpose already covered in another question)

Question What do you think is the best thing about the service of Sigmastocks?

Purpose To find out what they want to know about their portfolio. We assume they want to be able to overview the stocks. (Purpose already covered in another question)

Question The last time you looked at your portfolio, what kind of information were you looking for?

Question What do you remember about your portfolio? Options: Market, stocks, distribution and amount.

Purpose To find out if they have confidence in buying stocks from a mobile phone and if Sigmastocks' current mobile adaption is good enough for buying stocks.

Question Have you ever bought stocks from a mobile phone? (This question will only address those who have confidence in buying stocks from the mobile, not the ones who do not have confidence).

Question If yes on the previously asked question, was it through Sigmastocks?

Question Do you sometimes use your mobile phone for banking?

Question Do you purchase stocks through any other service than Sigmastocks'?

Question Have you ever purchased them using a mobile phone?

Question If yes on the previously asked question, what did you think of it?

Purpose To find out if we should create notifications, for example for monthly

savings. (Purpose already covered in another question)

Question What apps do you receive useful notifications from?

Purpose To find out why those visited Sigmastocks' mobile web site did so.

Question What kind of services do you find is lacking on the mobile site of Sigmastocks?

Purpose To find out if they have tried to use Sigmastocks from a mobile device.

Question Have you visited Sigmastocks from a mobile device?

Question What do you think of the mobile adapted web site of Sigmastocks?

Purpose To find out if they want to be able to change the portfolio settings, and if so, what settings.

Question Have you changed your settings in any of your portfolios, except at the time of creation?

Question If yes, what have you changed?

Purpose To find out if they want help with knowing when the stock market is open.

Question Do you know when the stock market closes today?

Question Have you ever tried purchasing stocks when the stock market was closed?

Purpose To find out if they want to be able to invest more.

Question When was the last time you invested in stocks with the help of Sigmastocks?

Purpose To find out if they want be able to sell stocks.

Question When was the last time you sold stocks?

Purpose To find out if they want to be able to remove a portfolio?

Question Have you ever removed a Sigmastocks portfolio?

Question If yes, how many?

Purpose To find out if they want to be able to create a new portfolio.

Question How many portfolios do you have? (This can be seen in data from Sigmastocks).

Question Have you ever thought about creating another portfolio?

Purpose To find out which credentials that should be included in the app.

Question Do you want to view: your mail, phone number, password, credit card, and/or payments made?

Question Do you want to be able to change them?

Purpose To find out if Sigmastocks Academy should be in the app.

Question Have you visited Academy? What did it give you?

Question If no, why?

Purpose To find out if the blog is interesting for the app.

Question Do you follow any blog?

Question Have you visited Sigmastocks' blog? What did it give you?

Purpose To find out if they want to read S̈å går det till:

Question Did you read the instruction manual to the last thing you bought?

Question Do you know how to create a portfolio?

Question Do you know how to invest in stocks through Sigmastocks?

Question Do you know how you do a rebalance?

Purpose To find out if information about Sigmastocks should be included.

Question What does Sigmastocks do?

Purpose To find out if FAQ should be included.

Question Do you know... [insert frequent questions]... ?

Purpose To find out if contact information for Sigmastocks should be included.

Question Have you been in contact with Sigmastocks through e-mail or phone?

Purpose Should terms of use be included?

Question Have you read the terms of use?

Question Do you feel more safe to use the service if you can read the terms of use?

Purpose To find out habits regarding mobile usage.

Question What apps have you used today?

Question What did you do on the last app you used?

Question If you take your phone and check which apps that are opened, what are they?

F

Answers from the customer interview

Below follows the compiled answers from the interview conducted with Sigmastocks' customers. The responses to open questions were aggregated after all interviews were held. Responses that pointed towards the same answer were clustered. This could leave some responses uncategorized since they were not similar to any other, and thus either categorized as "other" or referred to with a general term of what the individual responses had in common. The categorization covered almost all responses quickly. The reason is that seemingly open questions often still had a finite number of responses because they related to the existing service. An example of this is the question "what do you like most about the portfolio overview?" which is an open question but limited to a predefined set of answers. One could argue that there is a source of error in the interpretation of the responses. However, it would be an even bigger source of error to on beforehand limit the allowed answers to a set of possible answers.

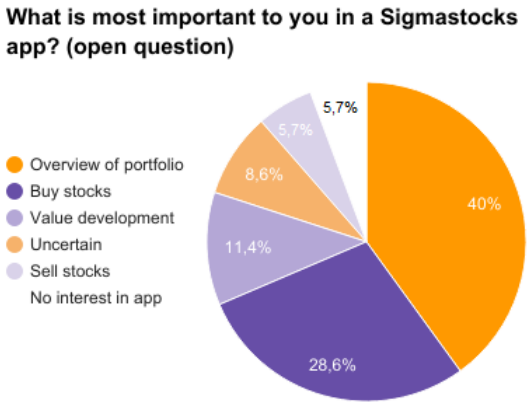

Figure F.1: Question 1: *What would be the most important functionality, in your opinion, to have in a Sigmastocks app?*

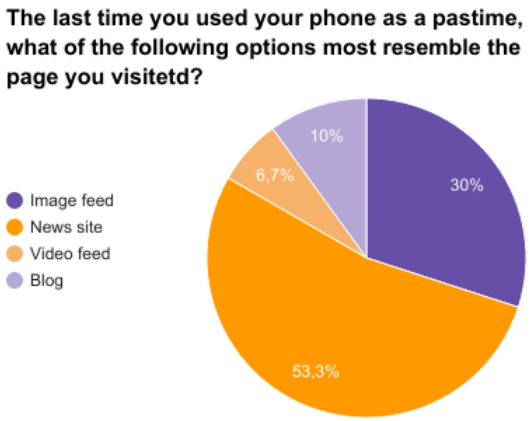

Figure F.2: Question 2: *The last time you used your phone as a pastime, what of the following options most resemble the page you visited? Video feed, image feed, blog or news site.*

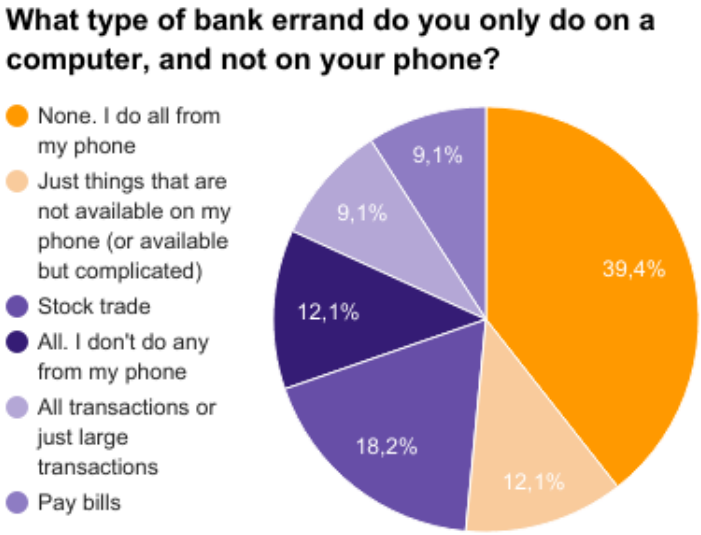

Figure F.3: Question 3: *What type of bank errand do you only do on a computer, and not on your phone?*

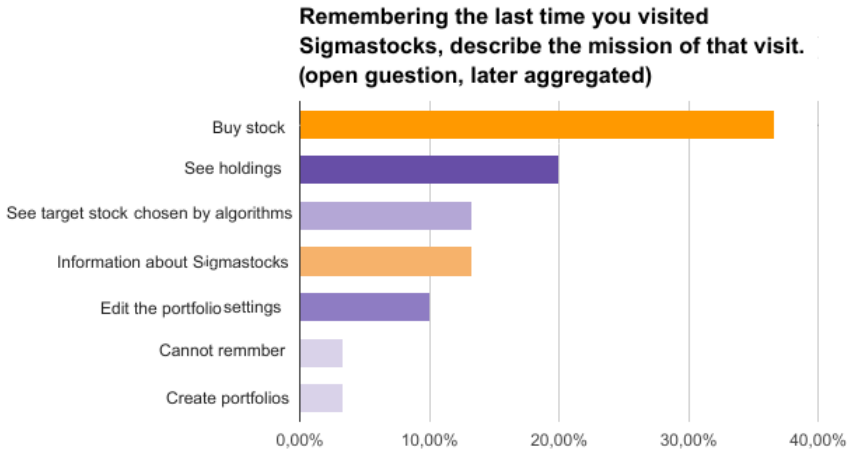

Figure F.4: Question 4: *Remembering the last time you visited Sigmastocks, describe the mission of that visit.*

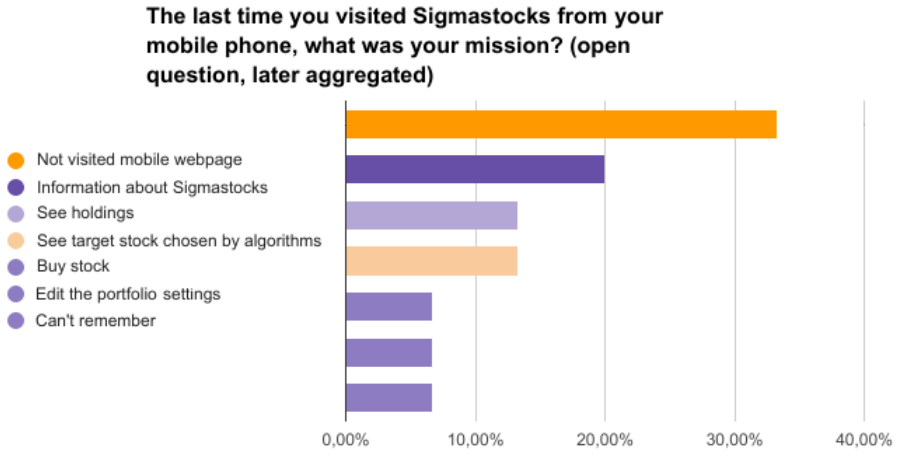

Figure F.5: Question 5: *When you last visited Sigmastocks from your phone, what was your mission?*

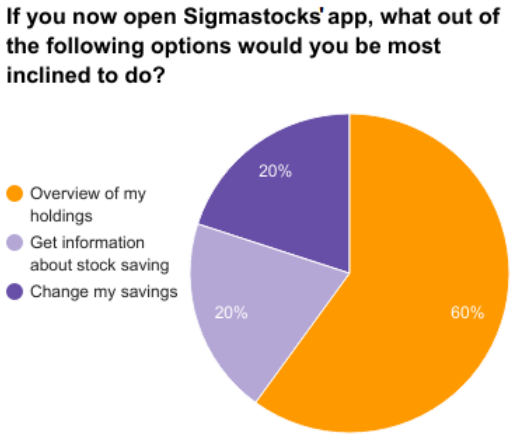

Figure F.6: Question 6: *If you now open the Sigmastocks app; what out of the following options would be most inclined to do? Overview your holdings, make a change in the holdings or get information about saving in stocks?*

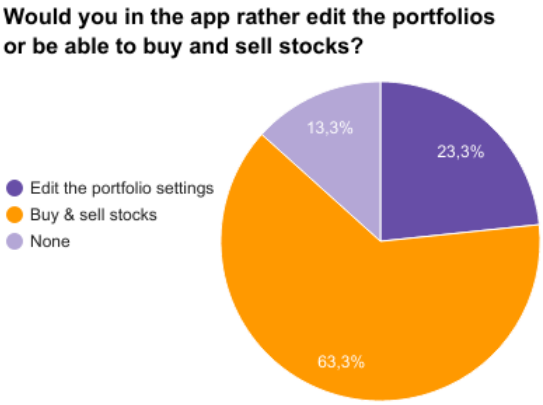

Figure F.7: Question 7: *Would you in the app rather edit the portfolios or be able to buy and sell stocks?*

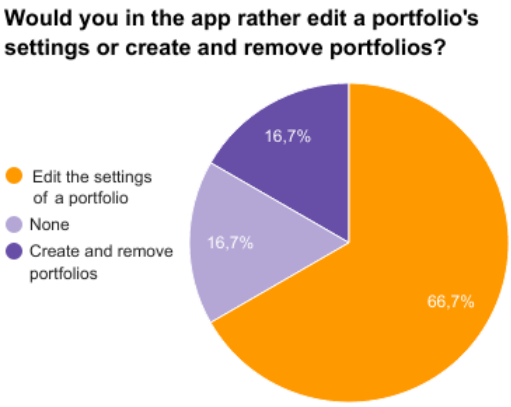

Figure F.8: Question 8: *Would you in the app rather edit the settings of a portfolio or create and remove portfolios?*

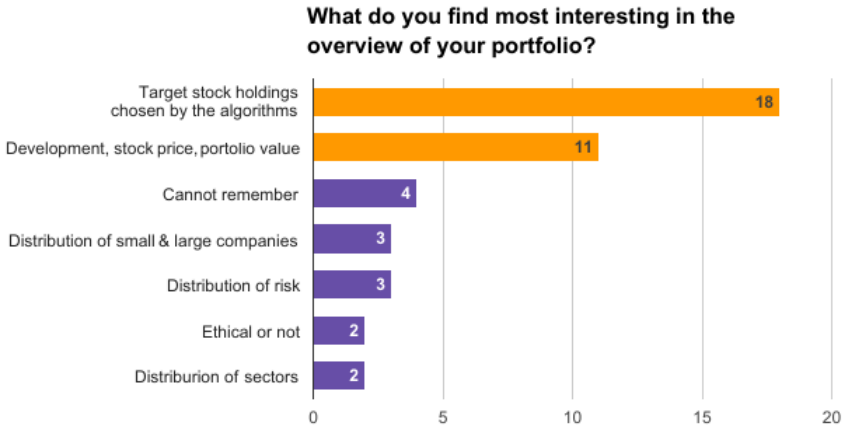

Figure F.9: Question 9: *What do you find most interesting in the overview of your portfolio?*

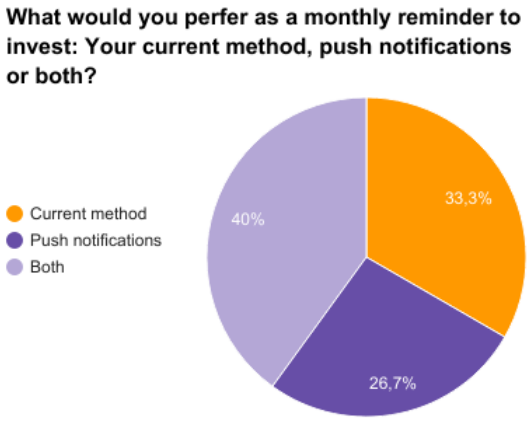

Figure F.10: Question 10: *What would you prefer as a monthly reminder to invest: Your current method, push notifications or both?*

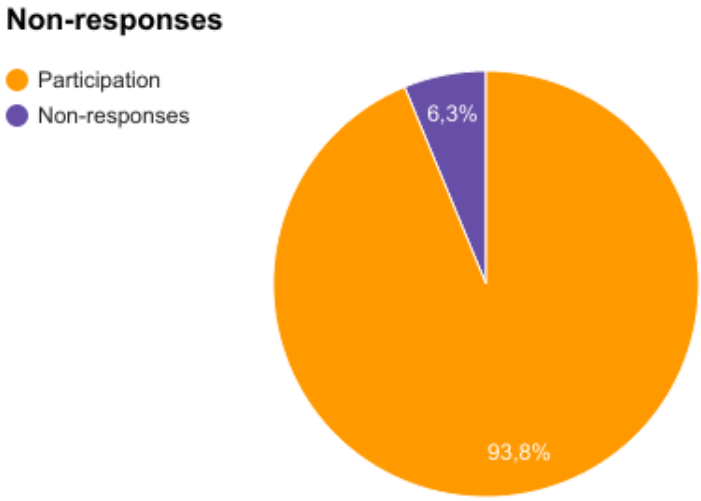

Figure F.11: The amount of non-responses was 2 out of 32 contacted

G

Personas

The following presents the personas Bengt Sturesson and Emilia Eriksson.

Bengt Sturesson

Personal Background:

- Age: 38
- Civil status: Married
- Partner: Beatrice, 45
- Children: Agneta, 23 (moved out)
- Education: Master of Laws
- Work: Criminal Defense lawyer
- Interests: Investments(mostly in Real-Estate), Cooking, Cars

Work

- What is a typical day?
    - Getting up in 5:30 am
    - Light workout exercises
    - Take a shower
    - Eat breakfast with Beatrice and reading the news from my tablet.
    - Kiss Beatrice Goodbye
    - Take the car to work 7:15
    - Arrive 7:45

    At work Alt 1. (Not a Court Day)
    - Make necessary preparations such as collocate documents for upcoming meeting(s)
    - Have a meeting with current client(s) regarding their case
    - Coffee break/checking phone and socialize approx. 15 minutes
    - See new clients or witnesses for a meeting.
    - Lunchbreak, possible lunch meeting with colleagues or clients.
    - Have meetings with and delegate tasks to paralegals, partners and assistants.In order to set goals and plans of action on case(s). Or meeting with the prosecution to arrange settlement.
    - Coffee break/checking phone and socialize approx. 15 minutes
    - Conducting Research, case building and write necessary files regarding case(s).
    - Go home around 6:30

    At work Alt 2. (Court Day)
    - Collect the necessary files and meet up with client(s) before court.
    - Participating in trial

    - 15 minute, mid-morning break
    - Participating in trial
    - Lunch Break 1 hour (talk with the client and/or prosecution)
    - Participating in trial
    - 15- minute mid-afternoon break
    - Participating in trial
    - Court recesses for the day at 4:30 pm
    - Bengt finishes up and leaves at 5 pm.
    - Bengt heads back home and keeps working until 7pm

  Home/Freetime
    - Helps preparing dinner with Beatrice
    - Eating dinner with Beatrice 7:30-8:15
    - Either reading news articles, checking social media on the phone, with apps until approx 10pm.
    - Investigating investment opportunities, mostly regarding real estate until approx 11 pm.
    - Time for bed

- What skills are required?
    - Flexibility, don't need much sleep, negotiability, durability (working long and intensive hours), passion, goal oriented. Team-leading ability.

- What knowledge and tools do you use?
    - Computer tools necessary for creating and managing text files suitable for taking notes during meetings and other paperwork. Also suitable apps for synchronizing these filer or taking notes.

Goals

- What are you responsible for?
    - besides from the work, my family. Also some of the housework.

- What does it mean to be successful in your role?
    - To represent my clients in the best way that I can.
    - To make sure that my family is provided for. Not just the necessities for survival but also provided for in terms of pursuing their interests and affections.
    - For Agneta to have a satisfying and well-paying job, and comfortable residency.
    - To be able to have some me-time for my own interests.

- What's your biggest issue to achieve success?
    - To keep a successful professional reputation.
    - Would like more time to spend on my family
    - Would like more time to spend on my interests/hobbies
    - Save up capital for the future

- What are your biggest challenges?
    - To find more effective ways for working and thereby save time.
    - Spend quality time with my daughter and wife.
    - Use my earnings well. Have a good salary but not much time for investigating further investments

- How do you overcome these challenges?
    - Try to leave work no later than 6:30
    - Do family vacations.
    - Call my daughter at twice a week.
    - Set aside at least an hour for myself in the evening.

- What associations and social networks do you belong to?
    - The National Lawyers Association.
    - Member of Aktiespararna.

Shopping preferences

- How do you prefer to interact with vendors (email, phone, in person?)
    - In person or on phone. Prefer to take my own notes rather than getting emails.

- Do you use the internet to research vendors or products? If yes, how do you search for information? What types of websites do you use?
    - I use google but I don’t shop that often. There is simply no time for that. Beatrice does most of the shopping.

Sigmastocks

- Goal:
    - Use for long time investments
- Heard it from?:
    - An article on Facebook
- Using currently:
    - I manage my portfolio a couple times a week.

- A good way to keep an overview of my savings and an indication of how to place them.
- I check my three different portfolios almost every day at some coffee/lunch break through my phone. I would like to manage it then aswell but because it takes to long i'd rather do it from my computer at home.

Emilia Eriksson

Personal Background:

- Age: 31
- Civil status: Married
- Partner: Mario, 35
- Family: Axel, 4 and Britta, 1,5
- Education: Certified Nurse Assistant
- Work: Nurse's assistant
- Interests: TV/Movies, Travel, My kids, Home Decor

Work

- What is your job role? Your job title?
    - Nurse's assistant

- What is a typical day?

Regular Working day

- Wake up at 5:00 am
- Eat breakfast
- Take shower
- Kiss my husband and my children goodbye
- Leave 5:45
- Arrive 6:30
- Talking to the doctor and the nurse
- put together things etc
- take care of patients
- assist them
- helping the nurses and the doctors
- quick lunch approx 15 min
- and so on...
- should be leaving at 5:30 but still so much work left -> not leaving until 6:30
- Home at 7:15
- eating dinner on my own when my family is watching TV

    - playing with the kids
    - tell them to go to sleep
    - some housework if there is needed
    - Go to sleep between 10:00-11:00

Day off

- Wake up at 9
- Go for a run with my husband
- Take a shower
- Cook breakfast for my kids
- Getting ready for today's activity, i.e sightseeing, lunch at someone's place, drive Axel to a friend of him or just stay home doing some home decor
- A mini shopping-tour at town + lunch
- Go back home at around 3
- Relaxing
- Eating dinner outside with family and sometimes friends
- Arrives back home at 7
- Watch movies
- Sleep at 10

- What skills are required?
    - flexibility, stress-hardy, don't need that much sleep, passion to the work, teamwork, durability

- What knowledge and tools do you use?

    simple computer knowledge - sending files, searching, savings, excel

Goals

- What are you responsible for?
    - besides from work, my two kids/family. Also some of the housework

- What does it mean to be successful in your role?
    - My kids and my husband have a good life
    - My kids don't need to worry about money as much as I do, me and my husband can afford things to them
    - Afford things to ourselves
    - Have time for my interests e.g more time for home decor
    - My patients are happy with the service I give

- What's your biggest issue to achieve success?
    - Would like more time to spend with my family
    - Would also like more time to spend on my interests
    - I have for now no savings or not that much

- What are your biggest challenges?
    - Save more money to my kids
    - Find more quality time with my family

- How do you overcome these challenges?
    - Try to not spend that much money on unnecessary stuff and work overtime if needed
    - Do family vacations

- What associations and social networks do you belong to?
    - "Department Beach" - workout community for nurses
    - "Movie lovers in Alingsås"
    - "Parenting as Nurse"

Shopping preferences

- How do you prefer to interact with vendors (email, phone, in person?)
    - mail

- Do you use the internet to research vendors or products? If yes, how do you search for information? What types of websites do you use?
    - Google
    - Medical websites
    - Shopping online

Sigmastocks

- Goal
    - Long term savings

- Heard it from?
    - Through colleagues
    - An article on Facebook

- Using currently:
    - A good way to keep an overview of my savings and an indication of how to place them. I have one portfolio.
    - Check "My portfolios" on my iphone, sometimes when commuting to work

H

Product Backlog

This is the prioritized product backlog. Only User stories that have been implemented are included.

- As Sigmastocks I want users to log in
- As a user I want to see which all my portfolios are
- As a user I want the data of portfolio overview to be shown in an easy way, especially target vs. actual stock
  - As Sigmastocks I want to show what market the portfolio belongs to
  - As Sigmastocks I want to show the distribution of companies size
  - As Sigmastocks I want to show the distribution of companies stability
  - As Sigmastocks I want to show if the portfolio is ethical or not
  - As a user I want to see the current target stock suggestions picked out by the algorithms
- As a user I want to be able to change my holdings
- As a user I want to be able to buy stock
- As a user I want the app to have a uniform design
- As a user I want to have a swift navigation of the app
- As a user I want to be able to log out
- As a developer I want to facilitate cognitive walkthroughs
- As a developer I want to facilitate heuristic evaluations

I

Heuristic Evaluation Questionnaire

The heuristic evaluation was held in Swedish, and the form, instructions, et cetera, are thus written in Swedish.

I.1 Detta är Sigmastocks

Sigmastocks marknadsför sig som ett alternativ till långsiktigt fondsparande. Deras verktyg hjälper personer att själva investera i aktier vilket ämnar ge lägre avgifter och högre avkastning. Sigmastocks har skapat en algoritm som matematiskt hjälper kunden att välja ut lönsamma aktier. Kunden behöver därför inte själv vara insatt i aktiemarknaden utan kan använda sig av detta verktyg för att skapa sin långsiktiga aktieportfölj.

Som Sigmastockskund prenumererar man på tillgång till verktyget mot en månatlig avgift. Man kan då logga in och skapa en eller flera portföljer. Varje månad sparar man undan ett fix belopp som man investerar i aktier till en portfölj. I sin portfölj h ar man därefter en samling aktier som brukar vara spridda över flera bransher och olika stora bolag för att skapa stabilitet.

I.2 Instruktioner

Detta är en heuristisk utvärdering. Du kommer få 10 olika regler som appen bör följa. Därefter vill vi att du berättar för oss hur du tycker att appen lever upp till dessa genom att peka ut på vilka ställen appen avviker och på vilket sätt. Utöver dessa regler är du välkommen att kommentera på andra områden och användbarhetsprinciper som du anser är relevanta för att förbättra designen. Den som leder utvärderingen kommer anteckna det du påpekar, varför det är viktigt att du tänker högt. Du är välkommen att ställa frågor under utvärderingens gång, både om designen och om Sigmastocks som domän.

För varje problem du upptäcker ber vi dig att referera till vilken regel de bryter (1-10 om du följer det regelset vi föreslår), samt hur allvarligt problemet är. Detta avgörs på en skala 1-5, vilken är förklarad nedan:

1. Problemet är någonting du knappt noterar, och som inte stör dig nämnvärt
2.
3. Problemet är irriterande men det går bra att fortsätta använda appen
4.
5. Problemet är såpass allvarligt att du inte längre kan eller vill använda appen

Hur du använder appen (härefter "Systemet") är upp till dig; vi rekommenderar dock att du går igenom hela gränssnittet två gånger för att dels få en känsla av hur allting är sammankopplat och sedan för att kunna undersöka mer i detalj.

Regelsetet som föreslås är fritt översatta från Jakob Nielsens *10 Usability Heuristics for User Interface Design* (Nielsen, 1995), som i sin tur är omskrivningar av de som presenteras i hans bok *Usability Engineering* (Nielsen, 1993). Du får använda något annat regelset om du vill, förklara i så fall vilket.

I.3 Regelset

1. Synlig status

   Systemet ska alltid förklara eller visa vad som pågår

2. Matchning mellan systemet och den verkliga världen

   Språket, bilder och andra konventioner ska vara lättförståeliga

3. Användarkontroll och användarfrihet

   Det ska vara enkelt att gå tillbaka till ett föregående stadie, samt ändra inställningar med mera

4. Konsekventtänkande och standardisering

   Samma ord ska betyda samma sak, även om det är på olika platser. Appen ska följa guidelines för iOS respektive Android

5. Förhindra att fel uppstår

   Inga fel ska uppstå under användandet

6. Igenkännande, inte ihågkomst

   Som användare ska man kunna känna igen information mellan vyerna, snarare än att behöva komma ihåg det

7. Flexibilitet och effektivitet

   Systemet ska kunna anpassas både för nybörjare och vana användare

8. Estetik och minimalistisk design

   Irrelevant information ska inte förekomma

9. Felhantering

   Felmeddelanden ska vara tydliga, koncisa och visa hur man som användare kan gå vidare

10. Hjälp och dokumentation

    Om dokumentation förekommer ska denna vara fokuserad på hur systemet

används, med specifika steg.

References

Nielsen, J. (1993). Chapter 5 – Usability Heuristics. In *Usability engineering* (pp. 115–163). doi:10.1016/B978-0-08-052029-2.50008-5

Nielsen, J. (1995). 10 Usability Heuristics for User Interface Design. Nielsen Norman Group. Retrieved from https://www.nngroup.com/articles/ten-usability-heuristics/

J

Heuristic Evaluation Answers

The following tables, Table J.1 and Table J.2, present the result from the heuristic evaluation.

Applicable for the app								
Problem	**View in app**	**Heuristic Category**	**P1**	**P2**	**P3**	**P4**	**P5**	**Sum**
When pressing the Log in button repeatedly, the app displays an error message	Log in	5			5	5		10
There is no confirmation that an email has been sent when the user resets the password	Forgot password	1	2		4	2	2	10
The back button in the portfolio overview causes the app to close, and a re-login is then required	Portfolio overview	3		4	3		3	10
Overall, words such as "target portfolio" and "stock shares" can be difficult to understand for a new user		7		2	3	4		9
The back button is unclear in the Forgot password view	Forgot password	4	3		2		3	8
It's not clear what the bars represent	Portfolio overview	1			3	4		7
It's not possible to create a new account	Log in	6	5					5
The user should be able to sort the stocks alphabetically, or some other order, in the portfolio overview	Portfolio overview	1		2		3		5
It's not possible to change portfolio [has been fixed]	Switch portfolio	5		5				5
It's not possible to log out	Log out	5		5				5
The ends of the bars are not visible	Portfolio overview	1, 8	3	2				5
There is no check to see if the email address is valid	Forgot password	1, 5				3	2	5
The "Change portfolio" button is hard to find	Portfolio overview	3			3		2	5
The wording is unclear, especially "market" and "ethical"	Portfolio overview	2			2		3	5
The error messages that are supplied are often to more use for the developer, rather than the user.		9		4				4
The stocks need to be better separated	Portfolio overview	8			4			4
It's annoying that stocks that aren't in the user's holdings still show up if they're in the target portfolio	Portfolio overview	8			4			4
It's not possible to sort the portfolios	Switch portfolio	3				3		3
There is no information whether a stock option is for a large or small company, or a stable or growth company	Portfolio overview	1				3		3
The email address and password is still filled in after a log-out; this feels unsafe	Log in	3				3		3
The view mixes English and Swedish	Forgot password	4				3		3
Sometimes a holdings row flickers black when pressed	Portfolio overview	8				3		3
It's not possible to just select a portfolio and not go directly to it	Switch portfolio	3			3			3
The geographical markets are unclear in the Change portfolio view	Switch portfolio	1	2					2
The headings have low visibility in the portfolio overview	Portfolio overview	1,6	2				2	4
It's unclear that the leaf represents ethical saving	Portfolio overview	1				2		2
The arrow, which is used to show more information about a stock, doesn't work to hide the information again	Portfolio overview	4				2		2
Sometimes a stock is not minimized when pressing on another stock	Portfolio overview	5				2		2
The three different parts of the portfolio content need to be made easier to discern (market, portfolio, and holdings)	Portfolio overview	10	1		1			2
There is no introduction for new users		7			2			2
It's unclear which bar is which in the portfolio overview, if both are at 50%	Portfolio overview	8	1					1
There should be a "reset password" option if the user can't log in	Log in	9	1					1
It's unclear what the percentages in the holdings section of the portfolio overview are percentages of	Portfolio overview	1		1				1
There are too many colors on the overview page	Portfolio overview	8		1				1
It's not possible to save the email address or password	Log in	3				1		1
The tab bar feels outdated		4			1			1

Table J.1: The results of the heuristic evaluation, with regards to problems applicable to the app. P1-5 denotes the participants. The severity of the problem is marked on each problem by each participant, if they found the problem. The problems are ordered by the sum of these numbers.

Applicable for only the sketch								
Problem	**View in app**	**Heuristic Category**	**P1**	**P2**	**P3**	**P4**	**P5**	**Sum**
In the invest view, it doesn't show which portfolio the user is investing in; it's not possible to select a particular portfolio.	Invest	1, 3	5				3	8
In the sell view, it doesn't show which portfolio the user is selling from; it's not possible to select a particular portfolio.	Sell	1, 3	5				3	8
It's not possible to adjust the amount of stocks being bought	Invest	3			5		3	8
The terms Buy, Invest, and Save are confusing, and it's not obvious if they mean the same thing or what that may be	Invest	2, 4	4				3	7
The sell view is a part of the invest view; this makes it harder to find and is illogical since they are separate actions	Sell	2, 3	3				2	5
The back button is in English, while Swedish is used everywhere else		4				2	3	5
It says "Include in purchase", even though the user is going to sell the stocks, not purchase them	Sell	4				5		5
It should be possible to change the investments manually if they don't go through	Invest	1		4				4
It's not possible to create a new portfolio	Switch portfolio	3				4		4
Counfusing "confirmation" message. What does "update" mean? The list can be interpreted either what is left in the portfolio, or what has been sold. The user interpreted it as what is left.	Invest	2					4	4
The "+" sign is still there when creating a new portfolio	New portfolio	4				4		4
It's hard to understand the bars; what happens if the current holdings is larger than the stock holdings?	Portfolio overview	6			4			4
It's unclear how the account settings are managed, what the edit button does and how lines are manipulated	Account	4	1		2			3
In the portfolio overview, the user should be able to see the proportion of market cap, etc, without scrolling through all holdings	Portfolio overview	7		3				3
The value of any particular stock is not shown	Portfolio overview	1				3		3
It's not clear if Buy, Sell, and Invest represent three different actions or a single combined one	Invest	4					3	3
The back button is different from the other ones	Invest	4					3	3
The user doesn't want to have to choose which bank to buy from if they only use one of them	Invest	8			3			3
The heading for holdings is not centered	Portfolio overview	4	2					2
I'ts unclear how the stock proportions are calculated if some stocks are left unticked	Invest	1		2				2
The Change portfolio view is missing values and markets of the portfolios	Switch portfolio	3	1					1
It's unclear which part of the circle is which when it comes to the market share of the holdings	Portfolio overview	8	1					1
It's unclear what inspirational emails are	Account	2		1				1
It's unclear what the push notifications will be	Account	2		1				1
"Go to sell [Gå till sälj]" is badly worded	Sell	2					1	1
The radio button icon for ethical saving has uncentered elements	Portfolio overview	8					1	1
The checkmark icon is misaligned	Invest	8					1	1
The icons in the tab bar should better match the views themselves		4			1			1

Table J.2: The results of the heuristic evaluation, with regards to problems applicable only to the sketch. The table is laid out in the same manner as Table J.1.

K

Cognitive Walkthrough

In the cognitive walkthrough the following three tasks with corresponding user actions and system displays were addressed. The raw outcome can also be seen below.

T1: Determine if your current Nordea holdings match the target holdings.

UA1: Fills in the login fields

SD1: The login fields displays the value filled in

UA2: Presses the login button

SD2: The overview of the portfolio is displayed

UA3: Presses the stock item of Nordea

SD3: Accordion for the holdings shows, displaying current and target holdings

T2: Change your Nordea holdings to four in the portfolio *Långsiktigt Spa*

UA1: Presses *change portfolio*

SD1: The switching-between-portfolio view is displayed

UA2: Presses the portfolio *Långsiktigt Spa*

SD2: The portfolio overview of *Långsiktigt Spa* is shown

UA3: Presses the stock item of Nordea

SD3: Accordion for the holdings shows, displaying current and target holdings

UA4: Changes the holdings, either with help of the increase and decrease buttons, or type in the value in the input field

SD4: An updated number in the input field is displayed

UA5: Presses the apply button

SD5: The feedback text *Quantity updated* is shown

T3: Invest in stocks for 20 000 SEK

UA1: Presses the tab *Invest*

SD1: The investment view is shown

UA2: Fills in 20 000 as amount

SD2: The amount field displays the value filled in

UA3: Presses the calculate button

SD3: The second view in the investment process is shown

UA4: Presses the go-to-buy button

SD4: The receipt view is shown, pretending the app of the bank has been displayed in between

Evaluator A

T1

Action-sequence	**Questions**	**Comments**
Action 1 (UA1, SD1)	1.Yes 2.Yes 3.Yes 4.Yes	
Action 2 (UA2, SD2)	1.Yes 2.Yes 3.Yes 4.Yes	
Action 3 (UA3, SD3)	1.No 2.No 3.No 4.Yes	It wasn't clear weather to scroll down or to the side in order to find Nordea. The user didn't understand that he/she could click on the stock Nordea AB. It wasn't obvious which staple that represented the owned amount of stock and which that represented the recommended. A correct assupmtion was done though.

T2

Action-sequence	**Questions**	**Comments**
Action 1 (UA1, SD1)	1.Yes 2.Yes 3.Yes 4.Yes	
Action 2 (UA2, SD2)	1.Yes 2.Yes 3.Yes 4.Yes	
Action 3 (UA3, SD3)	1.Yes 2.Yes 3.Yes 4.Yes	
Action 4 (UA4, SD4)	1.Yes 2.Yes 3.Yes 4.Yes	
Action 5 (UA5, SD5)	1.Yes 2.Yes 3.Yes 4.Yes	The user didn't know if a stock was sold or if the information was only updated. It was intuitive after it was known that the name of the

		stocks could be clicked on. The subject preferred the owned amount bar to update in realtime during incrementation and decrementation of a stock. It was intuitive to press the number indicating the owned amount for modification.

T3

Action-sequence	**Questions**	**Comments**
Action 1 (UA1, SD1)	1.Yes 2.Yes 3.Yes 4.Yes	
Action 2 (UA2, SD2)	1.Yes 2.Yes 3.Yes 4.Yes	
Action 3 (UA3, SD3)	1.Yes 2.Yes 3.Yes 4.Yes	It wasn't obvious which portfolio that was invested in. A possibility is to have the name of the portfolio written in this stage. The subject like to include the graphic staples for the stocks in the investment tab as well so the two can be easily associated for the user.
Action 4 (UA4, SD4)	1.Yes 2.Yes 3.Yes 4.Yes	It would be preferable to be able to undo the investment entirely.

Evaluator B

T1

Action-sequence	**Questions**	**Comments**
Action 1 (UA1, SD1)	1. Yes 2. Yes 3. Yes 4. Yes	
Action 2 (UA2, SD2)	1.Yes 2. Yes 3. Yes 4. Yes	

Action 3 (UA3, SD3)	1. Yes 2. No 3. No 4. Yes	The subject believed to be done when he/she saw the overview and answered yes, but this was incorrect. The recommended amount and the owned amount was mistaken for the recommended and vice versa. The subject suggested to have numbers or staple diagrams in the overview.

T2

Action-sequence	**Questions**	**Comments**
Action 1 (UA1, SD1)	1. Yes 2. No 3. Yes 4. Yes	Couldn't locate the button to change the portfolio.
Action 2 (UA2, SD2)	1. Yes 2. Yes 3. Yes 4. Yes	
Action 3 (UA3, SD3)	1. Yes 2. No 3. No 4. Yes	The subject didn't understand that the stocks were clickable objects
Action 4 (UA4, SD4)	1. Yes 2. Yes 3. Yes 4. Yes	
Action 5 (UA5, SD5)	1. Yes 2. Yes 3. Yes 4. No	The subject was unsure of the action that was performed was correct. The feedback should be more clear and the subject also preferred a completary text that the amount of stocks is being changed

T3

Action-sequence	**Questions**	**Comments**
Action 1 (UA1, SD1)	1. Yes 2. Yes 3. Yes 4. Yes	
Action 2 (UA2, SD2)	1. Yes 2. Yes	

	3. Yes 4. Yes	
Action 3 (UA3, SD3)	1. Yes 2. Yes 3. Yes 4. Yes	The subject would like to have more information than of just how the amount are distributed. How much money is spended on wach stock for example.
Action 4 (UA4, SD4)	1. Yes 2. Yes 3. Yes 4. Yes	The subject likes the confirmation. Would like to continue to the holdings and see the change. A bit confused of how it is going to integrate with the other apps (Nordnet, Nordea etc.)

Evaluator C

T1

Action-sequence	**Questions**	**Comments**
Action 1 (UA1, SD1)	1.Yes 2.Yes 3.Yes 4.Yes	
Action 2 (UA2, SD2)	1.Yes 2.Yes 3.Yes 4.Yes	The subject didn't understand that the coloring of the staple diagrams indicated different markets and said that the circle-diagram from the website should be added for it to be effective. The purple color of a stock was confused with the staple for Large companies
Action 3 (UA3, SD3)	1.No 2.No 3.Yes 4.Yes	The subject didn't understand that the stocks were clickable and couldn't understand what was the recommended amount and what was the owned amount

T2

Action-sequence	**Questions**	**Comments**
Action 1 (UA1, SD1)	1.No 2.No 3.Yes 4.Yes	The subject couldn't find the change portfolio button. It wenät smoothly after this button was shown.
Action 2 (UA2, SD2)	1.Yes	

	2.Yes 3.Yes 4.Yes	
Action 3 (UA3, SD3)	1.Yes 2.Yes 3.Yes 4.Yes	
Action 4 (UA4, SD4)	1.Yes 2.Yes 3.Yes 4.Yes	
Action 5 (UA5, SD5)	1.Yes 2.Yes 3.Yes 4.Yes	

T3

Action-sequence	**Questions**	**Comments**
Action 1 (UA1, SD1)	1.Yes 2.Yes 3.Yes 4.Yes	
Action 2 (UA2, SD2)	1.Yes 2.Yes 3.Yes 4.Yes	
Action 3 (UA3, SD3)	1.No 2.No 3.Yes 4.Yes	The subject preferred the “Buy” button to be renamed to “Calculate” and further said that the results are suggestions and therefore the name of the button is inappropriate.
Action 4 (UA4, SD4)	1.Yes 2.Yes 3.Yes 4.Yes	

Evaluator D

T1

Action-sequence	**Questions**	**Comments**
Action 1 (UA1, SD1)	1. Yes 2. Yes 3. Yes 4. Yes	

Action 2 (UA2, SD2)	1. Yes 2. Yes 3. Yes 4. Yes	
Action 3 (UA3, SD3)	1. Yes 2. Yes 3. Yes 4. Yes	

T2

Action-sequence	**Questions**	**Comments**
Action 1 (UA1, SD1)	1. Yes 2. Yes 3. Yes 4. Yes	It took some time before the change portfolio button was located.
Action 2 (UA2, SD2)	1. Yes 2. Yes 3. Yes 4. Yes	
Action 3 (UA3, SD3)	1. Yes 2. Yes 3. Yes 4. Yes	
Action 4 (UA4, SD4)	1. Yes 2. Yes 3. Yes 4. Yes	
Action 5 (UA5, SD5)	1. Yes 2. Yes 3. Yes 4. No	Procenten uppdaterades ej, så visste inte att det faktiskt ändrats The subject didn't understand that a change was made since the procent bar didn't change. .

T3

Action-sequence	**Questions**	**Comments**
Action 1 (UA1, SD1)	1. Yes 2. Yes 3. Yes 4. Yes	

Action 2 (UA2, SD2)	1. No 2. No 3.The action wasn't performed 4.The action wasn't performed	The subject didn't see the placeholder. Feedback is required if the field is left empty since progress is possible when it shouldn't be. The subject progressed without inserting an amount.
Action 3 (UA3, SD3)	1. Yes 2. Yes 3. Yes 4. Yes	
Action 4 (UA4, SD4)	1. Yes 2. Yes 3. Yes 4. Yes	The subject thought the feedback was clear and well.

float

L

Paper prototype of the App

This appendix presents all the sketches of the views. Since similar sketches have been made for both Android and iOS, only views from the operating system iOS are added. Besides from the user account screen, since there exist larger differences.

Figure L.1: Sketch of the login screen for iOS, displaying one input field for the username and one for the password, followed by the Login button.

Figure L.2: Sketch of a list view for viewing the users portfolios in iOS.

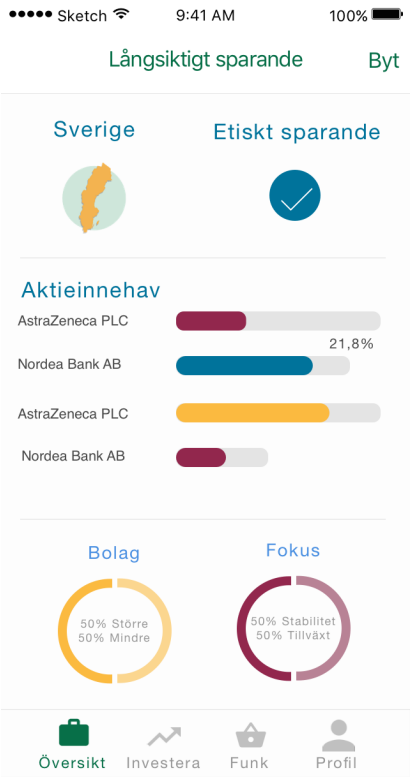

Figure L.3: Sketch of a users portfolio overview in iOS.

Figure L.4: Sketch of the first step in the investment flow for iOS.

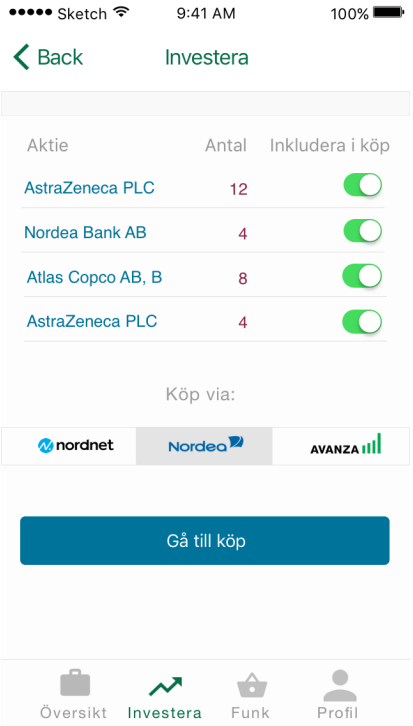

Figure L.5: Sketch of the second step in the investment flow for iOS.

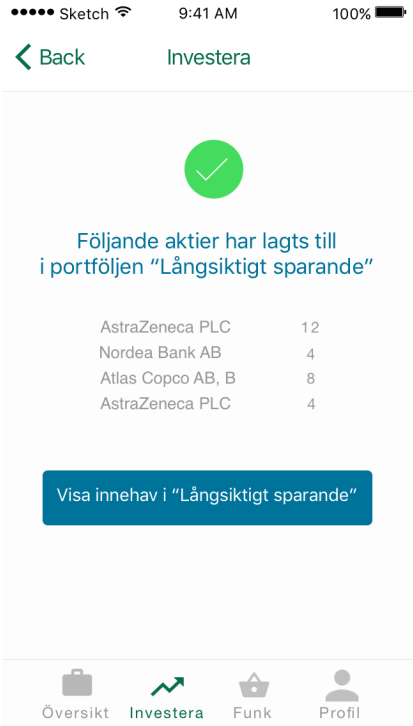

Figure L.6: Sketch of the third and final step in the investment flow for iOS.

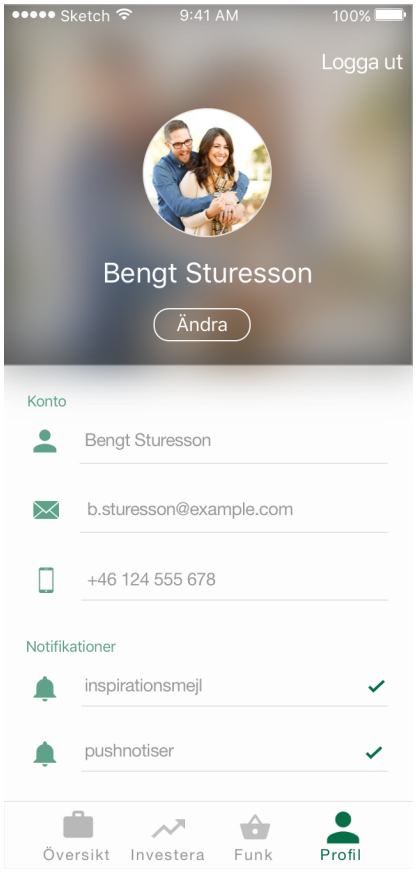

Figure L.7: Sketch of the user account screen for iOS, displaying the account settings as well as the notification settings.

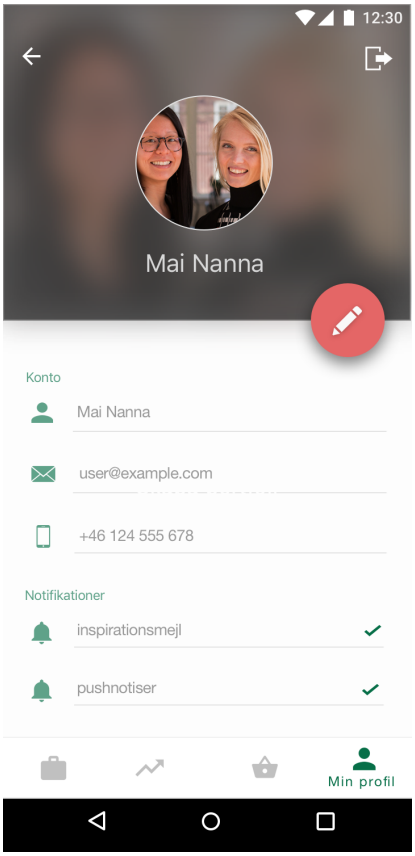

Figure L.8: Sketch of the user account screen for Android, displaying the account settings as well as the notification settings. A red floating action button with the icon of a pen is available to change settings.

M

The Final Version of the App

This appendix presents all the views in the final version of the app.

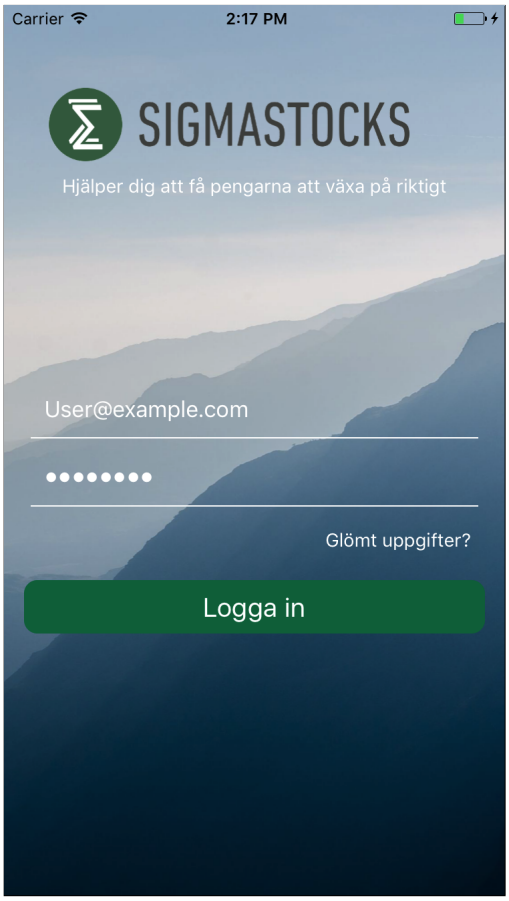

Figure M.1: The first view in the app, giving the user the possibility to log in

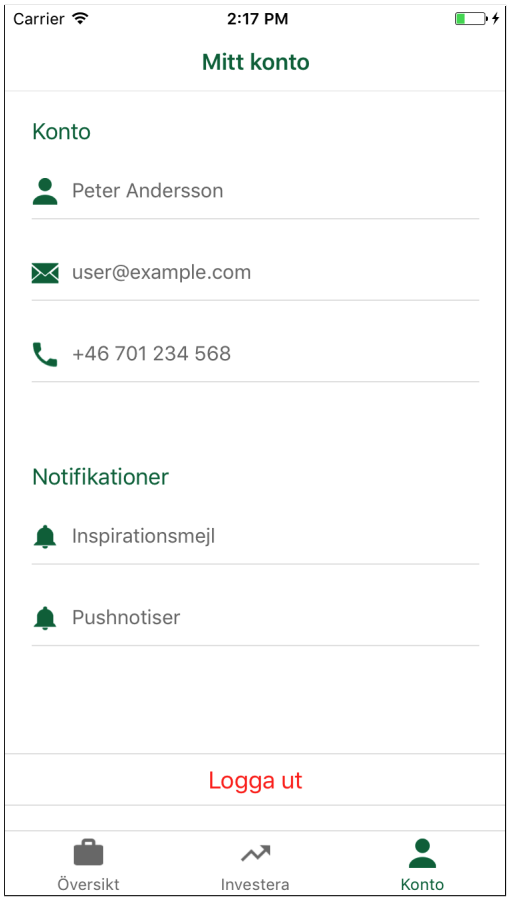

Figure M.2: The view displaying the account settings of the user

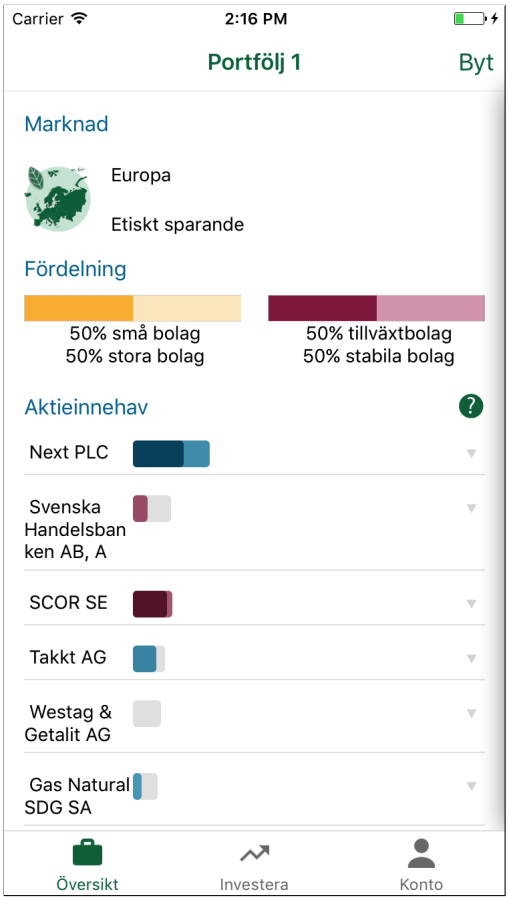

Figure M.3: The view displaying the holdings and market settings of the selected portfolio

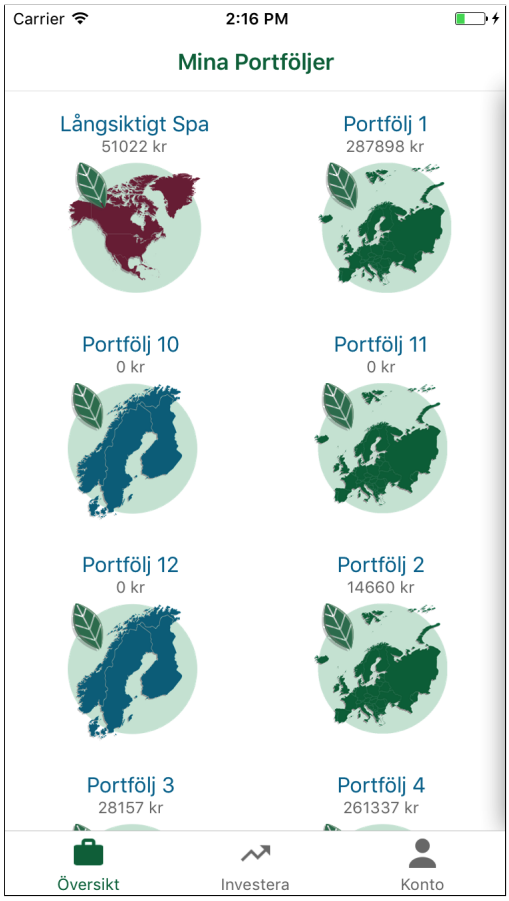

Figure M.4: The view displaying all portfolios of the user, together with the total value of holdings and settings. Each portfolio is selectable

Figure M.5: The first view in the investment flow, giving the user a possibility to select portfolio, amount to invest and bank

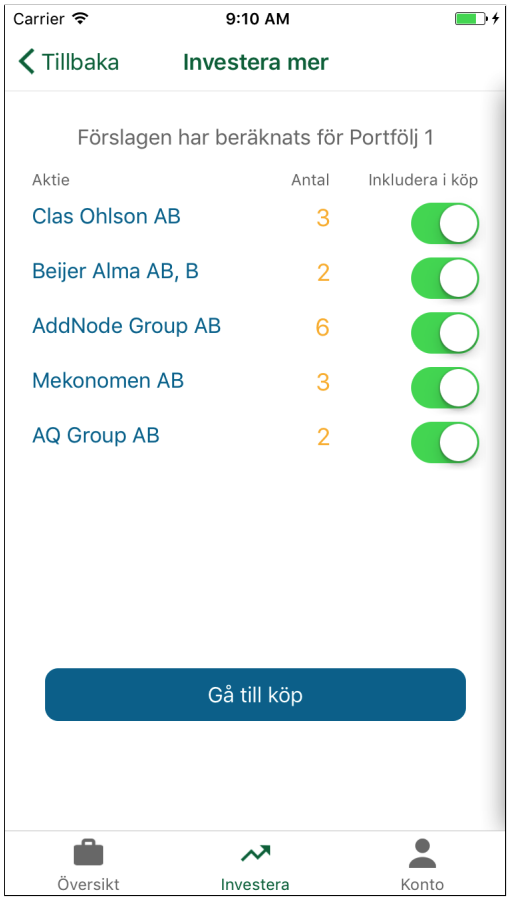

Figure M.6: The second view in the investment flow, where the user can choose which calculations to include in the investment

Figure M.7: The third view in the investment flow, where the user can choose which calculations to include in the investment

Figure M.8: The final view in the investment flow, displaying what stocks were added to which portfolio