Kodinportti Mobile User Interface Usability Research and Redesign

Abstract

Usability is described as follows "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". Usability plays a crucial role in the success of interactive products and services. With good usability can be achieved an important competitive advantage in an ever-growing market if it is involved in software products development life cycle. User experience (UX) is based on people's expectations and the following emotions and it involves extensively everything that happens outside the screen. UX design aims to emphasize features that are bringing pleasure in addition to practicality. Usability evaluation is easy and very cost-effective way to analyze user interface and find possible usability problems. In general, the empirical methods like heuristic evaluation and usability testing are the most used and principal means to evaluate user interfaces.

This thesis focuses on exploring the usability of Kodinportti Mobile application. The motivation for the study is to improve its user interface (UI) more user-friendly using usability research methods that include heuristic evaluation, usability testing, and user experience research. The practical work in the study is responsible by the University of Oulu usability testing course student group and the group also reports the results of research. The goal of the study is to redesign the app's UI. Kodinportti Mobile is designed to meet the needs of the residents of the housing association and serves as a supplement to the electronic bulletin board for the residents. Mobile application UI design applies the same basic guidelines as any other UI design process and in mobile application UI design, it is often recommended to keep it simple as possible and cut out as much as possible.

The results of usability research revealed several flaws in the apps usability and user experience. In the final phase of the thesis, the concept plan of new UI was designed based on the research results. There was also a perception during the process that it would be recommendable that designers are involved in all stages of the process. That would improve the process and minimize the possibility of misunderstandings during the process, which will certainly have a positive impact on the result.

Foreword

Contents

1.   Introduction

Everybody nowadays have experience of using some mobile application, so it means that people have expectations based to their earlier experiences, and people are also influenced by what they have heard from others. User experience arises from the user's expectations and subsequent feelings (Hiltunen et al., 2002). ISO 9241-11 describes user experience as "perceptions and responses that result from the use and/or anticipated use of a system, product or service" and "users' perceptions and responses include the users' emotions, beliefs, preferences, perceptions, comfort, behaviors, and accomplishments that occur before, during and after use". So, it is important to assure that quality does not disappoint expectations (Hiltunen et al., 2002). To maximize the user experience, the product or service must have the highest usability, which is to support the users achieve the goals in their tasks (Jokela et., al 2003). ISO 9241-11 explains the term usability as "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".

With usability testing can be eliminated, or at least reduced, the risks and negative effects of improper interaction with a product, system or service (Rajanen & Rajanen, 2017). Of course, the main goal of usability testing is to improve the usability of a product, but with it can be also improved the whole products design process that made mistakes will not happen again (Dumas & Redish, 1999). Over the years, there is a lot of evidence that testing only a handful of users provides enough information to eliminate the biggest problems with product usability (Nielsen & Budiu, 2013). Rajanen and Rajanen (2018) stated that heuristic evaluation is common and used usability evaluation method, where a group of experts go through a list of heuristics step by step to find the best solution for product design. Heuristic evaluations advantage is that it doesn't take much time and resources to do it and illustrative of its small requirements is that it can be done even alone, although it is preferable to do it in a group (Rajanen & Rajanen, 2018). Indeed, in the literature it has been argued that usability plays a crucial role in the success of interactive products and services. Good usability can provide an important competitive advantage in an ever-growing market as long as it is involved in software products development life cycle and the data it brings is taken into account when making decisions. (Rajanen & Rajanen, 2017)

This thesis explores the usability of Kodinportti Mobile application and attempts to improve its user interface design using the traditional usability research methods that include heuristic evaluation, usability testing, and user experience research. The app is free and can be downloaded by a resident of a housing association alongside an electronic bulletin board in the building lobby. Kodinportti Mobile is designed to meet the needs of the residents of the housing association. It allows residents to get information on housing association issues and make reservations and bookings, for example for the sauna. (Kodinportti, n.d.a). When it comes to mobile usability issues, perhaps the first to come to mind is that what is difference between mobile application and web usability? Accordind to Nielsen and Budiu (2013) there are hardly any. Mobile usability applies basically the same usability guidelines as, for example, Web usability, except that usability guidelines are even stricter because there is much less space available on mobile devices screen. (Nielsen & Budiu, 2013) In mobile application user interface design, it is often recommended to keep it simple as possible and cut out as much as possible. The less information is available the more effective it is for the user. (Oulaskoski, 2011)

The motivation for the study is the need to develop the Kodinportti Mobile user interface more user friendly, improve applications usability and user experience through Nielsen's heuristic evaluation, usability testing and user experience research (UEQ-S). Also, the aim of the study is to find from application objects and functions that require development and possibly find a feature that is missing from the application. So, the research questions for this study are simply:

- o Can usability test provide information that makes the mobile user interface more user-friendly?

- o What kinds of development suggestions will heuristic evaluation and usability test produce?

Thus, these questions will be searched for answers with the help of a test group made up of students of the usability testing course at the University of Oulu. Test group will be responsible for the implementation of heuristic evaluation, usability testing and user experience research. The design of the testing has been carried out in cooperation with the signatory and the test team. A literature review is performed to determine the requirements and recommendations for designing the user-friendly user interface for mobile application taking advantage of the methods of user centered design. Together with the chosen research method, literature review forms a red thread for this study to follow with the ultimate goal of creating a concept model for the new user interface.

The thesis is structured as follows, the first chapter goes through the related topics and ways to redesign the mobile interface. Chapter 3 presents the design object, Kodinportti, and chapter 4 summarizes the design science research method. Chapter 5 describes the stages of empirical research. Chapter 6 goes through the results of the research. Chapter 7 describes the Kodinportti Mobile user interface design process basing on the research results and knowledge from the literature review. Chapters 8 and 9 close the thesis by summarizing the results, discussing the end result and theorizing the possible future research.

2.   Related work

This chapter reviews the most important methods and techniques for the development of the mobile user interface. Also, it introduces earlier knowledge of usability and user experience.

2.1 Usability

The term usability is defined in in ISO 9241-11 as follows: "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". Jacob Nielsen (1993) describes in his article that usability can be measured with five quality parameters; learnability, efficiency, memorability, errors and satisfactory. Jokela et., al (2003) article defines that "Usability is about supporting users in achieving their goals in their work". Usability utilizes research on cognitive psychology and human-machine interaction (Sinkkonen, 2006). The roots of usability extend far into the history of mankind, as there have always been attempts to design products and objects that bring pleasure to their users and are easy to use (Oulasvirta, 2011). The earliest written documents concerning usability and identification of user needs can be found as early as the Roman Empire in the 1st century BC. At the time, an architect called Vitruvius documented some principles concerning system's usability for the user, such as suitability, convenience and usefulness. (Rajanen & Rajanen, 2020) Usability can be said to be a part of field of science from mid-80's when HCI (human-computer interaction) was born and after since has progressed the expression of quality of use and emphasize the results users get from interacting with the system. (Rajanen et al., 2017)

Usability can be evaluated from different perspectives and Marghescu's (2009) article goes through different standards of usability:

- ISO/IEC 9126 – Part 1 (2000) - Information Technology – Software product quality – Part 1: Quality model,
- ISO/IEC 14598 – Part 1 (1999) - Information Technology – Software product evaluation – Part 1: General overview,
- ISO 9241 – Part 11 (1998) - Ergonomic requirements for office work with visual display terminals. Part 11: Guidance on usability,
- ISO 13407 (1999) - Human-centered design processes for interactive systems,
- ISO 18529 (2000) - Ergonomics – Ergonomics of human-system interaction – Human-centered life-cycle process descriptions.

ISO/IEC 9126 and ISO/IEC 14598 according to Marghescu (2009) "focus on defining and evaluating quality of any kind of software products" and "all quality characteristics of the software product, not only usability" are covered in these two. But they exclude hardware and software of an interactive system, which rest of the standards include like ISO 9241. Marghescu (2009) explain that ISO 9241 "focuses on defining and evaluating usability of any product that is part of an interactive system and can be of nature software, hardware or service". All the above-mentioned standards are also united by the fact that they are aimed to stakeholders for the whole systems life cycle. This thesis focuses on ISO 9241 perspective of usability because it is the usability perspective of human computer interaction (HCI) where the whole system development idea is based on one and only; the ultimate usability. Usability is not just one aspect when it comes to product

quality, it is the starting point for everything. Marghescu (2009) state that "ISO 13407 focuses on designing computer-based interactive systems and evaluating different design solutions throughout the system development life-cycle and is addressed mainly to project managers, but to other stakeholders involved in system's development life-cycle too". On behalf in ISO 18529 the target is on how to model the system's life-cycle process, not in system's designing (Marghescu, 2009).

Usability has been explored a lot and there has raised a lot of different definitions to describe the term. (Rajanen et al.,2017). First was spoken a lot of "user friendly" systems, but professionals in the field thought the term is not sufficiently descriptive. So, user interface professionals have come up with the terms such as, HCI (human-computer interaction), CHI (computer-human interaction), UCD (user-centered design), MMI (man-machine interface) and UID (user interface design). (Nielsen, 1993)

Oulasvirta (2011) state that usability is a key design goal of a product or system, and the basics are already built in the early stages of design process when user needs and requirements are defined. When a product is usable it should meet the user's expectations and work fluently. Usability research is multidisciplinary. In addition to data processing, the greatest influence is on psychology. Sociology, marketing and linguistics have also been influenced. All of these are characterized by the fact that they try to model the users' activities and to explore the user behavior in the situation of use. Usability can be measured either quantitatively or qualitatively and they allow the product to be developed systematically but most of the data in the usability research is qualitative, so the importance of the metrics is limited. Usability is important for human and financial reasons. Products and systems with good usability improve people's quality of life and even bring joy to their users. The economic importance of usability is high, because poor usability causes extra costs for companies in product development and support services. (Oulasvirta, 2011)

Nielsen (1994a) has strongly influenced the emergence of the usability theory field. He is explaining in his (1994a) book that usability is a part of greater entity of system acceptability (Figure 1). The acceptance of the system, in turn, requires users its social acceptance and practical acceptance. When talking about system's practical acceptance very important factor is usefulness, meaning that can user reach the certain goal using the system. Usefulness term in this context includes two terms utility and usability. Utility means that is the system capable to perform functionalities needed and usability on behalf view that are users able to use those functionalities. So, term usability means everything can be imagined when speaking about how human interacts with the system. (Nielsen, 1994a)
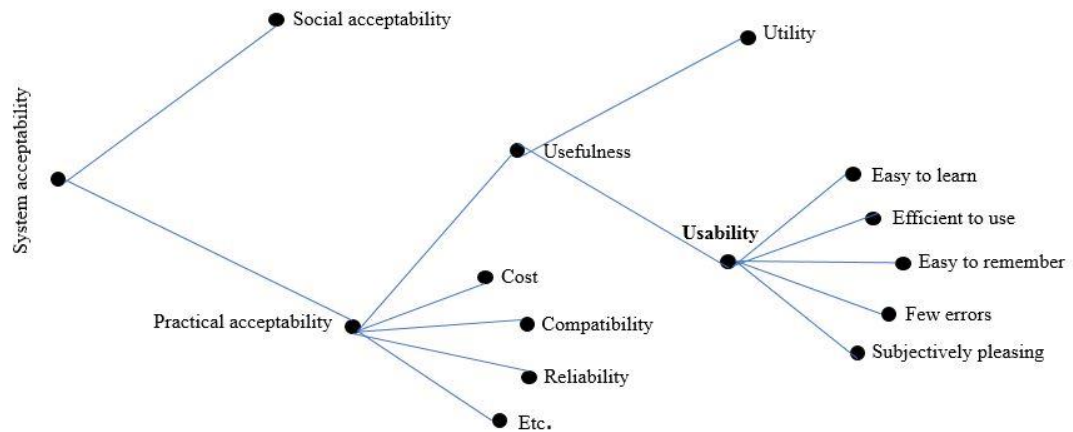
Figure 1. System acceptability model. (Adapted from Nielsen, 1994a)

Nielsen (1994b) is describing in his article the features of usable system and stating that usability can be measured with five quality parameters;

Learnability: The system should be easily adaptable so users can start working without delays. Learnability of the system is specifically influenced by the user's previous experience. Initial learning of is easiest to measure; when someone who has no experience of the system start to complete given tasks when time and performance is measured. (Nielsen, 1994a)

Efficiency: The use of the system should be effective. Efficiency can be measured by a user who has learned or has previous experience of using the system. Efficiency measures the level of productivity of system use and it is usually measured by testing users who have some certain level of system expertise and measure how long it takes for them to complete given tasks. (Nielsen, 1994a)

Memorability: The system should be easy to remember for the user. System should be built as consistently as possible so that users who do not use the system on a regular basis or have a longer break can easily return to use it, without re-learning the functions. System memorability is tested infrequently but can be tested with occasional users and measure the time how long it takes to complete most common tasks. (Nielsen, 1994a)

Errors: The system should have less errors as possible, i.e. obstacles that slow down or prevent the desired goal during the use of system. Systems errors are measured by counting the number of above-mentioned obstacles when user tries to complete tasks. Usual errors are no catastrophic and easily recovered. Serious error situations that are blocking the use of the system completely or are difficult to recover, should not occur at all. (Nielsen, 1994a)

Satisfaction: The use of the system should be pleasing. The user satisfaction of the system has been successful when users are satisfied and enjoy it. User satisfaction can be measured by psychophysiological attributes, such as user's electroencephalography (EEG) or heart rate but usually it is done by asking shortly users' opinions about the comfort of use of the system. (Nielsen, 1994a)

2.2 User experience

People have always expectations, no matter what they do. User experience (UX) is based on people's expectations and the following emotions. (Hiltunen et al., 2002). ISO 9241-11 describes the concept of UX in these ways: "user's perceptions and responses that result from the use and/or anticipated use of a system, product or service" and "users' perceptions and responses include the users' emotions, beliefs, preferences, perceptions, comfort, behaviors, and accomplishments that occur before, during and after use". Concept of UX was born in early 2000's and it has been increasingly used since. (Oulasvirta, 2011). Rajanen et al., (2017) article mention that UX design aims to emphasize features that are bringing pleasure in addition to practicality. When talking about UX, we talk extensively about everything that happens outside the screen. So UX is a rather broad concept which consists of many elements (Figure 2) when it encompasses everything a user experiences when using a device. (Hiltunen et al., 2002)
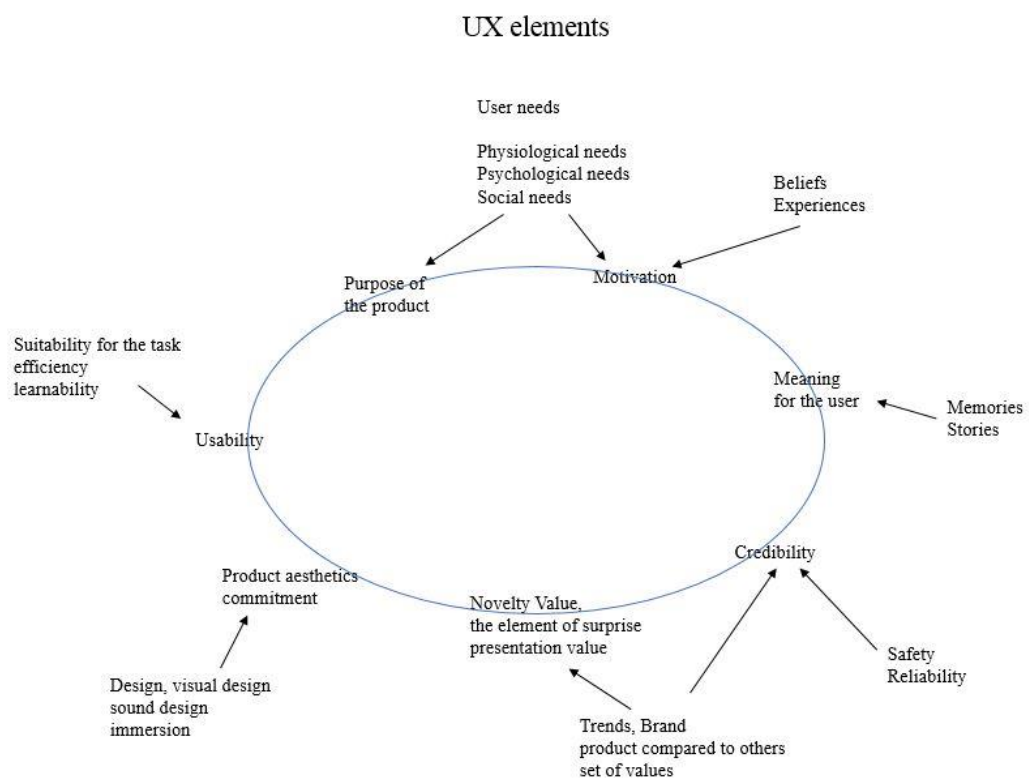
Figure 2. Elements of user experience. (Adapted from Sinkkonen et al. 2006)

Hiltunen et al., (2002) explain that the user experience is roughly made up of five factors that they say they are" utility, usability, availability and supporting offline processes". UX consists also of factors that affect the relationship between the user and the organization when the interaction is through the product. UX is not only created by the experience of using the product, but is influenced by the manufacturer's brand, the user's image and the experience of the entire product family. So, if a product has been successfully built on a good brand that the user is likely to have to pay a higher price for, the upfront expectations of the user are high and the risk of producing a bad experience is bigger. The advantage of a product with a lesser known brand is that the user's expectations are not so high, and a good user experience might be more easily achieved.

Also, past images and experiences put product on expectations and assumptions that affect the user experience. (Sinkkonen, 2006; Kraft, 2002)

Kraft (2002) state that people create expectations from their earlier experiences and what they hear from other sources. So, it is important that quality does not disappoint expectations, because one bad user experience might need ten good experiences to in order to have a great overall experience. For the user experience, first impressions are obviously very important. The first impression is probably the experience that will last the longest. Even if the product had met all of its expectations and had a good first impression, the user will need good experiences in using the product, which will leave a good experience even after use. This can be achieved, for example, by providing the user some positive surprises during the use of the product. Positive surprises might give user kind of a "wow" effect and also leave the user a good mood after the use. Such good mood effects can be, for example, some small animation or hidden feature that will surprise the user. (Hiltunen et al., (2002); Kraft, 2012) User emotions, motives and needs form the concept of user experience which is very abstract concept. (Sinkkonen, 2006)

Hassenzal (2008) article describe UX "as a momentary, primarily evaluative feeling (good-bad) while interacting with a product or service" and that UX means "all aspects of the user's experience when interacting with the product, service, environment or facility". UX can be considered as a result how humans perceive and react to the use of some system, artifact or service. In UX the focus is on how individual person is experiencing the use of, for example, UI rather than in usability the focus is on effectiveness or in efficiency of the use. The ease of use of the product alone does not make the use pleasant. However, the satisfaction of the users is subject in both UX and usability studies, so they share many same features. (Lankoski & Kirvesmäki, 2002; Rajanen et al., 2017)

Shneiderman et al. (2018) write that good UX comes along with "quality features such as usability, universality and usefulness". It is possible for the designer to achieve a good user experience focusing on basic things in design like careful planning, taking into account the needs of the user, dedication to analyzing requirements and with plenty of testing. (Shneiderman et al.,2018)

2.3 Interaction design

Designing is a creative work that always brings surprises, no matter how well prepared for them, nor does interaction design make an exception on it. The designer is required to have a technical understanding of what is feasible as well as a visual eye and common sense, so that the execution also pleases the user's eye and the user experience in all its dimensions is pleasant. (Shneiderman, 2018; Preece et al., 2011) Shneiderman et al. (2018) emphasize that design is a process that does not progress hierarchically and that the process generally involves changes and re-setting objectives.

2.3.1 Design process

Preece et al. (2011) and Shneiderman et al. (2018) present that interaction design process has four basic actions; verifying requirements, designing, building prototypes and evaluating. These actions are interconnected instructing each other and they are reproducible. In other words, the process is iterative. (Preece et al., 2011; Shneiderman et al., 2018)

Firstly, in software development is needed to find out what are the requirements for the developed product. Defining the requirements is a basic prerequisite for successfully starting to build an interactive system. Product developers and users should share the same understanding of requirements to make a product workable. (Shneiderman et al. (2018) Shneiderman et al. (2018) write that the requirements defined in the interaction design requirements analysis can be divided into three categories:

- Functional requirements; where is defined individual functions that system should conduct.
- Non-functional requirements; meaning different processes which the system produces for the user.
- User experience requirements; are such things like user interfaces visuality and typography. All interaction between the system and the user. (Shneiderman et al., 2018)

In second phase of interaction design all system requirements should be internalized so that the designing can be started. Designing phase can be divided in two different phases. In a preliminary (also called architectural or conceptual) designing stage high-level concepts of the system are made and users' mental models are being reviewed when they use the system. In detailed design phase, all actions users and system might have when interacting are planned to the point without no technical implementation. (Shneiderman et al., 2018)

In implementation or also called prototyping phase a step is taken to start producing something concrete, such as code, and the result of this step should be a finished product, but not necessarily the final product. After the prototype is done, starts the final evaluation phase of design cycle where prototype is tested that the product fulfils all the requirements users have for it and all functions can be found to work as planned. If system passes through the validation process it is possible to proceed to system deployment or continue to a new cycle in interaction design process. (Preece et al., 2011; Shneiderman et al., 2018)

2.3.2 User-centered design

According to Shneiderman et al., 2018 user-centered design is (UCD) describing the design process where users are participating in the products design process and take their opinion into consideration at every stage of the design. There are many ways how users can take part in design process as for example, in requirements definition or in usability testing. Many times, users are taking part all the way of design process, thus, they can challenge designers with their opinions and bring out their views on how things work in real life. In particularly, in the early stages of the design process, user-centered design has been found to significantly reduce the time and money spent on software development. However, it is essential that the user-centered design results in products that users want and thus, for example, the efficiency of the organization is enhanced. (Abras, et al., 2004; Shneiderman et al., 2018) The benefits of UCD can be mentioned also according to Kieffer & Vanderdonckt, 2016 "reduction of user needs for support, reduction of development and maintenance costs, optimization of decision-making processes".

Rubin and Chisnell (2008) write in their book that UCD presents different methods and techniques for designers how to design usable products. In software development many times the technology is in the focus first in the design, i.e. firstly consider whether the product can be implemented technically. In UCD development process the user takes the

place of technology in the spot of design and the technology is built around the user. Technology adapts to user requirements, not user in technology's requirements. Rubin and Chisnell (2008) highlight following as a key principle of UCD:

- Early focus on users and their tasks

- Evaluation and measurement of product usage

- Iterated design

Direct contact with the client from the beginning until the end of products development lifecycle and systematic data collection of users and their tasks are forming the basis of design. Also, it is important from the beginning to start to measure the how users learn to use the product and test the porotypes with the actual users. (Rubin & Chisnell, 2008)

Starting point in user-centered design is the design organization's identification for the need of user-centered design and this, of course, requires that there is basic knowledge of usability and user-centeredness is considered important in the organization. In the beginning it is important to understand the context of use. Context of use includes in addition to physical environment, task, social, psychological and technical context. So, there is many variables designers should understand when it comes to context of use. Next step in UCD process is to define user requirements. It means that designers need to understand the users and organizations requirements needs and goals. Also, technical requirements must be considered. Requirements are usually found out doing interviews, observing users and competitor analysis. (Oulasvirta, 2011)

After requirement analysis it is time to start to iterative design process which is illustrated in Figure 3. In iterative design process is made design solutions and evaluate them by experts or end users. This is repeated as many times as is deemed necessary. It is very important that designers receive feedback from users repeatedly about design solutions. Iterative design means that designers must ready for even major changes and make them repeatedly throughout the design process. (Oulasvirta, 2011; Rubin & Chisnell, 2008)
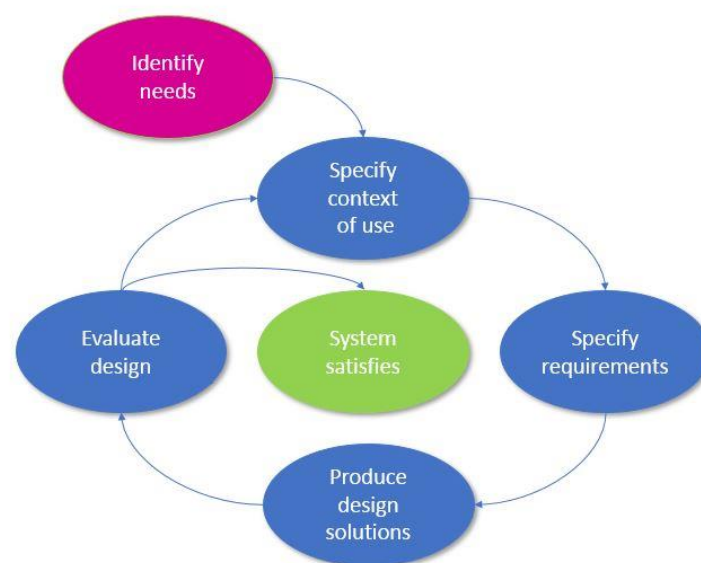

Figure 3. User-centered design process. (Adapted from Usability.gov. n.d.)

2.4 Usability research

There is four basic ways of running usability evaluations for user interfaces; automatically, empirically, formally, and informally. When user interface is evaluated automatically it means that its usability is measured using computer program. If usability is measured empirically, it means that real users are testing the user interface. Formally measured usability means that UI is measured by calculating with specific models and patterns. Informally measured usability is built on the evaluator's professional experience and personal skill and knowledge. Nielsen states that automated methods evaluating methods are not working and formal methods are hard to use especially when measuring bigger user interfaces. Therefore, empirical methods are the most used and principal means to evaluate user interfaces. Sometimes getting real users to the tests can be expensive or there is not time enough, so many times there is also a need for informal evaluating methods. (Nielsen, 1994b)

2.4.1 Evaluation methods and techniques

Usability evaluation is easy and very cost-effective way to analyze user interface and find possible usability problems (Nielsen, 1994b). UCD provides the designers with quite a variety of alternatives in techniques, methods and practices which can be used at different stages of product design. **Ethnographic research** is based on anthropology and it monitors the user in their natural environment and collects all related data. In **participatory design** the users are taken as part of a design team developing the product and thus the designer will always receive all the information and feelings directly from the end user. **Focus group design** is useful in the early stages of the project. It requires several participants and its goal is usually to produce very primitive concepts for design. Focus groups at its best offers very in-depth knowledge and emotion directly from multiple end users. **Surveys** in turn, provide information easier about the bigger masses and help designers draw larger lines in design. Surveys can be done at any stages of design, but usually done in early phase, like all the techniques mentioned above. (Rubin & Chisnell, 2008)

According to Dumas & Redish (1999) **walkthroughs** are a standard method to ensure products quality. Walkthroughs can be used to assess technical features or to assess usability. **Cognitive walkthrough** is designed for user interface evaluation. The method primarily evaluates how well the user learns to use the user interface. In this method, professionals go through the tasks and evaluate the strengths and weaknesses of the design. Tasks are reviewed in detail, looking at how consistently they are divided into different parts, how well the necessary steps are found in the user interface and how the activities get feedback. Great thing in this method is that there is no need for a ready-made model or prototype to make an evaluation. (Dumas & Redish, 1999)

In **paper prototyping** user gets the idea what user interface lay out could look like and users get to test its usability on paper. In addition to visuality, paper prototype is good way, for example, to test UI's navigation functionality and that are the planned categories similar to users assume. Paper prototyping is useful way for the designer to obtain information quickly and very cheaply. (Dumas & Redish, 1999; Rubin & Chisnell, 2008)

Heuristic Evaluation

Heuristic evaluation is well known and much used software usability evaluation method, because it does not demand hardly any resources to make it happen. (Rajanen & Rajanen 2018) This evaluation method is often heard also called expert evaluation, because to do heuristic evaluation is needed someone who has experience from usability field to look at whether the assessment matches the agreed usability principles that are being sought for the evaluation. It also would be good if the heuristic evaluation would be done some professional who which is not very strictly tied to the development work itself. The evaluation itself goes so that the evaluator goes through the user interface in accordance with agreed usability principles called heuristics and reviews the outcome within the principles. The best result is obtained when the evaluation is done alone, after which the results are reviewed by the group. (Mack & Nielsen 1994); (Rubin & Chisnell, 2008) Mack & Nielsen (1994) state that different people tend to find different usability problems. In simplified way, the goal of heuristic evaluation is to find as much as possible usability problems from the user interface (Mack & Nielsen 1994).

Jakob Nielsen one of the most well-known usability researchers. He has created heuristics for the evaluation of interaction design which are much used to verify usability of user interfaces. Nielsen's heuristics consist of ten principles for evaluating usability and principles are listed below in List 1:

- **Visibility of system status:** The system should always keep users informed about what is going on, through appropriate feedback within reasonable time.

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

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

- **Consistency and standards**: Users should not have to wonder whether different words, situations, or actions mean the same thing. Follow platform conventions.

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

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

- **Flexibility and efficiency of use**: Accelerators -- unseen by the novice user -- may often speed up the interaction for the expert user such that the system can cater to both inexperienced and experienced users. Allow users to tailor frequent actions.

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

- **Help users recognize, diagnose, and recover from errors:** Error messages should be expressed in plain language (no codes), precisely indicate the problem, and constructively suggest a solution.

- **Help and documentation:** Even though it is better if the system can be used without documentation, it may be necessary to provide help and documentation. Any such information should be easy to search, focused on the user's task, list concrete steps to be carried out, and not be too large.

List 1. Nielsen usability heuristics. (Adapted from Mack & Nielsen, 1994)

2.4.2 Usability testing

Usability testing can help to find out a lot of information, but its main idea is to get a better product quality by identifying users' mental models in a situation that is as real as possible. The aim is also to develop and repair the design process for the future, so that the made mistakes will not happen again. (Dumas & Redish, 1999; Sinkkonen et al., 2006) Rubin and Chisnell (2008) state that it is important to comprehend the key principles of UCD so that the context of usability testing can be understood, because usability testing is only one part of UCD process and to get the best out of the rest other UCD processes are good to understand.

The people who are participating to the test must be presenting the actual user group which the product is planned to design. If the test is conducted to persons who are not actual users, the test cannot be considered as a usability test. Usually test participants are doing the test one by one. They are doing tasks that are a part of a test scenario, which is a small story build as realistic as possible facing for example some daily operation in a workplace. So, it is important in usability testing is also that the participant is actually doing the real tasks, what they are doing in their homes or in their workplaces. During the test testers are observing and recording participants comments and performance. Also, tester needs to ask participants opinions about the product orally and with the questionnaire. (Dumas & Redish, 1999; Sinkkonen et al., 2006)

Sinkkonen et al., (2006) write that there are two kinds of usability tests; tests to develop a product and tests to complete the product. The purpose of development tests is to find the best possible solutions for user interface development, while the purpose of the acceptance test is to make sure that the product meets its usability requirements. Usability tests can be arranged in the laboratory or in the actual environment of the product. Some have criticized laboratory tests because the laboratory is considered too isolated and undisturbed space. However, that the usability issues that come to light in the laboratory are even more evident in the real environment. (Sinkkonen et al., 2006)

Sinkkonen et al., (2002) state that the usability test can be roughly divided into three parts: test organization and test plan preparation, test execution and finally analysis and test report. Before testing, its goals and usability requirements must be clear. The goal may be, for example, that the product can be learned quickly or that it should fit into irregular

use, so that its functions should be easy to remember. It is good to note the accessibility requirements because the product can be used, for example, mainly on the phone service or its users may be completely inexperienced. Also, the choice of the functions to be tested and who to test and how many to be tested must be decided. If the product is to be tested several times, a few tests will be enough, but the more tests you have, the more errors you will find. (Sinkkonen et al., 2006; Rubin & Chisnell, 2008)

The test scenario and the tasks must be prepared, and the test method must be chosen. The test method can be, for example, that the user thinks aloud and always tells what he is doing and why. Another common method is that the user performs the tasks and after that, they are interviewed and / or they fill the questionnaire. Before the actual test, a pilot test should be carried out to ensure that all the technology works, cameras, microphones, etc. Also testing the functionality of the tasks and measuring the time it takes to complete the test and to make sure that everything is working in testing sessions. Actual test session includes usually first determining the test situation for the user and short pre-test questionnaire or interview to identify user background information and, for example, previous experience of the product being tested. After that the test is conducted and a final interview is done. The test report, that is write out after the tests will collect the problems found in the test, their causes and the amounts. In addition, the report presents the results of the performed measurements and justifies the need for repair. (Sinkkonen et al., 2006; Rubin & Chisnell, 2008)

Usability testing should be done throughout the product development and should start at the latest when making the first prototypes. Testing is done throughout the iterative product development process, making it better for the user in every iteration cycle. It is worth investing in several small tests and correcting the problems that have arisen between them, rather than making one big test. (Rubin & Chisnell, 2008)

According to Sinkkonen et al. (2006) iterative user interface development has been found to accelerate the development of the user interface. Usability testing is the only objective way to determine the usability of a product. Usability testing always pays for itself if it has been properly executed and any errors that have occurred have been corrected. The benefit of usability testing is immediate, as it provides better quality products. The cost of product service and the number of errors in use will be reduced. In turn, the efficiency, utilization rate of use and happy customers are increasing. (Sinkkonen et al., 2006)

2.5 User interface design

User interface (UI) means a system that allows a person to use an IT device. It is a link between the user and system. IT devices, such as, mobile phones are always operated through UI. From the user's point of view, UI is often the same as used device or service, so UI design is very important when designing devices or applications. In addition to software, the user interface is thought to include all physical input devices that allow the user to communicate with the system, such as a mouse or keyboard on computers. The addition of more familiar user interfaces such as the graphical user interface, the menu interface, and the touch interface has begun to develop user-interfaces based on human motoric sensors such as human posture-based interfaces, conversational interfaces, voice and brain-computer interfaces. (Lankoski & Kirvesmäki, 2002; Oulaskoski, 2011)

2.5.1 Mobile user applications user interface design

Hoehle & Venkatesh (2015) state that "A mobile application is an IT software artifact that is specifically developed for mobile operating systems installed on handheld devices, such as smartphones or tablet computers". Mobile application UI design applies the same basic guidelines as any other UI design process, researching the context of use, specifying requirements, evaluation etc. In mobile application UI design, it is often recommended to keep it simple as possible and cut out as much as possible. The less information is available the more effective it is for the user. (Ouluskoski, 2011)

According to Nielsen, the user interface should be as simplified as possible, it must fully correspond to the task performed by the user and the present information only information relevant to the task in question should be included. Every additional function and information compete with the necessary things and thus contributes to the creation of error situations. The user interface should only show the information that users really need and what is necessary for progress. (Nielsen, 1993)

Nielsen and Budiu (2013) state that maybe the best way, cost effectively and from the usability point of view of mobile devices, is that the website is be designed in a responsive way. Designing responsively means that the website can be adapted to fit different sizes and differently directed screens. When the site is designed responsive it may cut the costs caused by maintaining two or more platforms. (Nielsen & Budiu, 2013)

Theresa Neil (2014) present that most common user distractions in the mobile applications are:

- crashes
- lack of key features
- confusing UI design
- bad navigation

First two cannot be fixed with UI design, but navigation and confusing interface design are surely things good UI design can affect. When these above-mentioned things are in order the users will find the one, they want. (Neil, 2014)

Kalimo (1995) writes that few areas of computing arouse so many passions and opinions as the visual design of the user interface. Everyone has an opinion on what a good user UI looks, but few can design it. Kalimo (1995) presents William Horton's excellent advice to resolve this issue: "Don't argue, argue, argue. Test, test, test."

2.5.2 Layout

Whenever hear talking about designing a mobile application, hear about the limiting factors of the small screen. Shneiderman et al. (2018) Despite the challenges of the small screen, it is possible to design usable and enjoyable mobile application UI. The key to success is consistently designed layout, randomness causes confusion in the user. Designer need to create a base that all pages follow, and it helps that information in the application is fast located and efficiently organized. In order for consistency to be realized, it is needed to create a "grid" (seen in Figure 4) where is defined such things as spacing and alignment, and locations for different objects. To facilitate this, ready-made design templates have been created, they are called "patterns". These patterns are created

by the designers, based on earlier proven solutions that make it easier to start building a successful layout applying these models. (Hoober & Berkman, 2011)
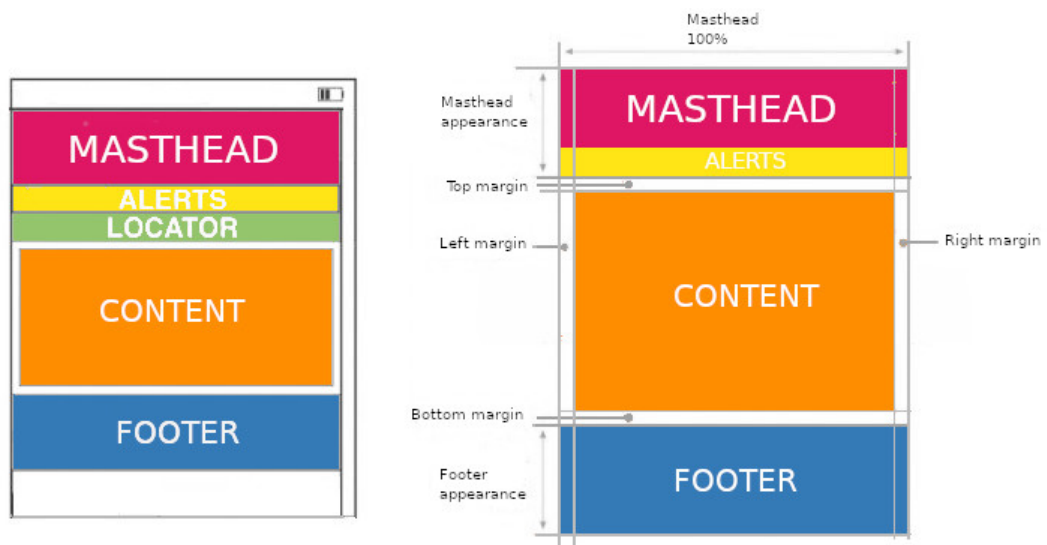

Figure 4. "A grid" for consistent layout design. (Adapted from Hoober & Berkman, 2011)

There are many design patterns available for mobile applications and one of the most well-known is **Springboard**. Springboard shows for the user up to nine options to choose and by selecting the option user will navigate in the application further. Returning naturally happens using the back button. Springboard allows, for example, create 3 x 3 or 2 x 3 options grid as seen in Figure 5. (Neil, 2014)
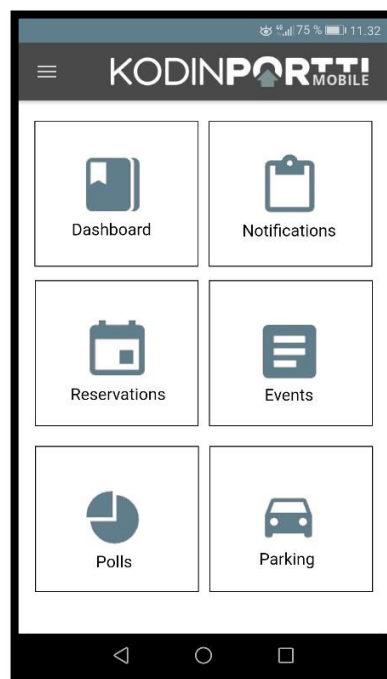

Figure 5. Springboard with 2x3 options grid.

The **List Menu** behaves in the same way as the Springboard, pressing the wanted option user will proceed in the application screen by screen always making on option per screen until reaching the wanted destination as Figure 6 demonstrates the progress logic in this pattern. List Menu is a bit clumsy in the sense that if the user wants to change direction

the user will always have to go back so far until the right choice is available again. No shortcuts are available in this also hierarchical called navigation model. (Neil, 2014)
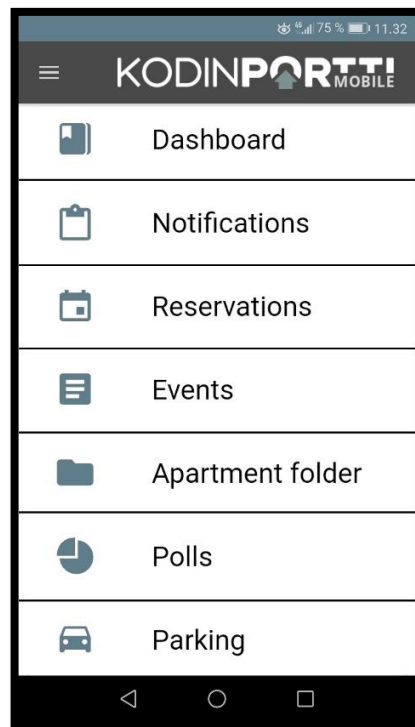

Figure 6. List Menu.

The **Gallery pattern** is a grid as Springboard, but instead of text or icons user gets the message form highly visual contents. Gallery menu works well when wanted to emphasize the message more visually than with text, such as food recipes or news stories as Figure 7 below shows good example. Gallery pattern works when no hierarchy is needed in the menu. (Neil, 2014)
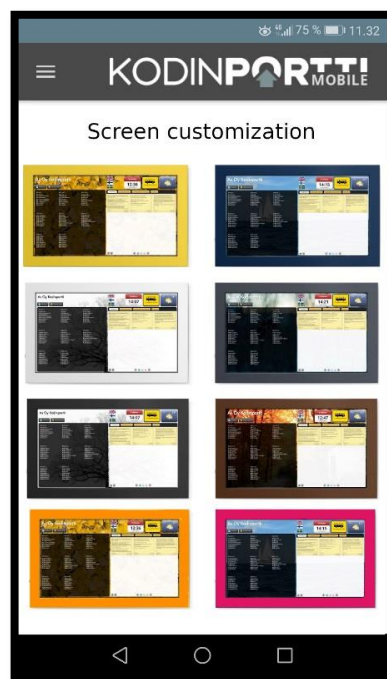

Figure 7. Gallery pattern example of visual navigation menu.

Side Drawer belongs to transient menus category. Transient Menu means a menu which is visible only a limited time; when user wants something from there it pops up and after found what looking for vanishes away. There are two sorts of Side Drawers; overlay and inlay. On the overlay version the drawer covers the screen partially, while in inlay version the side drawer is pushing the main screen aside of its way as it is in Figure 8 seen. Both drawers can be displayed by tabbing or swiping and usually the drawer is on left side of the screen. There are also multilevel side drawers in use where the user navigates level one by one, with the same principle as in Springboard menu. (Neil, 2014)
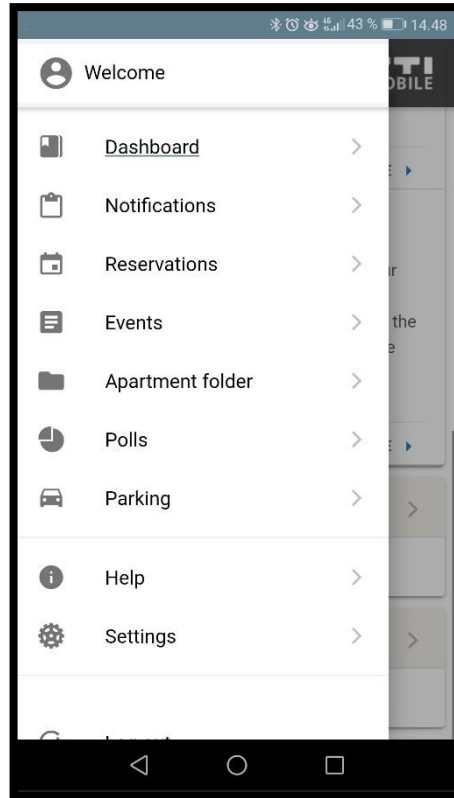

Figure 8. Example of side drawer menu.

Tab Menu is good when there is equal information structure in the application. It is making possible to show all main categories in main screen. The complications may be caused by the fact that there is no more space than for categories in one screen, or if there are more categories to be added they must be added under the fifth selection. In IOS Tab Bar menu can be mixed with Tool Bar menu which may be confusing for the users. In Android Tab Menu options are more available. Fixed Menu, Spinners and Navigation Drawers. In Fixed Menu the same menu is displayed to the user all the time as it is in Spinners and Navigation Drawers, so it is easy for the user to navigate through the various items. Spinners and Navigation Drawers user can scroll the menu which allows to import multiple items into a menu while Fixed Menus can hold only a few. (Neil, 2014)

2.5.3 Navigation

When it comes to navigating in the user interface, essential is that the user knows where he is, and that user finds what came looking for. Navigation is the key when creating a functional interactive application. With good navigation it is easy for the user to identify the essentials and avoid unnecessary choices in the user interface and thus easily and quickly reach the desired or accomplished task. The designer's job is to provide the user fluent navigation which will help user to find goals and the possibilities to choose alternative routes and, if necessary, route retreat easily. In the user interface, it is important to arrange the menus relevantly to make the selection quick and therefore a good user experience. Relevantly means in this context that information is available, for example, by alphabet, location, time, or category. Especially on a mobile device with a small screen, it is important that the most relevant information is first displayed, since not all information is usually displayed at once (Lankoski & Kirvesmäki, 2002; Shneiderman et al., 2018). De Parros et al. (2014) point out in that it is easier for the user if "all of the application's main categories on the start screen so that users are able to more easily understand hierarchies and system structure." Also, de Parros et al. (2014) found out in their study that start screen can be used as safe point where user can return and "a sort of table of contents". According to Shneiderman et al., (2018) "navigation may follow a linear sequence, a hierarchical structure that is and comprehensible, or a network structure when choices may be reachable by more than one path." de Barros et al. (2014) discovered in their study that mobile design in application's navigation should consider for instance, that panorama and pivot controls caused difficulties for older people "to develop a mental model of the organization and hierarchy of these components."

Using visual elements in navigation allows the designer to guide the user's view along the screen surface. The most important thing is that the user's gaze is first directed to the right place from which it is directed to forward, so that the user can see things in the right order. For example, different lines can be used to guide the user, but the correct order of presentation is important because then the information acts as a gaze director.(Sinkkonen et al., 2002) Sinkkonen et al. (2006) state that user's gaze is the first to the left of the screen, and then comes to the left to the point where you expect the first thing to be found. Also notable is that, usually in the user interface, the gaze falls under the heading, not the title. if the elements in question have some sort of order it should be followed, but if not, the gaze should come first to the most important and then the second most important, etc. The designer should make sure that the look of the gaze is clear and unambiguous. (Sinkkonen et al., 2002)

2.5.4 Visuality

The purpose of visualization is to define the exact appearance of the user interface, the terms used, the icons and other details. Visualization also provides a prototype that makes it easy to view the planned interface. The most important aspect of visual design is clear and unambiguous design, which allows the user to perceive the whole and respond to the user's perception of reality and facilitate the visibility of important signals (Kalimo, 1995; Sinkkonen, 2006). As a practical example particularly in mobile designing it is important that there is left space enough between different actionable items that unintended presses can be avoided (de Parros et al. 2014).

Colors

In mobile applications, the appearance of the interface is determined by the existing aesthetics and research findings in the field of user interface design. The user interface should be both beautiful and functional, easy to learn and flexible. The color world and the general style are the things one first sees when it looks at the user interface. Graphic user interfaces generally use very discreet colors and colors have very strong emotional, social and cultural meanings. It is advisable to carefully consider the color scheme and be aware of the differences between different cultures in which certain colors in different cultures are combined. For example, in Japan, blue is strongly combined with negative and bad things, while in Western countries it is combined with masculinity. Color can also affect, for example, the efficiency, speed and accuracy of work. If you are not sure about the cultural significance of a color when designing, it is advisable to break the color, so it is likely to lose its meaning when the color is no longer clean. Broken colors should also be used because they are the easiest to detect and other elements of the interface such as text are better distinguished by the background color that has been broken (Lankoski&Kirvesmäki, 2002; Sinkkonen, 2006)

According to Lankoski and Kirvesmäki (2002) the challenge of color design is that color is affected by its place, size and shape. For instance, a white square on a black background looks larger than a black square on a white background. When deciding on the application's color scheme, should be also consider the saturation of the color. This means how bright the color is and whether it is mixed with other colors. Some very clean and bright colors may cause the effect called chromostereopsis, where the other color on the screen seems closer than the other. Such an effect can also be utilized if wanted to create a depth effect. Colors should be used sparingly because the more colors on the screen are the more confusing the user interface is. Colors are used to merge a thing, as for example titles are often made in the same color. in the user interface, the most secure is to use combinations of the same colors, resulting in a harmonious result. Colors should also be used by the user in accordance with the values, such as red color as a warning or to alert the user. It should also be noted that if a color is created within a user interface, some meaning of the same color should no longer be used in the other sense as it mixes the user. The user interface should favor colors that have a clear mutual contrast. If the user has the opportunity to customize the color scheme of the application, it should be designed so that it is not possible to choose bad combinations because it reduces usability. (Lankoski&Kirvesmäki, 2002; Sinkkonen 2006)

Hoober & Berkman (2011) mention about colors that when they are obviously not natural, they want to point something to the user. With yellow color is usually referred to show some interactive feature. Blue is used to highlight graphical contents such as images and other visualized elements while gray is usually indicated to items that cannot be selected. The orange color is often used when you want to emphasize, for example, a button that seals a process, such as an e-commerce order. (Hoober & Berkman, 2011)

Typography and Icons

Typography is the visual processing of a written language intended to enrich visual communication and it aims stylish and clear layout. The best result is achieved in user interfaces when only a few fonts are used. Choosing a font is very important, because, for example, all fonts are not suitable for a relatively small display of a mobile user interface as well as others. On a small screen, it is advisable to avoid or use very sparingly text effects because they produce a much larger effect than a big screen. Effects such as italics

and bold make their own kind of impact on the text and the colors also affect the message transmitted to the user. When highlighting it is advisable to use bold or some color, because italics and underlining are making the text unclear. Meanings can be added to the text by manipulating typographic forms. The written language is very visual, for example, considering the emotion icons (i.e. emoticon) popularity in the text. Other types of visual content than images can be created in the text. (Lankoski&Kirvesmäki, 2002; Sinkkonen 2006)

Icon means an image that guides the user to its purpose. Its purpose in the user interface is to present some part, function or element of it as comprehensibly as possible. It is not advisable to aim for realism in the design of the icons, but for their identification. Today, the designer faces great challenges when designing icons because the functions can be so complex and abstract today. Nowadays, the icon must also work on a variety of devices, environments, and resolutions.(Lankoski&Kirvesmäki, 2002) In mobile application design de Parros et al. (2014) guide designers that "use of icons next to textual labels in order to improve the affordance of elements".

3.   Kodinportti

This chapter presents the developed object Kodinportti Mobile as well as Kodinportti product, including a touch screen and its remote interface.

3.1 Electronic bulletin board

Kodinportti is a product for residential and commercial properties. It contains a digital user interface where the apartment list, the bulletin board and the common space scheduling lists are replaced by one touch screen (seen in Figure 9). It contains also a remote interface called Kodinportaali that can be used with a personal computer or a mobile device and a mobile application. Kodinportti offers many benefits for residents, administrators, and housing associations. It saves time and money, provides better and faster information, and is a modern solution for housing associations. Kodinportti facilitates the flow of information, improves the comfort of living and increases the value of the property. (Kodinportti, n.d.b)

Figure 9. Kodinportti touch screen. (Kodinportti, n.d.c)

3.2 Touch screen and Kodinportaali

The touch-operated screen serves the residents daily with diverse functions, gathers up-to-date information for the residents and performs the functions of bulletin boards, resident lists and booking booklets. Kodinportti collects all the important information of a house community in one place. Residential lists, housing company, property maintenance and residents' announcements, as well as various reservations are easy to read. The Touch screen may also include, for example, weather information, timetables for public transport and reservation of parking spaces. For housing association residents,

it is easy to sign in Kodinportti using the touch screen and for example, book time for the sauna, or other common spaces, or reading the messages left by the landlord or property maintenance bulletin board. Kodinportti can always be identified from the color of the case up to the graphic displayed in the user interface (seen in Figure 10) and there are also several sizes available. Kodinportti touch screens are also called staircase displays or stair displays. (Kodinportti, n.d.d)
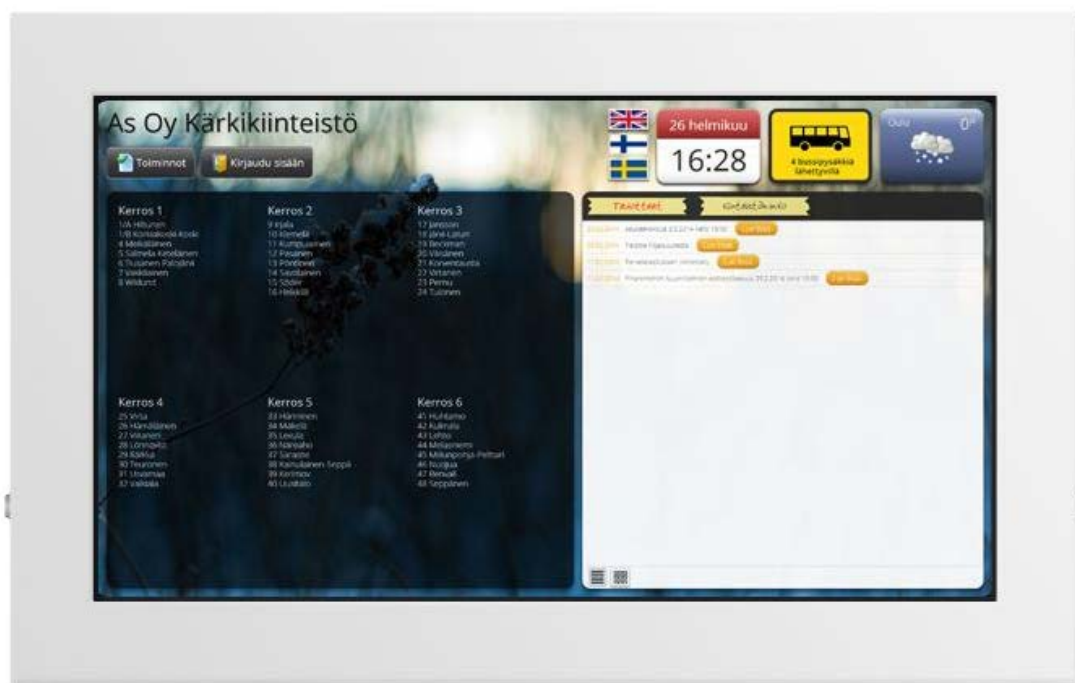

Figure 10. Kodinportti touch screen user interface. (Kodinportti, n.d.e)

Kodinportaali can be used with a computer, smartphone or tablet when connected to the Internet. Updating and managing the data in Kodinportti is done by using the Kodinportaali. For example, administrators, such as, the property manager or housing board can use it to update information and manage housing company issues, while residents can use it to take care of bookings and read announcements. (Kodinportti, n.d.f)

3.3 Kodinportti Mobile

Kodinportti Mobile is an application for resident users. It is available for Android, IOS and Windows platforms. Application (Figure 11.) allows users to get information on housing association issues with their mobile devices and make reservations and bookings, for example for the sauna and the gym. With the app resident users are able to check the bulletin board with Kodinportti Mobile and read important notices, news and other important information. With the application residents are able to get automatically informed about new and important information on the bulletin board directly to their mobile device. (Kodinportti, n.d.a)
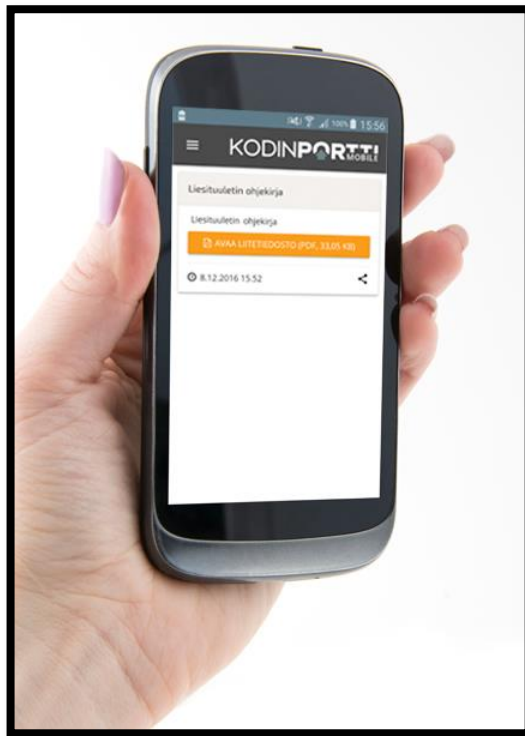
Figure 11. Kodinportti Mobile application user interface. (Kodinportti, n.d.a)

Booking calendar enables users to make reservations for common areas of the building or home community. These can include for example, swimming pool, sauna, laundry facilities, gym, conference room, etc. The apartment folder is the residents own file folder, which can be used in the same way as the apartment binder often found in apartments, but now in digital form. Different documents can be uploaded there for residents to read, such as operating instructions for equipment in their apartment and housing association rules. The apartment folder supplements content displayed on the message board, offering larger space and longer display time for documents, which may perhaps not be of a message nature or public. With the Kodinportti Mobile, residents can open and read their documents on their smart devices. Neither the apartment folder nor its contents are visible on Kodinportti screens. (Kodinportti, n.d.a)

In the event calendar feature residents are informed about common events in the housing company and the residents can announce their participation in them. Opinion poll feature can be used to organize inquiries about common issues in the housing company. (Kodinportti, n.d.a)

4.   Research Method

Since the purpose of this study is to develop a concept of user interface, the research method for this study was chosen to be design science research method presented by Hevner & Chatterjee (2010). This research method has been developed for the development of IT systems and it offers for the research a framework and guideline to follow. Therefore, this chapter discusses generally the most important things related to chosen research method and how they will be utilized in this study.

4.1 Design science research

Research method used in this study is a method that is combining design and research. Designing can be defined simple as done by Hevner & Chatterjee (2010) in their book: "Design is the instructions based on knowledge that turns things into value that people use". March and Smith article (1995) defines that information is "data that has been processed into a form that is meaningful to the recipient and is of real or perceived value in current or prospective actions or decisions". Also, the article brings out that "information is valuable insofar as it helps individuals form true beliefs which, in turn, promote effective, goal-achieving action" (March & Smith, 1995). In a very brief and concise manner, the purpose of the research is to produce information about some interesting phenomenon. So, when design and research are combined, a science is created that combines fundamental design knowledge with extreme utility. Therefore, the purpose of DSR is to produce things that are beneficial to people while at the same time bringing new knowledge to the scientific community (Hevner & Chatterjee, 2010). March & Smith (1995) present in their article that "IT research should be concerned both with utility, as a design science, and with theory, as a natural science". Article highlights the fact that IT research should be leaning the interaction between design and natural science where natural science purpose is to explain how and why designed artefact is going to work in the environment where it is used (March & Smith, 1995).

In addition to the above in design it is good remember to theorize and justify the made decisions. As March & Smith state (1995) in their article where they present framework for IT research which brings up the things specific in natural science research, like theorizing and justification. In this context, theorizing means considering the features of the designed artefact within the environment and observing its functionality and interaction in the environment in which it will be used. Data from the observation will be collected and analyzed thus justification is obtained. (March & Smith, 1995)

4.1.1 Design Science Research Guidelines

Hevner & Chatterjee, (2010) present seven-point guideline for DSR. Guidelines are designed to facilitate the implementation and evaluation of the design and research. Guidelines and their explanations are listed in Table 1.

Table 1. Design science research guidelines (Hevner & Chatterjee, 2010)

Guideline	Description
Guideline 1: Design as an artifact	Design-science research must produce a viable artifact in the form of a construct, a model, a method, or an instantiation
Guideline 2: Problem relevance	The objective of design-science research is to develop technology-based solutions to important and relevant business problems
Guideline 3: Design evaluation	The utility, quality, and efficacy of a design artifact must be rigorously demonstrated via well-executed evaluation methods
Guideline 4: Research contributions	Effective design-science research must provide clear and verifiable contributions in the areas of the design artifact, design foundations, and/or design methodologies
Guideline 5: Research rigor	Design-science research relies upon the application of rigorous methods in both the construction and evaluation of the design artifact
Guideline 6: Design as a search process	The search for an effective artifact requires utilizing available means to reach desired ends while satisfying laws in the problem environment
Guideline 7: Communication of research	Design-science research must be presented effectively both to technology-oriented as well as management-oriented audiences

4.1.2 Design Science Research Framework

This research follows the framework Hevner & Chatterjee (2010) present in their book. DSR framework (Figure 12) is described below and it is called general design cycle (GDC). In the model design begins by detecting the problem. As in the study process starts when noticed that the user interface should be developed. After the problem detected, the next step is preliminary suggestion. According to Hevner & Chatterjee (2010), suggestion is prepared from the existing knowledge, as in this project the knowledge for design and research has been sought from existing literature. Next step in DSR is the development phase where the actual artifact is created and in this project the artefact is the concept of Kodinportti Mobile user interface. (Hevner & Chatterjee, 2010).
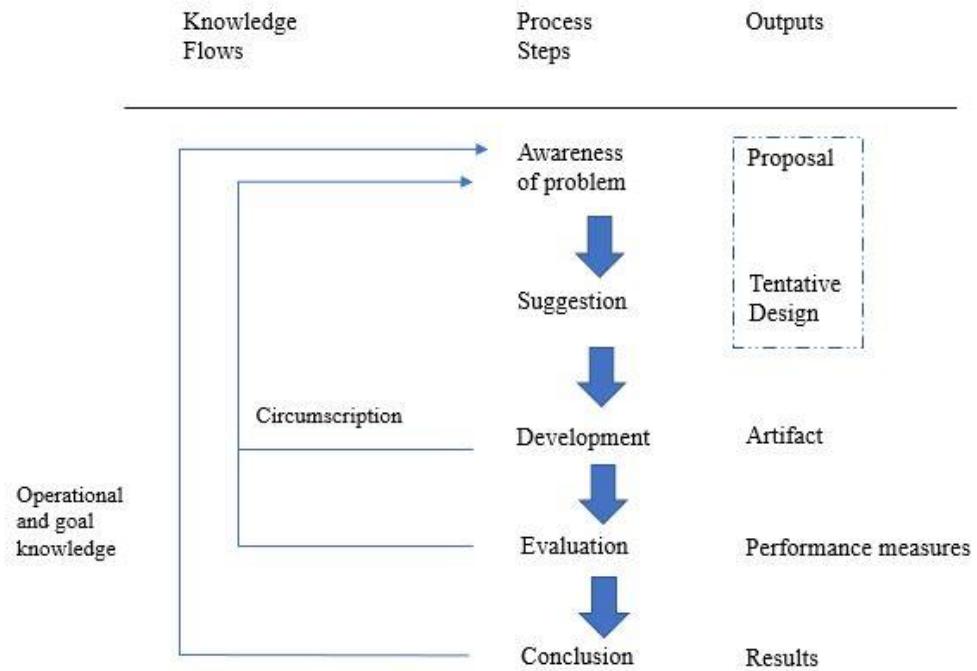
Figure 12. General design cycle designed by Vaishnavi and Kuechler. (Adapted from Hevner & Chatterjee, 2010)

Whenever the artefact is finished, its functionality must be evaluated and tested, and this project does not make an exception, but the manufactured artefacts performance is measured by heuristic evaluation and usability testing. Based on the results, changes are made on it and new artefact is born again. If necessary, the phases are repeated, i.e. iterated until the result is pleasing to all parties (Hevner & Chatterjee, 2010).

5.   Empirical Study

This chapter deals with the empirical part of the study. Kodinportti Mobile's usability testing was done by the students who are participating in the usability testing course of University of Oulu and its Faculty of Information Technology and Electrical Engineering. The idea of conducting the usability tests by the course students gave this research's supervisor Mikko Rajanen who was also running the course with Jouni Lappalanen. The test group consisted of five members, Terhi Kemi, Heikki Mustonen, Jonas Oppenlaender, Nasrin Akter and Nijar Hossain.

5.1 Usability testing goal

Usability testing was traditionally started with a kick-off meeting, where the testing team got to know the Kodinportti Mobile application at the company premises, followed by testing goals, schedules, etc. The team did the testing independently, but the author of the thesis was involved in the test planning. It was agreed in the technology discussion to try to find an answer to the following questions:

- Is the information easily available in the application?
- Are there too many clicks used when doing tasks?
- Is the application consistent?
- Is the visual look of the application pleasurable?
- Are there errors while using the application?

The usability criteria measured in the tests are learnability, efficiency, memorability, errors, satisfaction and user experience. Usability tests will be conducted by giving tasks to test user during the test session and after the test they will be asked to answer a questionnaire. The user will be encouraged to think-aloud while doing the tasks. Data collected from the test sessions will be both quantitative and qualitative data and it will be analyzed afterwards by the usability testing team members. The test results will be used to redesign Kodinportti Mobile application.

5.2 Pre interview

Customers wishes and requirements for the usability test were considered during the visit to Dream IT office in the kick-off meeting. Also, the testing group got to know company's other Kodinportti products as the touch screen and web portal in addition to mobile app. Test group did the pre interview with the author of the thesis within the kick-off meeting. Hence, the group got necessary information as the result of the interview and for them, the project got off to a good start. Following questions were asked during the pre-interview:

1. How to download this application and what type of devices should be used for running this application?

2. What type of user is able to use this application? Is there any age limit for the user?

3. What is the purpose of the app? Why we need that?

4. How this app interacts with your system to users?

5. What will be the registration process for the app?

6. How we get the notifications regarding the apartment issues?

7. How we booked the gym and sauna through the app?

8. If someone losing his key from his apartment what will be the procedure by using app?

After pre interview, the facts and issues regarding the Kodinportti app were analyzed by the group. Also, another meeting was organized with the group which further discussed the application as well went through the coming testing process with planning schedules, test methods etc.

5.3 Test methods

Below are went through all the methods used testing Kodinportti Mobile's usability and user experience.

5.3.1 Heuristic evaluation

In the meeting with the group it was decided that usability test team will conduct a traditional heuristic evaluation according to Jacob Nielsen for the Kodinportti Mobile. The plan was that group will do the evaluation first individually and then as a group. After that they summarize the findings into one report.

5.3.2 Usability test scenario and questionnaires

It was agreed with group that usability testing situation is progressing as follows; first, the user fills out a consent form, then proceeds to run the scenarios, and then answers the survey. Author of the thesis will plan the test scenarios and questionnaire (the basis for the questionnaire can be found from the appendix) for the usability testing. Later the scenarios were reviewed and agreed together with the testing team. Afterwards testing team modified scenarios and questionnaires to Google forms.

After the scenario and questionnaires were edited in the final form, meeting was organized between testing team where team discussed how usability testing based on the scenario and questionnaires is going to happen.

5.3.3 Think-aloud method

In usability testing sessions the goal is that users think-aloud as much as possible and it was discussed with the testing team is that they must be prepared to encourage users think-aloud as much as possible. With think-aloud method it is possible to get better idea of user experience. But at the end it will depend on the user how much think-aloud method will be used in the test situation.

5.3.4 User Experience Questionnaire (UEQ)

Within the questionnaire decided to include the User Experience Questionnaire (UEQ-S) as a part of the test. Short version of questionnaire includes 8 items. The questionnaire measures aspects of usability and user experience (attractiveness, perspicuity, efficiency, dependability, stimulation and novelty). Attractiveness assess the overall image of the product to the user. Whether it was liked or not? Perspicuity measures was the product easy to learn to use and get familiar with? Efficiency assesses whether the user can solve tasks without too much work and does the product react quickly to the user? Reliability assessment of the user's sense of interaction. Is it safe and predictable for the user? Stimulation measures whether using a product is exciting, motivating and fun? With novelty is assessed that is the design creative and interesting for the user? (UEQ, n.d.)

5.4 Choosing and recruiting test participants

Usability research is conducted with a diverse sample of the target demographic (i.e. residents of apartment complexes managed by a housing association). The aim is to recruit a sample of this target demographic. Table 2 summarizes the planned demographics of the sample.

Table 2: Demographics of the planned user sample.

Group	No.	Age	Position	Level of education	Level of experience with mobile applications	Living in housing associations	Further requirements
Teenager	2	8 - 18	Pupil	none	high	yes	
Student	2	19 - 24	Student	A levels	high	yes (PSOAS)	1 test on tablet device
Young adult	2	20 - 29	Employee	Bachelor / Master	high	yes	
Salaried employee	3	30 - 45	Employee	Bachelor / Master	medium	no	1 test on tablet device
Senior citizen	3	65+	Retired	Master or higher	low	2 yes, 1 no	1 test on tablet device
Total	12						

In the kick-off meeting it was agreed that the test participants should be of all ages. Testing group recruited student participants from the campus of the University of Oulu. Rest of the participants as teenagers and senior citizens group recruited using their own social contacts.

Before the usability test participants had to fill the proper consent form and they were instructed to read and sign the consent. For the pilot testing group was prepared to spend

approximately one hour and it was done in the usability lab in Oulu University. Actual usability tests were decided to do as a field tests in order to make it easier to find the test participants, and we considered with the test team that the lab does not offer as much benefit to testing mobile application as it is necessary to perform tests in the lab. In addition, we thought that when a test situation is performed in a so-called natural environment for the test subject, it is easier for the test subject to relax, which can facilitate the test run and improve, for example, thinking aloud during the test. The field testing was expected to last as about 15 minutes.

5.5 Features of the application being tested

This section highlights parts of the mobile application were tested in the usability tests. Goal of the usability test is to get test functionality and get results of user experience of application. Before the test, users need to install Kodinportti application from the App store or Play store to their own mobile devices. The test scenarios which participants went through in the usability test apply to following parts of the Kodinportti Mobile application.

5.5.1 Logging in and out

In logging screen user need to enter the user ID that they are able to use the app (Figure 13). When user has logged in, app's dashboard opens for them (Figure 14).
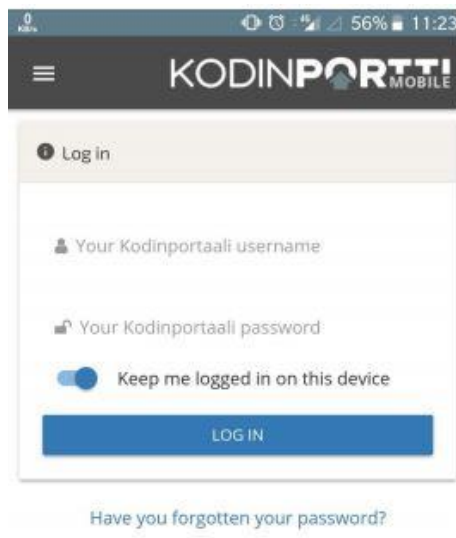
Figure. 13 Logging in view of the app.
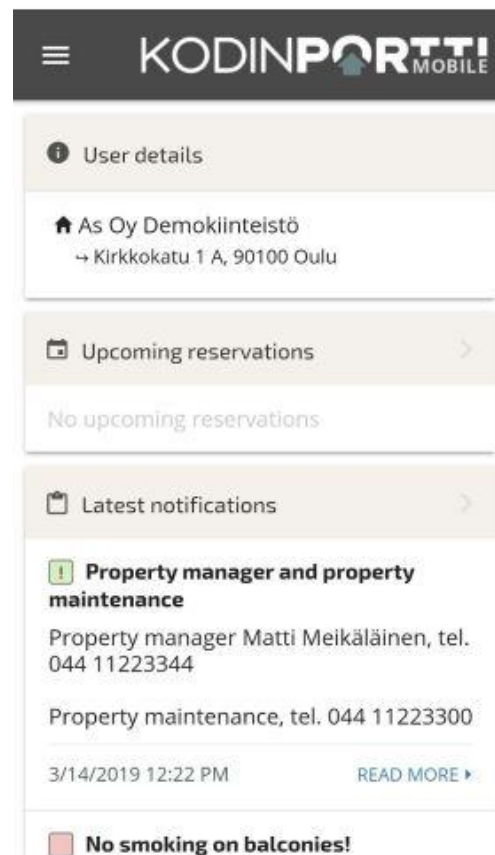
Figure 14. Dashboard view of Kodinportti
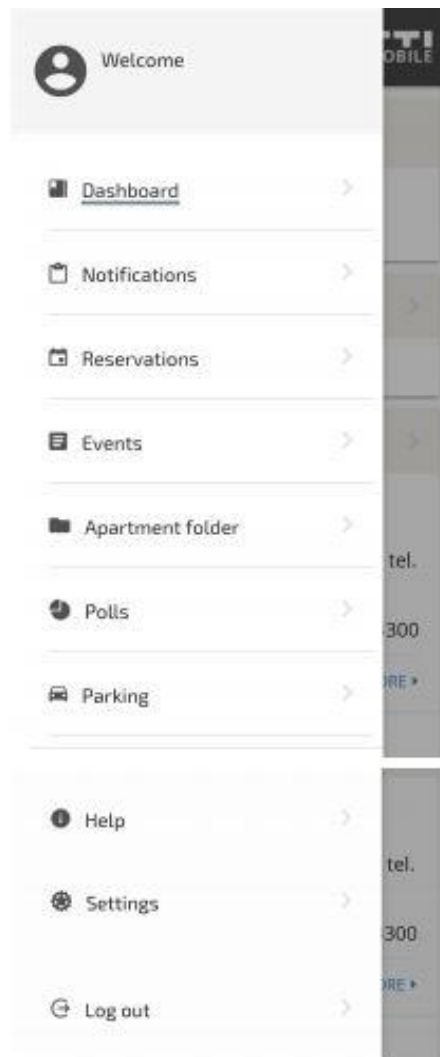
Figure 15. Application's main menu.

Signing out happens from the app's side drawer menu's log out feature, which can be seen in Figure 15 above.

5.5.2 Notifications

The notifications function (Figure 16) allows the user to check the housing company's latest announcements. Under the notifications section are three categories for different types of announcements; notifications, information for residents. The numbers displayed in the alerts indicate to the user the number of alerts under each category. When a user selects a category, all the messages below it will be displayed. Figure 17 presents the announcements from "information for residents" category and when user clicks the "read more" link announcement opens to read in its entirety.
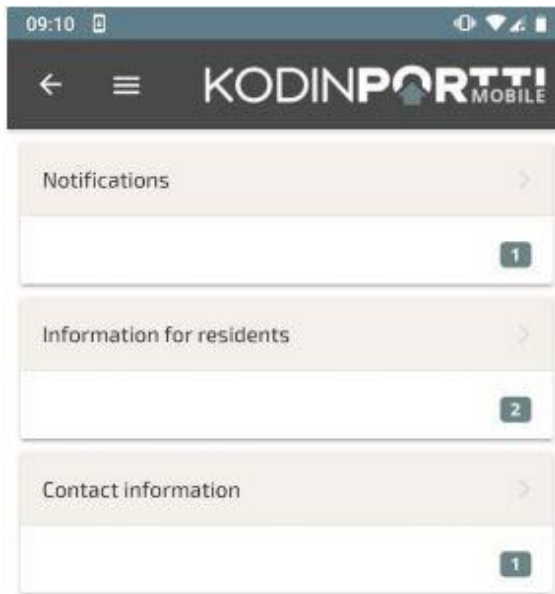
Figure 16. View of all types of notifications.
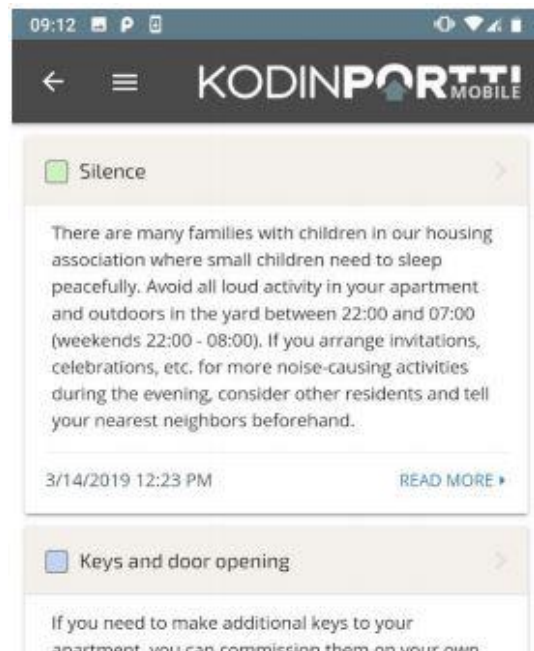
Figure 17. Information for residents' screen
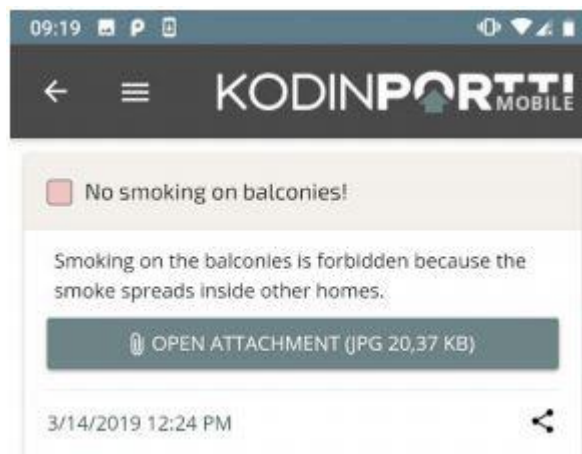
Figure 18. View of opened announcement.

Figure 18 above illustrates the view announcement is opened completely. Administrator can add also attachments in notifications. In a usability test tester will get notification as push message from observer and tester need to open it with the attachment.

5.5.3 Reservations

Housing company's residents are able to book, for instance, sauna shifts from reservations function of the app. In Figure 19 is seen the view where user can select a shift from available options.
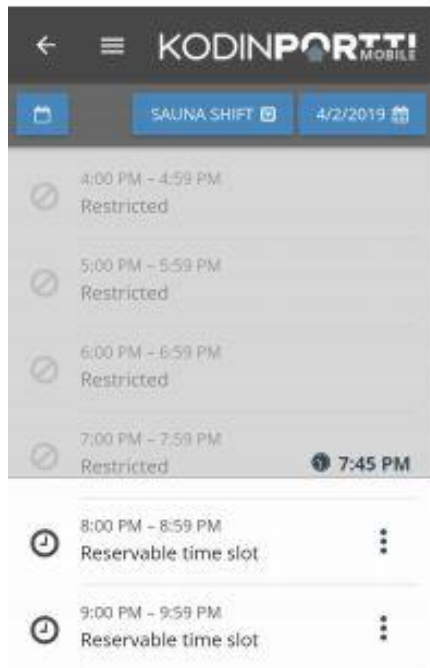
Figure. 19. Available sauna shifts.

Figure 20. A plus icon appears on the right to make a reservation.
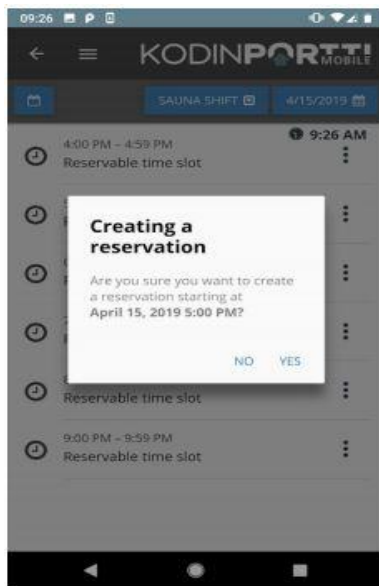
Figure 21. Confirmation view for booking.
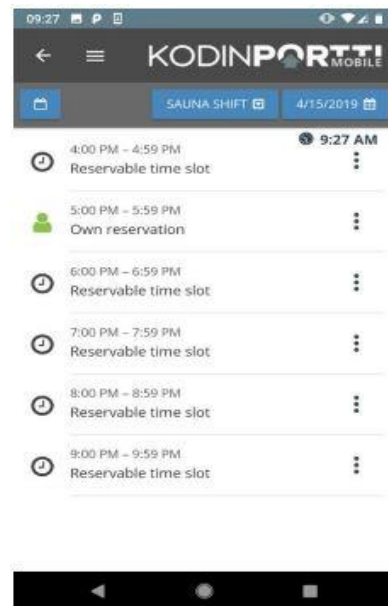
Figure 22. Reservation highlighted in the list.

To make a reservation, user need click the desired time. After that, a plus icon will appear to the right (Figure. 20) and clicking it will then give the user a confirmation dialog about the time of booking. Once the user has made a reservation, it remains highlighted in the reservation list.

5.5.4 Events

The event screen consists of a link to the event calendar (see Figure 23). Events are displayed as card items in this calendar (see Figure 24). Residents can sign up to an event by clicking the "read more" link. The signup to an event is confirmed by a colour change of the button and a notification bar at the bottom of the screen (see Figure 25 and 26). With a click on the same button, users can sign out of events

Figure 23. View of event calendar

Figure 24. Added event in calendar.

Figure 25. Not signed in event.

Figure 26. Signed in.

5.5.5 Apartment Folder

The apartment folder consists of a screen with one category: "Apartment folder" (see Figure 27).
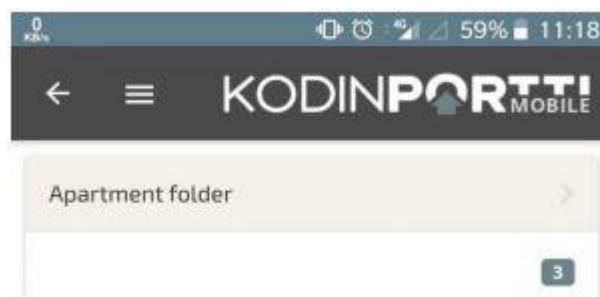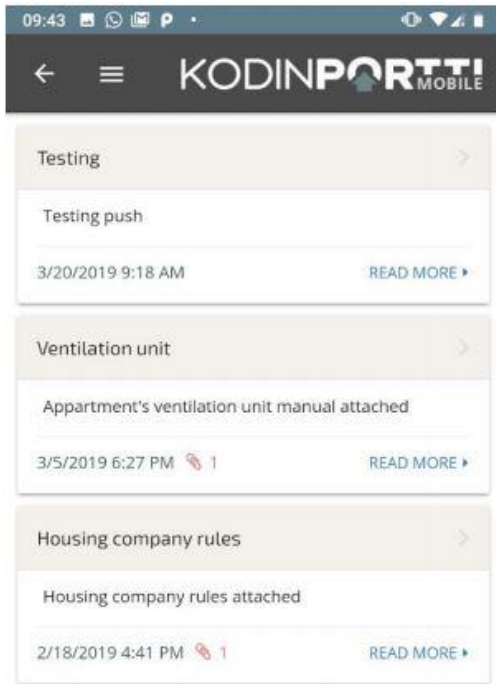

Figure 27. View of Apartment folder.
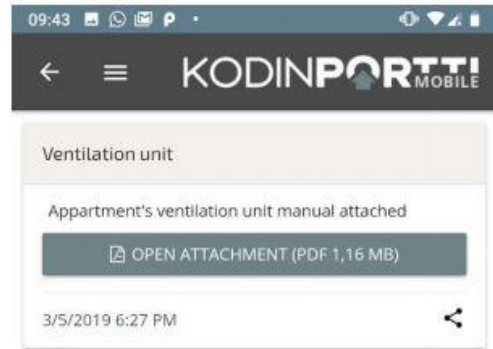
Figure 28. Items in Apartment folder.

Figure 29. Opened announcement.

A click on this category reveals several information items related to apartments as it is demonstrated in Figure 28. Each item can be viewed. Items can also have document attachments (see Figure 29).

5.5.6 Polls

The housing administration can publish polls to collect information and opinions from residents. The available polls are listed on the polls screen (Figure 30). An individual poll can be opened with a click on the "read more" link.
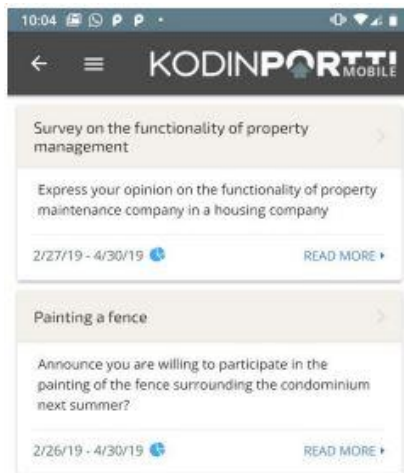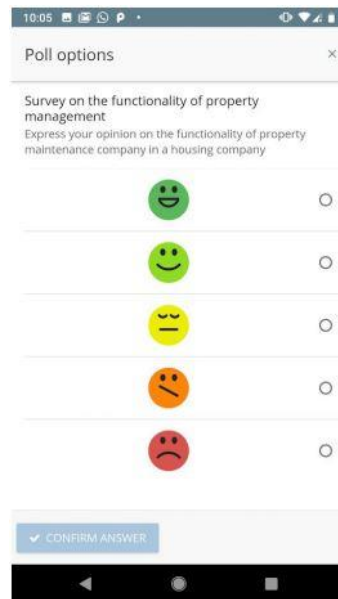

Figure 30. Poll feature view.

Figure 31. Poll emoticons.

Polls can be answered by clicking the answer poll button. Polls have multiple choices and can contain icons (see Figure 32)

5.5.7 Settings

In the settings screen (see Figure 32), users can set a number of settings, for instance changing the language of the application. Push notifications can be switched of either completely or for individual types of notifications (Figure 33).
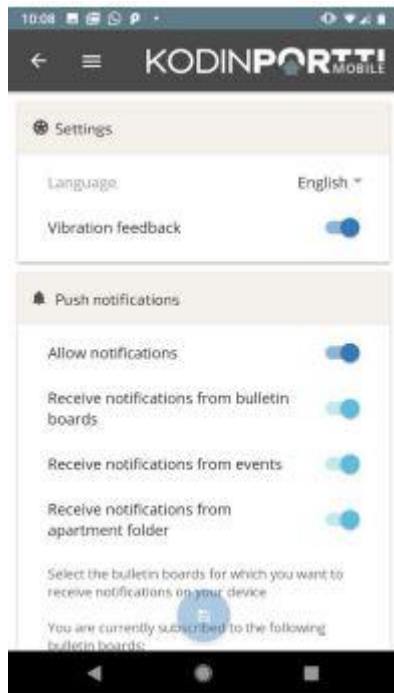
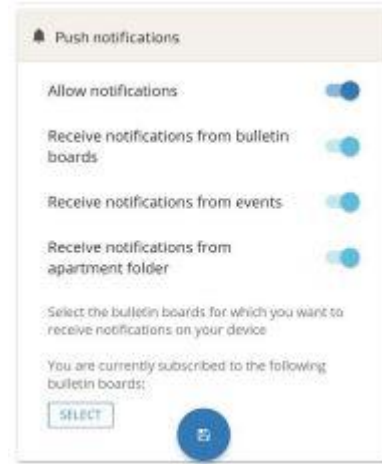

Figure 32. Settings main view.

Figure 33. Push notification settings.

Figure 34. Bulletin boards subscribe.

Furthermore, residents can subscribe to "bulletin boards" by clicking on a select button which opens another screen that allows users to switch notifications on or off (Figure 34).

5.6 Definitions of test tasks and circumstances

This section covers the usability test scenarios and locations where the tests were performed.

5.6.1 Test scenarios

The usability test is performed using a scenario that is given to the tester in written format. The scenario aims to create a realistic model for the user and also to take into account the functions of the application as widely as possible. Tasks are designed to collect data about specific use case of the application and for each task, there is 2 minutes time for tester to get the task done.

1. *"Sign in Kodinportti"*. Tester will be provided login and password with the task

2. *"Take some time to go through the application"*. Tester has first an opportunity to browse through the application and get an overall picture of it.

3. *"Some of the residents of the condominium have been dissatisfied with the operation of the property management about the cleanliness of the yard, and the property manager has organized a survey on the functionality of property management at Kodinportti. So, you want to have your opinion expressed in a questionnaire"*. Tester should be able to find the questionnaire and participate in it".

4. *"From the yard cleanliness comes up to your mind housing association's work yard party organized every spring, so you decide to check when it takes place and sign up"*. Tester should be able to sign into the work yard party.

5. *"You want to make an extra key to your apartment, so you check out if there are any instructions for that on the application"*. Tester should search and find the instructions for getting the spare key.

6. *"You remember that your friend is coming to spend the weekend with you and decide to book a sauna shift for the upcoming weekend"*. Tester should manage to book the sauna shift".

7. *"Ventilation unit in your apartment has not worked properly lately and you want to check if there is a manual for it in the application"*. Tester should be able to find the manual for the ventilation unit.

8. *"You have received a push notification. After reading it you want to make sure that the app will no longer send you push notifications of messages* coming into app's apartment folder and you go and put them off". Tester should turn off only the push notifications from the apartments folder and not from anywhere else. Tester should also press 'save' after making altering the push notification settings.

9. *"Sign out"*. Tester should be able to sing out from the app.

5.6.2 Usability Laboratory

Usability Laboratory is a room for running and observing user' experiments in a controlled laboratory environment. Oulu University usability lab consist of two

workspaces, separated by a dividing wall. The test participant sits on one side of this wall, while the observer sits on the other. With this two-part setup, researchers can without disturbing observe the testing participants. The test participant side is equipped with two web cameras. The lab includes screen recording and audio software.

5.6.3 Field Environment

When designing the tests, it was decided that tests were not necessary organize usability tests in usability lab. In our point of view tests could be done also elsewhere that in usability lab, for example, in test organizers home or in testers homes etc., because in our opinion, when testing this particular mobile application, the lab recording is not that crucial, the testers feedback and observers observations are most important. Also, home or another other familiar environment to the user was thought to be good test environment because it might provide more naturally valid test results. So, it was decided that the testing would take place at the following locations; homes, offices cafes or in Tellus Innovation Arena at Uni Oulu. Also, it was decided that the tests should be conducted on the user's own mobile device, to make the application use in the test situation as natural as possible in the test. This also allows the test to be performed on as many different devices and operating systems as possible. The testing is going to be conducted by only one researcher. The number is low on purpose to improve the natural validity of the test.

It was decided that the test layout is informal, and participants are tested individually. For the test it does not matter if there are other people around, because the application use in reality might happen in some public place. The test participants are instructed to think-aloud as much as possible during the test and observer is will write them down. Unstructured interview is going to be held immediately after the usability test. Only premise for the test, is the Wi-Fi or LTE connection on the participant's mobile device.

In the test situation the participant is welcomed and briefed for the test. The consent is given on the printed form and questions answered. After that the test can begin and observer will also take time in addition to observing. In the test participants have two minutes time to complete task, but they do not know about the time limit. If the task is not completed within the time limit, the participant is instructed to move in the next task. Otherwise the observer will not communicate during the test or help the participant. Right after the usability test, test participant completes online questionnaire. After the questionnaire is completed, the unstructured interview is held. The interview is concentrating the answers of the usability questionnaire and the observations of the usability test. Also, the first impressions and feelings of the application are taken into account in the interview.

5.7 Pilot test

Pilot test was done in the usability lab at University of Oulu. There was one participant, a bit over 40 years old female who was not familiar with the Kodinportti application, but otherwise was an experienced user of different mobile apps.

5.7.1 Pilot test setup

Set up was done in a way, that during the pilot test observers could not see the facial expressions of the tester. Participants actions done with the phone where recorded with a

software. There was also another camera targeted to the hands and the phone used by the tester. Test moderator was sitting next to test participant and observing happened behind folding screen.

5.7.2 Description of the pilot test

The pilot test took place at Oulu university's usability test lab. It was decided with the crew that the pilot test is done as planned, but the test team would focus in pilot test is to test and learn how testing is going to succeed in natural environment, for example, in homes. The tests contained all the planned tasks and the testers actions were recorded on with video and audio. Before the pilot test session participant filled the consent (see appendix), which did not raise any questions. Then participant was led to the testing scene and was told the basics of the test. Again, no questions asked, and the participant got the first task. Participant had some problems to log in, because she felt that the login-button looked that it is in a state that it could be pressed without filling the username and password. She needed to be reminded that to log in the app username and password should be filled. After the initial problem's tester went through the test without any problems in silence. Test session was taking shorter time than it was expected. After the usability test, participant filled a google form, which was about the application user experience.

5.7.3 Pilot Test recording

This combined to the fact that setting up video recording gear at testers home etc. would bring extra steps to the tests in overall, the team decided to leave the videos off from the tests. Only interviews and observers' notes were important for this situation. Analyzing video recording from tests in the test would not bring any big surprises to the test data.

5.7.4 Learnings from the pilot test

The participant was experienced using the mobile apps, so the speed of concluding the tasks was faster than first thought. In the test, it came clear that talking during the test situation would distract the user. So, it was considered that it may work better if the tester fills the Google form after the test with test team member in interviewing style. That could cause more probing questions than the way that participant fills the form alone. According to test report other learnings were that "observer should engage conversation if an opportunity should rise during the test". Also, testing group state in report "that setting up video recording gear at testers home etc. would bring extra steps to the tests in overall, the team decided to leave the videos off from the tests. Only interviews and observers' notes were important for this situation. Analyzing video recording from tests in the test would not bring any big surprises to the test data". They found that test tasks should be in bigger font in the papers, because naturally it would be easier read for participant and the observer.

5.8 Description of the test sessions

Kodinportti Mobile applications usability tests were conducted as a field test. Tests were managed by each usability testing team member individually, where team member worked as an observer and moderator. After the test tasks were done, the moderator/observer of asked Google Form questions and filled answers into it.

Usability test sessions were held in test group members homes, participants homes or in Tellus area in University of Oulu. The tests were done with tablets and mobile devices. Following devices were used in tests: Google Pixel 1, Samsung Galaxy Tab A 10.1, Honor 7, Huawei Lite Mini, Sony Xperia tablet, Oneplus 3T, Samsung S9, Honor 8x, Huawei GT and Samsung Note 8. The tests did not reveal any error in using Kodinportti app that would have caused from device. Testers were mainly between age of 25 to 30 years old, but there was also one 18 years old and two 70+ persons participating.

Participants experience using mobile applications varied greatly but at least all had earlier experience of web applications. Also, there was a big difference between participants how they used talk-aloud method. The length of the test sessions varied slightly depending on how much the participant used the method. Overall usability tests produced a lot of valuable information of the Kodinportti app when participants were thinking aloud and proposed good ideas for the further development of the app.

In test sessions it was noticeable how participants were learning to use the app during the test, because they could pass tasks using the knowledge from the earlier tasks. The difficulties encountered in the tests will be discussed later in the study. Many participants got relaxed when filling the questionnaire after the test and latest in that point gave valuable feedback which is used in later analyses. The following paragraph is describing the test setups of testers 1-3 as an example.

First test participants numbered 1-3, were 72- and 18-years old males and 39 years old female. All of them have experience of mobile apps before. Devices used in tests were Honor 7, Huawei Lite Mini, Sony Xperia (tablet). The first test was done in test participants home and other two in of group member's home. The benefit of the tests was that one test person didn't talk much during the test session but other two used well think-aloud method.

6. Test results

This chapter reviews the results of usability research from both heuristic evaluation and usability tests. At the end of the chapter, the results of user experience questionnaire (UEQ-S) are also presented.

6.1 Collected materials

The data from Kodinportti app is collected with a custom Likert-scale questions in an online questionnaire on Google Forms. Questionnaire also included eight questions from the User Experience Questionnaire (UEQ-S). The data was collected from total 15 test participants. Below is seen the data that was collected:

- basic demographic data (age, gender, and whether the person is living in an apartment building)
- Likert-scale ratings of the eight different tasks (Sign In, Property management feedback, Sign in to yard work party, finding the key and lock company information, booking the sauna, finding the ventilation unit manual, setting push notifications to off, and signing out), on a scale from 1 (very easy) to 5 (very difficult).
- The user's agreement, on a Likert scale from 1 (strongly agree) to 5 (strongly disagree), to six statements:

  - App is easy to use
  - The information in the app is easy to find
  - In my opinion, the application has the necessary functions related to the housing
  - association
  - The app's appearance is pleasant
  - The text content of the application is easy to understand
  - I'd love to use the app again

For each of the above Likert scale ratings, the user could leave free-form comments.

The UEQ-S included a rating of eight pairs on a scale from 1 to 7:

- Obstructive (1) vs. Supportive (7)
- Complicated (1) vs. Easy (7)
- Inefficient (1) vs. Efficient (7)
- Confusing (1) vs. Clear (7)
- Boring (1) vs. Exciting (7)
- Not interesting (1) vs. Interesting (7)
- Conventional (1) vs. Inventive (7)
- Usual (1) vs. Leading edge (7)

Each team member was responsible for managing three test sessions and independently administered and managed the test session. The team members individually noted down observations in spreadsheets which are the main source for the discovered usability issues seen later in this chapter. The team members individually analyzed their observations and

added the usability issues to the list. Later observations were collaboratively analyzed in a group meeting to ensure that there were not any issues missed.

6.2 Heuristic evaluation results

According to testing group heuristic evaluation method revealed several flaws in application design. As a result test group described following findings: About the apps **visibility of system status** group reported that the menu's "Apartment folder" could be instead named "Apartment section" and in main menu underlining displays the position for the user, but elsewhere could be shown more clearer where user is. About how Kodinportti **matches with the real world**, group states that its language is appropriate, and the topics are clear, but user should be able to change language at the first login screen. Navigating through options is difficult with the strange language. In the apps help section group found an object of development. When a user needs help, it should be possible to get help directly through the application rather than having to seek help through the internet site.

Apps **user control and freedom** group figured that there is emergency exit is present back icon is at the top of all sub-pages. App's side menu can be swiped open on all pages, but there is not undo functionality in the app. About the aps **consistency and standards** group found there is room for improvement at least on reservation section where group found that calendar button on top right of reservation page shows the same info as the list on the page and they suggest to remove this button and allow navigation in the calendar on the page itself. Also, they found that in the reservation system is a button that seems to work inappropriate when trying to pick a day for reservation. From the app's "settings" group found "select" button which purpose is confusing the user. About apps **error prevention** stated that opening pdf attached to app was a little confusing, because attached file opened in internet browser and kind of booted out of from the app. Group mention also that user should get the specific error message from the error in log in. The message from the app is "401- invalid username or password" if the user does not give any username and password. The reason for the error should be specific.

In **recognition rather than recall** point of the evaluation the group had stated that three-dot   icon   on   reservation   page   hides   the   action   and the icon also only offers one action and therefore is not appropriate. Another note was that side drawer menu is good, but arrow doesn't make any sense while doing the other actions. This seems little bit confused when doing another action through side drawer menu. From the app's **flexibility and efficiency of use** group had following findings. There are too many clicks when making reservations; First need to click three-dot icon and then plus icon. It should only require one click. Some of the app's settings can be modified by the user, but not much to customize. User cannot not swipe back from sauna or gym when making reservations.

In **Aesthetic and minimalist design** phase of the evaluation group reported that reservation dialog sis showing the reservation start date and time, but not the end time. The colors in the app are calm, maybe yellow box on add, could be changed not to look like checkbox. In **help users recognize, diagnose, and recover from errors** phase group reported only one finding about the app's login that login button should not active without login data. About the app's **help and documentation** test group mentioned that there is not any documentation and there could be more guidance about application' use, now there is only contact info for to get help. Heuristic evaluation also revealed from the app's sauna booking feature a failure where the user starts adding a reservation but clicks the

cancel before saving and then starts to re-select the other day and makes a reservation. The app informs the user that reservations cannot be made anymore; the reservation limit has been exceeded even though only one reservation has been made for the week. However, if the user waits for a while, it is possible to add a new reservation, but not immediately after the first booking.

6.3 Usability test results

In the following Table 3 can be seen the results of the usability test task success. The tasks were limited to 120 seconds and if the task took longer than 120 seconds it was marked as a failure.

Table 3. Usability test task success rates and taken time.

Task	Task Success Rate (%)	Average time taken (seconds)	Fastest time taken (seconds)
1. Sign In	100%	40,92s	10s
2. Property management feedback	100%	36,31s	20s
3. Sign in to yard work party	92,31%	40,54s	22s
4. Finding the key and lock company information	61,54%	93,38s	23s
5. Booking sauna shift	92,31%	58,54s	24s
6. Finding ventilation unit manual	84,62%	68s	18s
7. Setting Push-notification off	69,23%	64,23s	32s
8. Sign out	100%	10,08s	6s

Table 3 above provides an overview of the test sessions. Some test participants finished the tasks very quickly. Finding information about the key and lock company took the longest time and some participants (15.4%) failed to complete the task. Table 3 does not sort out if the task was completed correctly. If the task was failed, the whole 120 second were used when calculating average times.

6.3.1 Findings from the test tasks and questionnaire about user experience

Here is a summary of answers to Google Form questions. First it was asked about the how users experience the given test tasks and after how they experienced about the use of the application in general and its different features. Questionnaires were filled either by interviewing test users after the test session or letting tester fill the questionnaire by themselves after the test. We got 15 answers to questionnaire. 80 % of testers where

male and 20 % were female. Age of testers varied from 18 to 72 years. 80 % of test users are living in apartment building.

Sign in

More than 80% of the test participants (as seen in Figure 35) thought that sign into app was easy task, but there were users who couldn't sign in without help of the moderator. Many users pushed the login button before adding user id and password and that was caused because the login button was looking active before the user id and password were set. Also, user id and password fields seemed to be inactive because they were having light gray color.
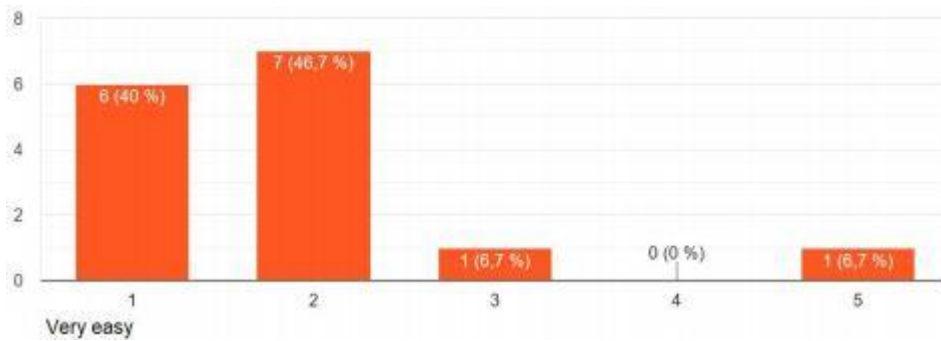
Figure 35. Opinions about sign in.

Property management feedback

Property management feedback was found to be easy to task, only one found it difficult (Figure 36). Users proposed that open text field would be good for this feature, so that it would be possible to give more feedback than just push emoji. Also, some thought that it would be nice to see other users' feedback as well. Some participants thought that there should be opportunity to change your voting afterwards.
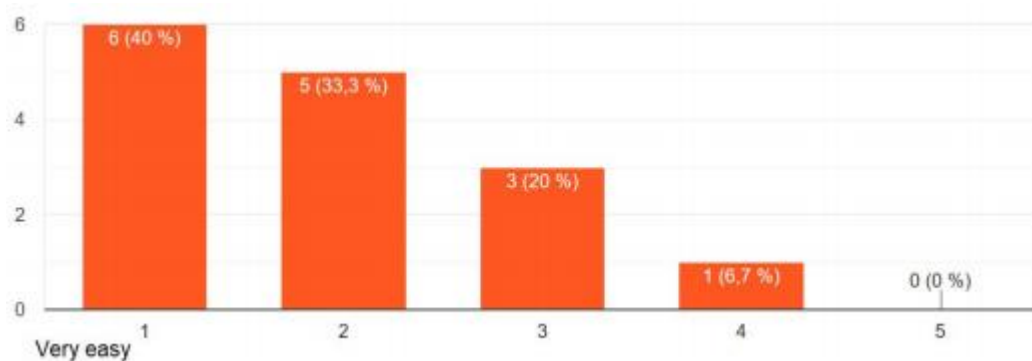
Figure 36. Property management feedback.

Sign in yard work party

Many participants (over 80% as seen in Figure 37) found feature to be easy, but there was also one user who found it hard to use. In two open answers was mentioned that there is unnecessary extra click in event calendar. One participant was positively surprised that there was no need to fill any contact info while signing in.
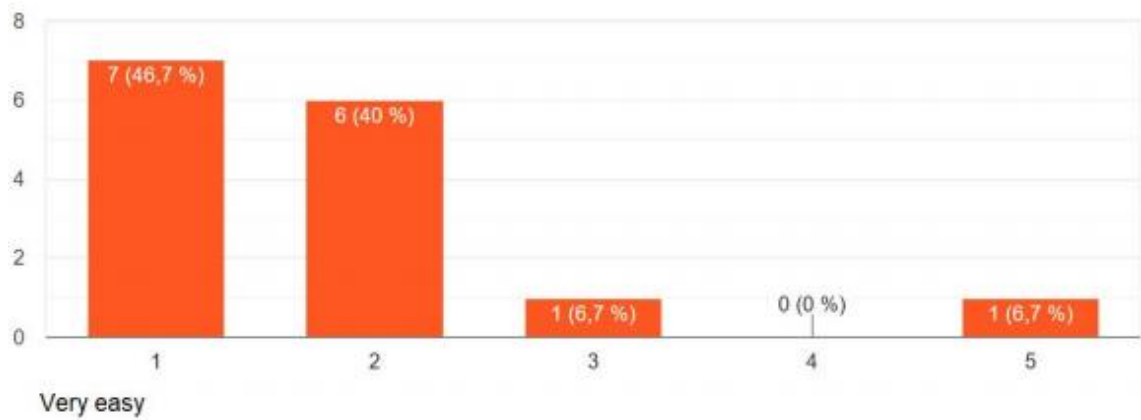
Figure 37. Sign in yard work party.

Finding the key and lock company information

This assignment slightly divided the user's feedback. Most of the participants verbal comments were saying that the information was hard to find, but the comments are not in line with selections (as seen in Figure 38) made in Google Form questionnaire. Some users expected to find the information from the app's Apartment folder.
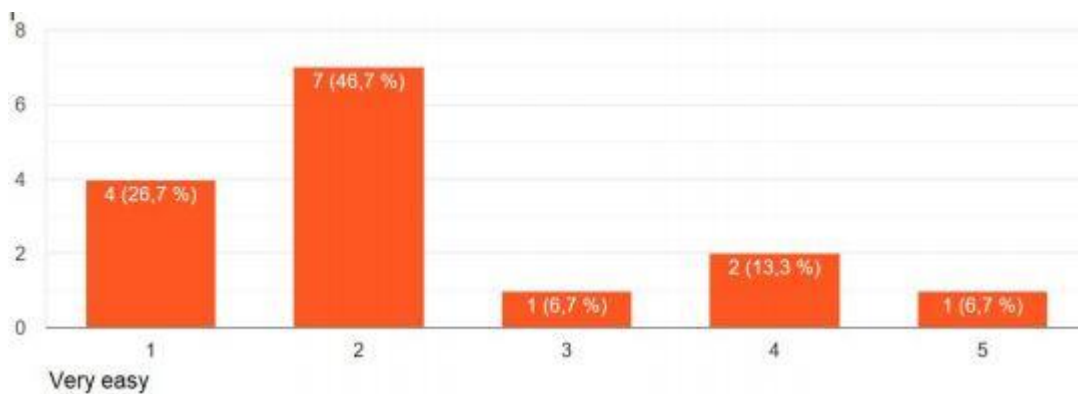

Figure 38. Finding the key and lock company information

Booking the sauna shift

In open comments the feature was said to be "fine and useful" and its use has found to be easy as it can be seen in the results of Google questionnaire (Figure 39). For some users it took time to figure out how to choose the correct date. One user couldn't book the sauna shift and got message "Could not book - no reservation available for this property", this might have caused by account problem.
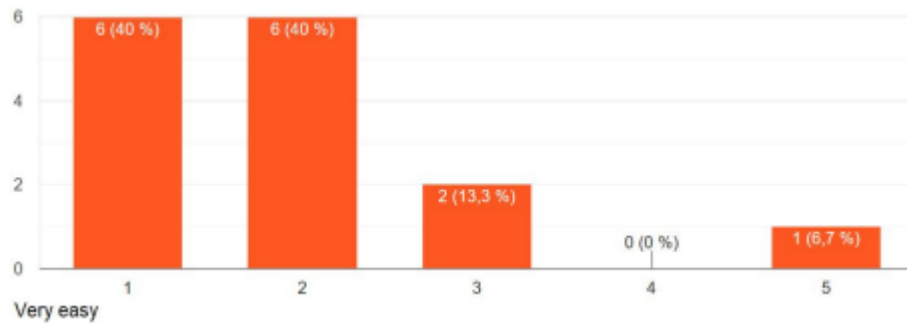
Figure 39. Booking the sauna shift

Finding ventilation unit manual

Finding ventilation unit manual was found to be difficult by couple of users (Figure 40) and some users failed to find it at all. Manual was placed in the Apartment folder and especially English-speaking testers found it difficult to find for them, because it was in Finnish.
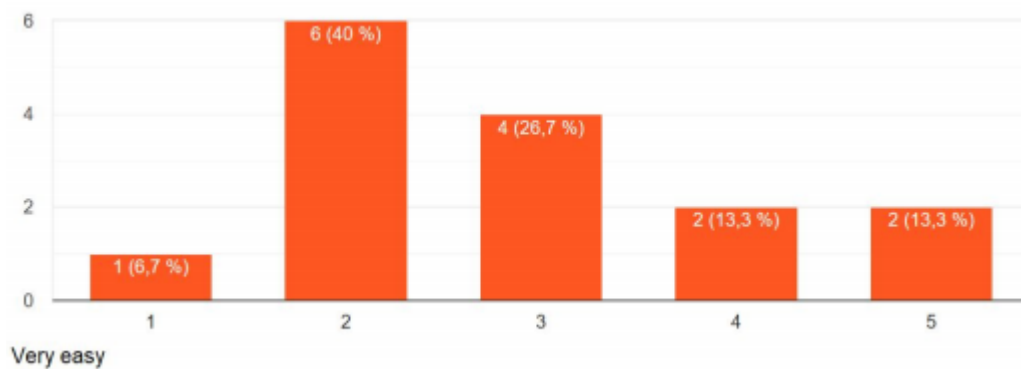

Figure 40. Finding ventilation unit manual was hard for some user.

Turning Push-message off

Test participants comments on this task were, that it took time to get the push-message. Some users failed to turn the right notification off, and some didn't notice to save changes or needed two tries to complete the task. But still almost half of the users (seen Figure 41) thought that the task was quite easy to accomplish. One user's language of the app changed from English to Finnish while saving changes.
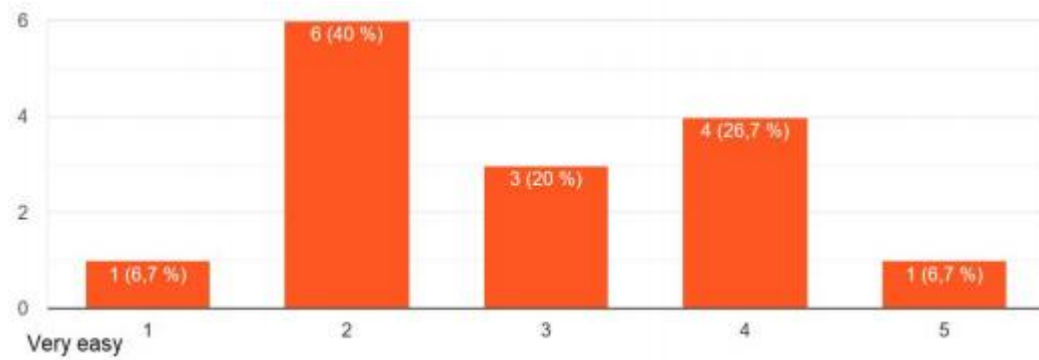
Figure 41. Turning Push-message off

Sign out

Signing out of the app was found be very clear to users as Figure 42 shows. One user comment was that maybe there could be feedback when sign out is done successfully.
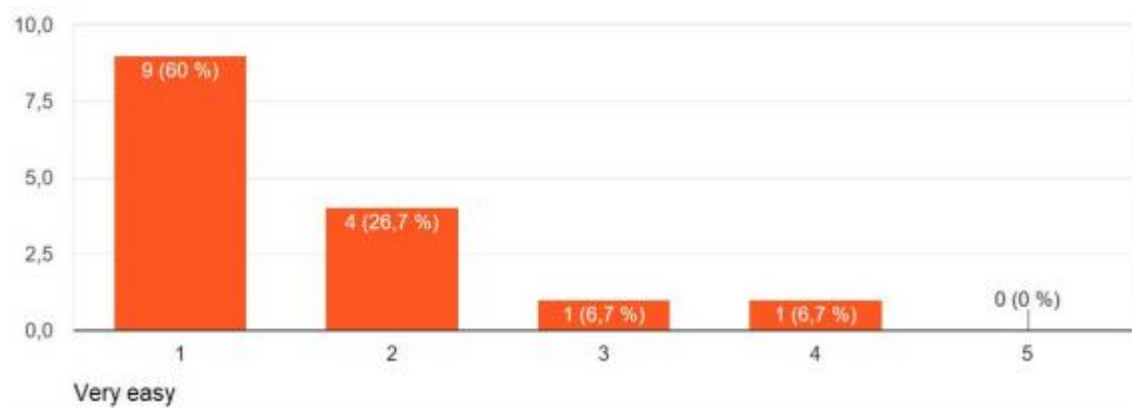

Figure 42. Sign out

The application was easy to use

In general, users found the application to be relatively easy to use as it can be seen in Figure 43, and no one found it difficult to use. In open comments was said that saving configurations was difficult to do.
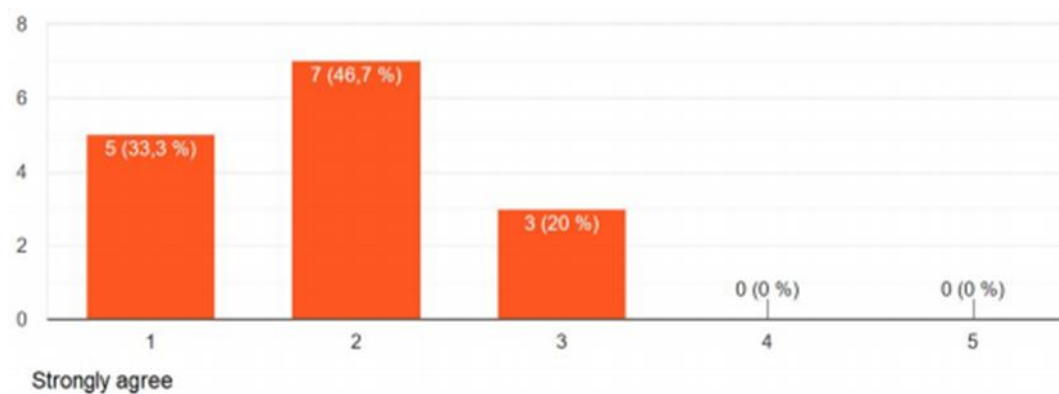

Figure 43. The claim was that the application was easy to use, and nobody denied it.

Information on application was easy to find

Open comments claimed that for some functions took too long to find information and too many clicks to open attachments. As Figure 44 reveals the proposition shares user opinions, because all grades between very easy to very difficult were given by testers on this.
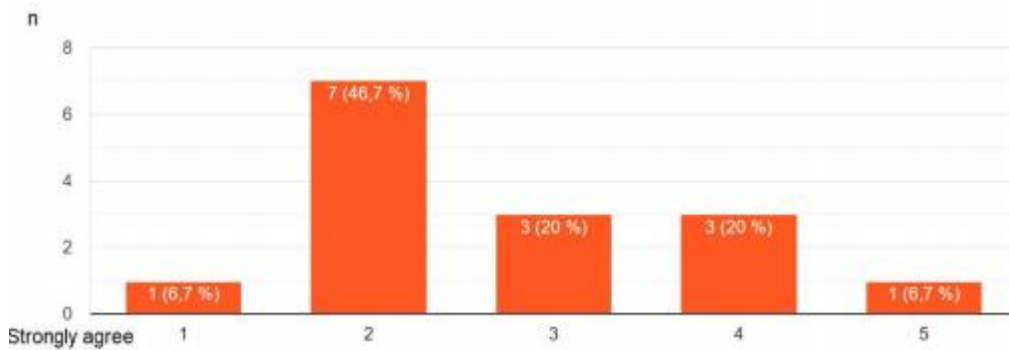

Figure 44. Information of application was not that easy to find.

Necessary functions in application

It was claimed that the application contains the necessary functions in relation to the housing association. Many users thought that there could be more functions in the application, even though any of them disagrees it in the questionnaire (Figure 45). Given examples were that there could added, for instance, discussion area, leaving messages for government of housing association, list of the residents, booking janitor visit or place for house association rules.
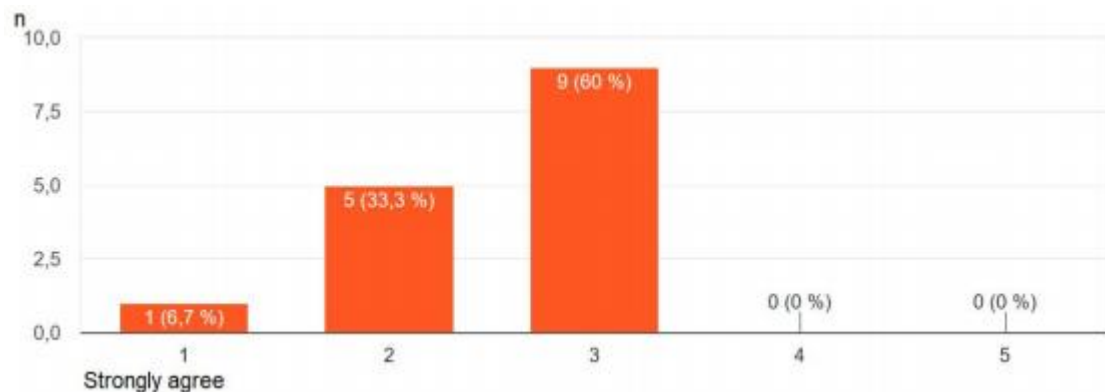

Figure 45. Users thought that app could have even more functions.

The appeal of the app layout

Users open comments about the app's appearance varied as selections in questionnaire (Figure 46). There were comments that appearance is boring and more visual elements like pictures could be added. Apartment folder was found not pleasant for some user.

Overall opinion was that application was functional and serving its purpose. "Suitable for engineer as I am", was one participant comment.
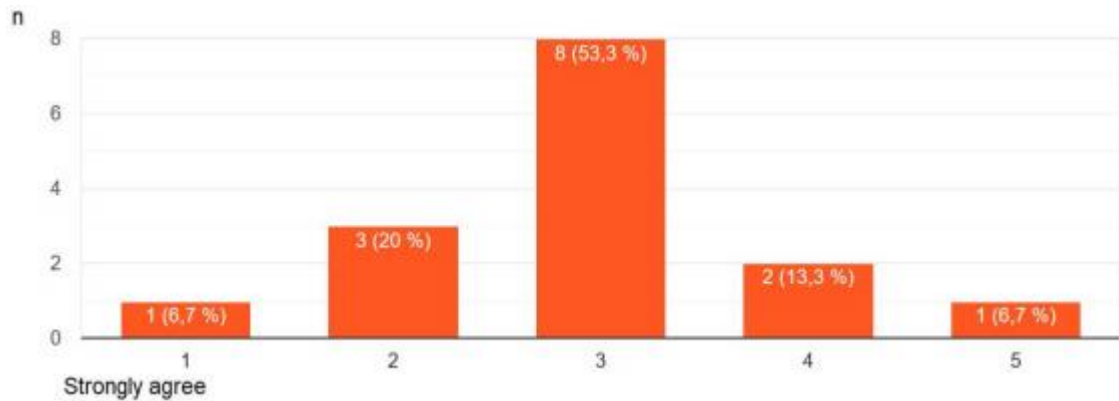

Figure 46. Appearance of application needs improvement from users' point of view.

Text content of application

Results of questionnaire claims that the text content of the application is easy to understand, users did not comment much, but according to the questionnaire (Figure 47), no one thought it was very difficult. One participant comment here was that push-up message was a bit challenging to use.
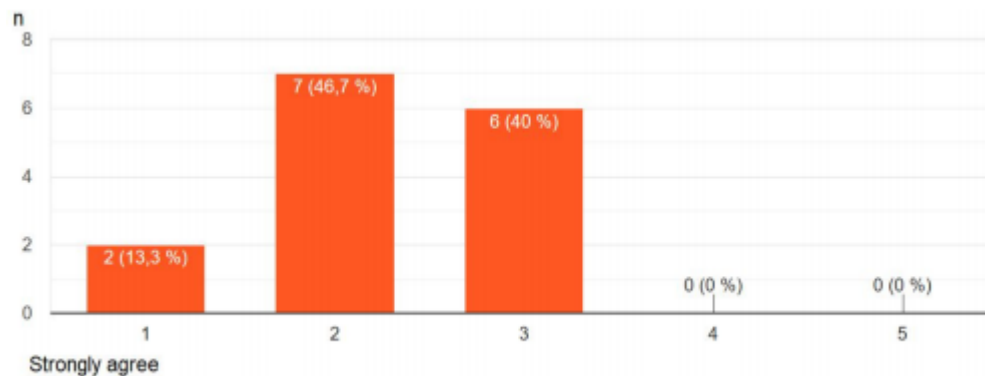

Figure 47. Text content of application was quite easy to understand.

Use of the application in the future

Open comments were mainly positive saying that if there would be chance to use the app in real world, they would do it (as results in Figure 48 show). Kodinportti Mobile was seen to be beneficial and because it is available as a mobile app, it can be used anywhere. Negative feedback from users was that there was not much information that would help user and the app should be improved by doing it more user friendly.
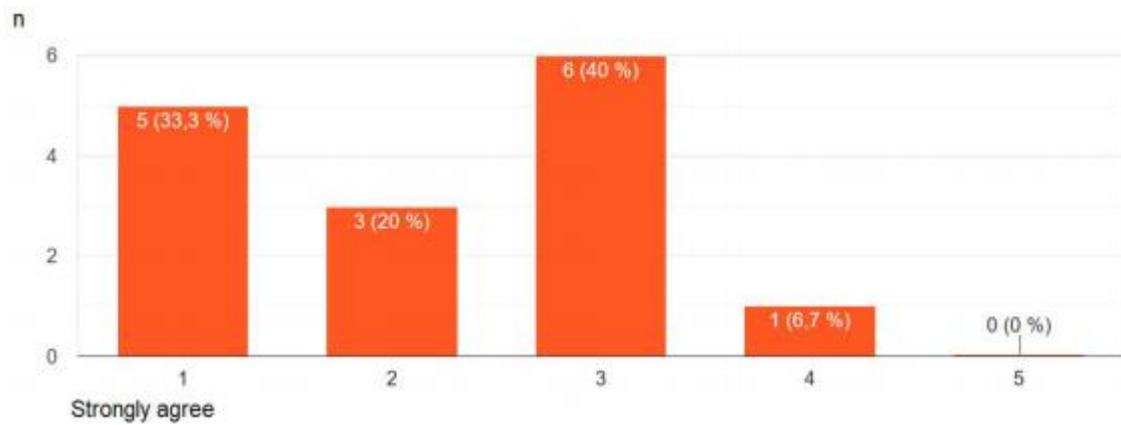
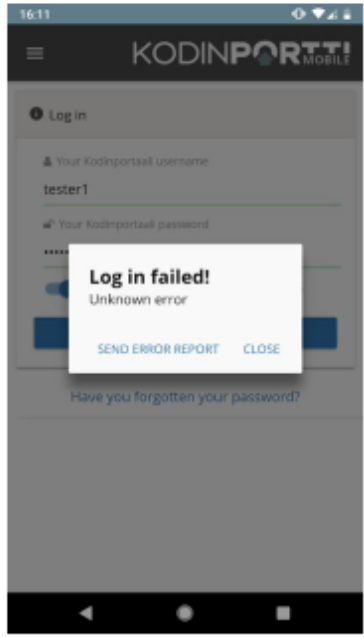Figure 48. Many test users would like to use Kodinportti Mobile again.

6.3.2 Usability findings

Usability findings are based in the results of heuristic evaluation, observations of usability test sessions, questionnaires and interviews of the test users. The findings were put in two categories: major and minor usability issues. In Nielsen's severity scale the minor findings range from 1 to 3 and the major issues from 4 to 5:

1. I don't agree that this is a usability problem at all

2. Cosmetic problem only: need not be fixed unless extra time is available on project

3. Minor usability problem: fixing this should be given low priority

4. Major usability problem: important to fix, so should be given high priority

5. Usability catastrophe: imperative to fix this before product can be released.
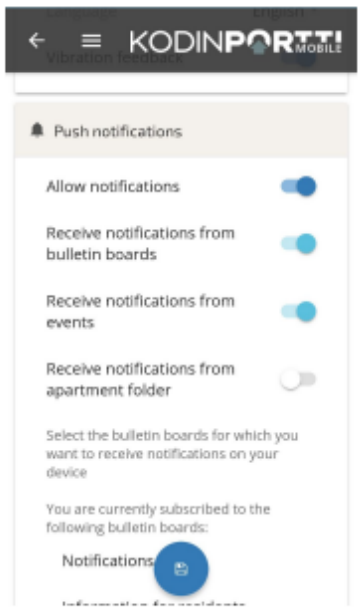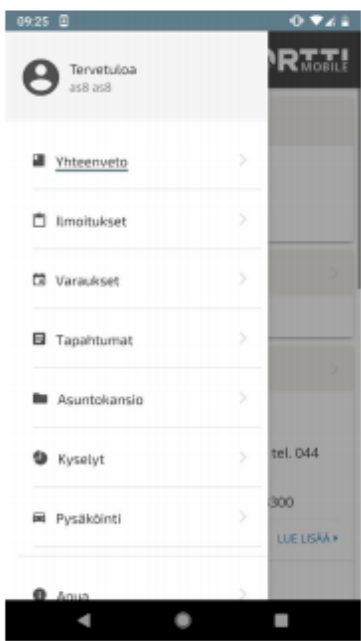
Major and minor usability issues were observed during the test sessions. Main source of information is the observation notes of the test managers. Feedback left by the users in the free-form questionnaire was not that valuable as it was thought to be. Overall feeling and feedback from the test users were positive, participants thought that Kodinportti app was useful and with some improvements it would create even better user experience.

Table 4. Major errors log in the application.

Part of the application	Description of error	Screenshot
Login (Severity 5) Errors	There was a login error. No reason was provided to the user for this "unknown error". The next login attempt worked.	
Login (Severity 4) Errors	Overall the login page was difficult for some users, since username and password fields are shown on light gray color which is usually used for inactive field. Further, the input boxes are styled so that they only show a line. Some users did not realize that they could enter text in these input fields. The login button is active before filling the username and password and some users tried to login without username and password several times.	

Major errors were found to be in applications log in and settings. Table 4 describes the error while user is trying to log in. It is quite devastating to use the application if the application states that it will not be able to sign in for "unknown reason". In addition, many users found the login very confusing because the fields where the username and password should be logged in seemed inactive and there was not the traditional box where to enter the username and password. The confusion was also caused by the fact that the button to log in after the logins are entered, was the only active-looking element on the screen. As a result, many users were merely trying to log in pressing the button, and not even trying to enter their IDs.

Table 5. Major errors in the use of application settings.

Settings (Severity 5) Efficiency	On the settings screen while turning off notifications there is save button which should be used to make changes in settings. Some users did not notice that button and changes were not saved.	
Settings (Severity 4) Errors	After saving the settings, the language of the application switched from English to Finnish. As the user did not select Finnish as language in the settings, this is a major error.	

Major errors were caused the application settings, where, after making the changes, the user should still press the save button on the bottom of the screen (seen in Table 5). This problem is probably since mobile app users are not used to the save button, because usually mobile apps do not have it. A major problem can also be an unexpected change in the language of the application without the user deliberately doing so, as happened to one user.

Table 6. Minor problems in user experience and usability of the app.

Part of the application	Description of error	Screenshot
Login (Severity 2) User experience	On the login screen after logging in, a logo is overlaid on the screen. The logo indicates to the user that the site is loading. Below this logo is a text that reads "Please wait…". This text is very hard to read, given that it is overlayed on top of other text.	
Login (Severity 1) User experience	Login is quite slow. It takes several seconds for the user to be redirected to the home screen after login.	
Dashboard (Severity 3) Errors	After the screen of the mobile phone turned off due to inactivity, it seems the connection was lost. The information in the boxes was not loading. Animated icons were indicating that the content of the boxes was loading, but the content did not show. Closing and opening the app brought back the usual view of the dashboard.	
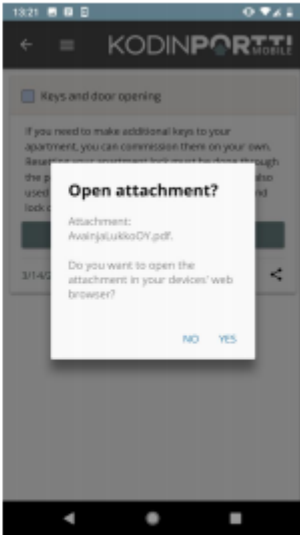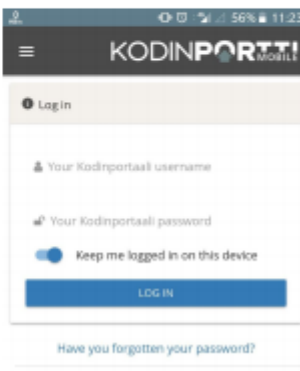
Minor error when logging in were, especially when thinking user experience, that big logo appeared in front of the log in screen (seen in Table 6) after logging in covering the screen with the small text "please wait" which is mixed texts underneath and log in was taken time.

Table 7. Errors concerning user experience found from Kodinportti.

Polls (Severity 3) User experience	There is no possibility to add free text while answering to poll options. This feature was requested by some of the test users.	
Polls (Severity 3) User experience	Once a user has voted, the vote can no longer be changed.	
There is no Home-button on application (Severity 2) User Experience	There was proposal by user to add home-button to application. Could highlighted 'home' icon be used for it?	
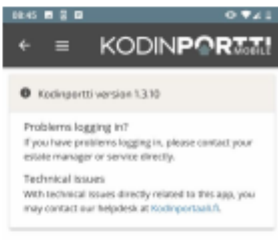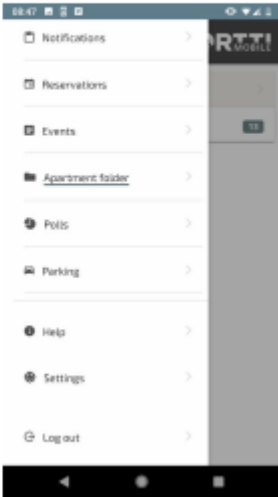
Some minor issues found from app were that users thought that when asked for feedback, it would be nice to be able to justify the feedback in writing rather than sending just emoji (Table 7). Also, after giving feedback, you could not change it if you had, for example, accidentally given false feedback.

Table 8. Pdf file downloading was deemed laborious.

Opening pdf attachments (Severity 3) - Efficiency/Learnability	Downloading a pdf file is complicated and requires many clicks. First, the user has to click a button. Then a dialog box opens. The user has to confirm the download by selecting 'Yes' in this dialog. Then a browser window opens. The browser downloads the pdf file to the storage of the device. The browser shows a message at the bottom of the screen when the download is finished. This message will disappear after a few seconds. The browser window stays blank. The user either needs to go to the browser's history of downloads or the device's history of downloads to find the file. Some of the test users downloaded attachment twice because they couldn't find it (function was learnt after first try) and some commented about extra clicks while opening attachment.	
(Severity 2) Usability	When user signs out there is no feedback for the user about successfully signing out. The application redirects the user to the sign in screen.	

Application is missing the "home button" which makes it easy for the user to navigate back to the start page. It was found that downloading attached pdf file is a little complicated and requires too many clicks (seen and explained more specifically in Table 8).

Table 9. Testers missed the help of the application's help function.

(Severity 3) User experience	Many screens in the application carry little information. These screens function as interstitial in the user's flow through the application. For instance, to get to the events, the user has to make an extra click on the event category to get to the listing of events.	
(Severity 3) User experience	The "Help" entry in the menu does not actually provide the user any help about using the application.	
(Severity 1) Learnability	One of the menu items, "Apartment folder", follows a different naming convention. All other menu entries do not have "folder" in their name.	

From user experience point of view, it can be frustrating that help function only includes contact information, the application does not offer any immediate guidance or help for the user (Table 9).

6.4 Results from User Experience Questionnaire (UEQ-S)

Table 10. User's replies to the UEQ-S questionnaire.

Item	Mean	Variance	Std. Dev.	Negative	Positive	Scale	
1	0.4	1.3	1.1	obstructive	supportive	Pragmatic Quality	
2	0.4	1.8	1.4	complicated	easy	Pragmatic Quality	
3	0.6	0.8	0.9	inefficient	efficient	Pragmatic Quality	
4	0.1	0.9	1.0	confusing	clear	Pragmatic Quality	
5	0.3	0.8	0.9	boring	exciting	Hedonic Quality	
6	0.8	0.9	0.9	not interesting	interesting	Hedonic Quality	
7	0.3	0.9	1.0	conventional	inventive	Hedonic Quality	
8	0.5	0.6	0.7	usual	leading edge	Hedonic Quality	

Analyzing the UEQ-S results, test group used Martin Schrepp's UEQ Data Analysis Tool. The UEQ-S table (Table 10) seen above is a rating the pragmatic quality, hedonic quality and an overall rating. The range of the UEQ-S scales (illustrated in Figure 49) is between -3 (horribly bad) and 3 (extremely good). After the ratings of Kodinportti test users, the app scores 0.367 for pragmatic quality and 0.467 for hedonic quality. Hedonic quality indicates the app's stimulation and novelty on user. Pragmatic quality comprise efficiency, perspicuity and dependability of the app. Kodinportti got the overall rate of 0.313. This rate is in the "neural evaluation" scale of the UEQ-S (-0.8 to 0.8). The rates of > 0.8 represents a positive evaluation and rates < -0,8 represent a negative evaluation.
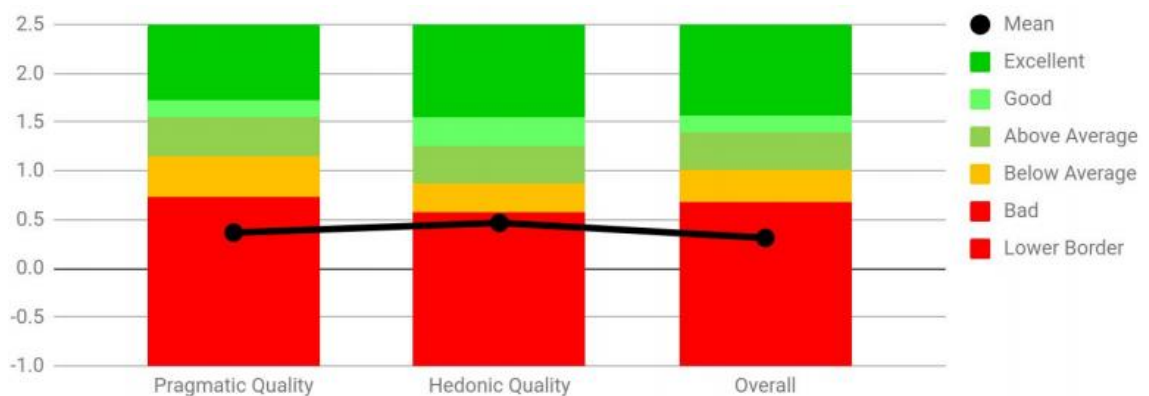
Figure 49. Kodinportti's UEQ rate is bad.

Table 11. Results of benchmark dataset comparison.

Scale	Mean	Comparison to benchmark	Interpretation
Pragmatic Quality	0.367	Bad	In the range of the 25% worst results
Hedonic Quality	0.467	Bad	In the range of the 25% worst results
Overall	0.31	Bad	In the range of the 25% worst results

The results were compared to a benchmark dataset. The dataset holds data from 14,056 users from 280 UEQ studies. The study includes many different products (business software, web pages, web shops, social networks). Note that this benchmark dataset is based on the full UEQ, not UEQ-S. In this presented relation to benchmark dataset,

Kodinportti is not doing very well, it is within the 25% worst results (Table 11). Based on the UEQ-S evaluation, it can be concluded that there is room for improvement in the application.

7.   Redesign

Based on the observations and results of the usability tests, it can be concluded that Kodinportti Mobile needs to be redesigned and a user-friendly interface must be developed to provide a pleasant user experience in future. This chapter goes through the major changes and introduces them as redirected. In addition, the chapter also explores other development areas identified by the tests, but they have not been re-modeled because they mainly concern the technical aspect of the application, not the user interface.

7.1 Development targets

The main areas of the Kodinportti Mobile's UI improvement based on test results are as follows:

- o The app's login needs to be more user friendly. Username and password feeding needs be fixed follow user friendly design and the entering button should be corrected to deactivate looking for the user until username and password are entered. Also, the Kodinportti's logo appearing was experienced annoying when user is logging in for the first time.

- o The app's side drawer menu's contents need to be readjusted, so that the user finds what they are looking for effectively.

- o Setting section and especially button selection was found out to be not clear for the user.

- o Users were missing more help and support from the app, for example, in emergency situations like key lost.

- o App's layout was found to be looking boring and users were asked for more visuality.

7.2 Layout

The layout of the application has not undergone any major redesign as it was well received by the users based on usability tests. User's found the app relatively easy to use, so there was no need for major changes in the lay out. Thus, for example, the application font has also been left unchanged because the tests did not show any need for change. Mostly users wanted more visuals, so a little more color has been added since in the old version (Figure 50) seemed a little colorless. It is recommendable to keep the layout as simple as possible, considering that its potential users can range from young children to the elderly.

New colors in the app are petrol green, fuchsia red and yellow. With the new colors has been tried to bring a slightly fresher and warmer feel to the app to improve the user experience. From the old version the upper part is replaced with fuchsia red (seen in Figure 51) to give more contrast between the dark grey logo background and the image in the logo has been changed to yellow. The background of the application's features titles has been changed from grey to petrol green.
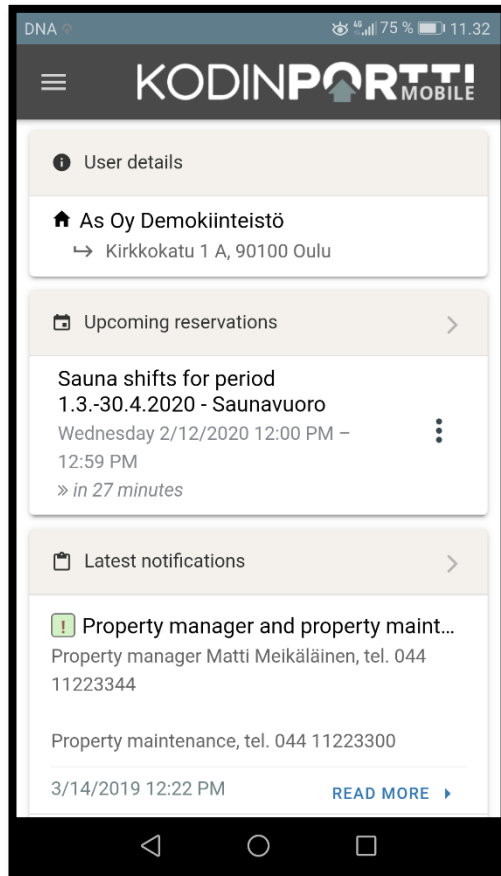
Figure 50. Kodinportti's old lay out.   Figure 51. Kodinportti's new lay out.
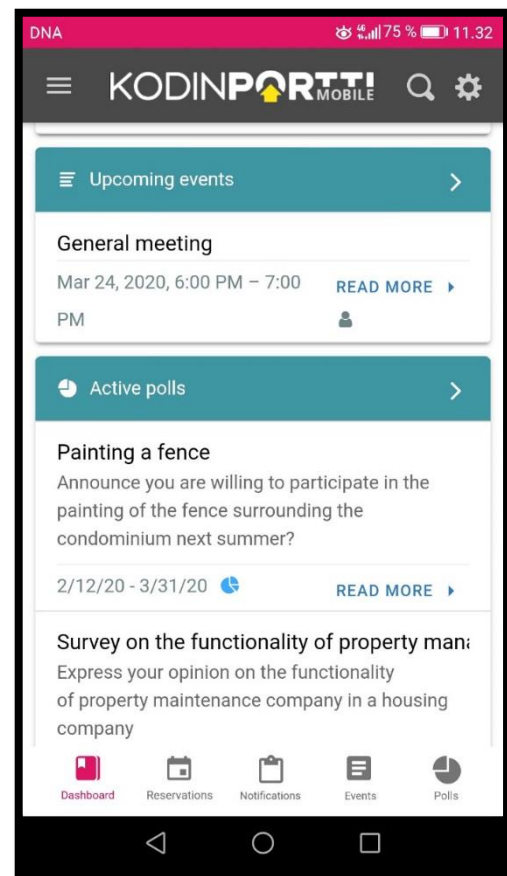
The application logo has been slightly reduced to fit the settings icon next to it and look for the icon. Also, the logo would work as the home key in the new version as suggested in the usability test. The settings icon has been added to make it easier for the user to change the language of the application so that the user does not have to search for language settings in a menu in a language that he is completely unfamiliar with. The search function has also been added to make it easier for the user, since users may not want to start wading through the application while searching for information.

7.3 Log in

As the tests revealed, users had trouble logging in to the application due to an obscure username and password entry field in the old version, as seen in the Figure 52. The application log in has been changed so that the user has been trying to clearly indicate the fields with boxes to enter the username and password as it is been demonstrated in Figure 53. Also, the login button has been changed to appear light blue to the user indicating that it is not active until the user ID's are entered into the fields, whereupon the button turns dark blue (seen in Figure 54) to indicate to the user that it is active. In the old version, the user login remembering feature was also pre-active even though the user had not yet entered any text into the fields that participated, which made the login function less clear. In the new version, the text is reduced, and the user must put a tick in the box to remember the login so that the application remembers the login. Which also looks consistent with the input of text fields with boxes.

Figure 52. Kodinportti's old log in screen.
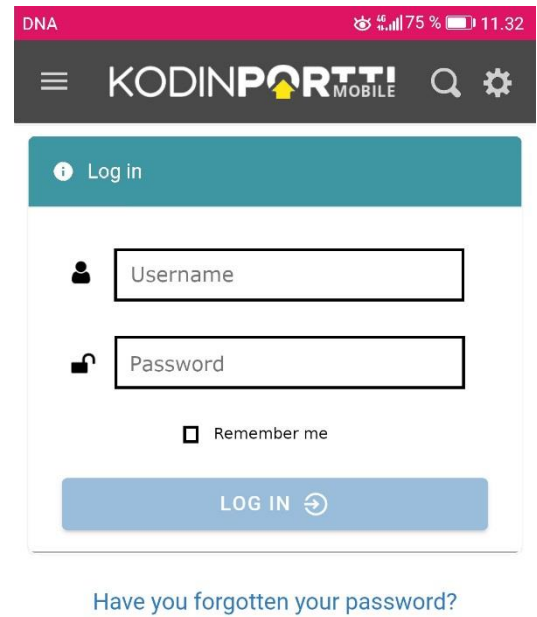
Figure 53. Kodinportti's new log in screen.
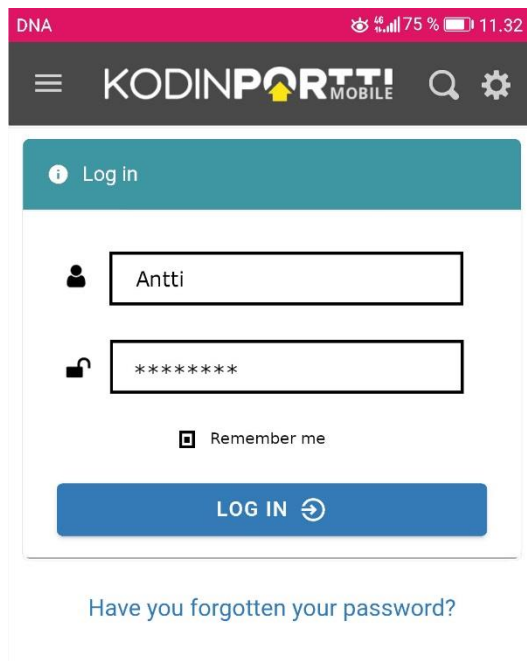
Figure 54. Log in button activated.
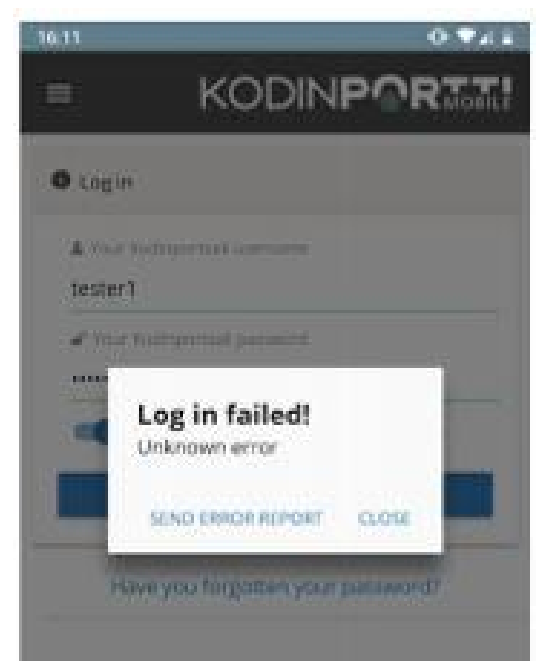
Figure 55. Old error message.

There was also a problem in the tests when trying to sign into the app, the app gave an error message, but no reason for the error was reported to the user as the Figure 55 shows. Of course, the user should be informed of the reason why the login fails at the moment such as; "invalid username or password" or "connection to the server cannot be reached."

7.4 Dashboard

Application's dashboard has been changed in a way that user details has been removed away, because it takes the best space off the screen by telling the user in that point needles information about the apartment address and the name of the housing company that the user already knows as seen in Figure 56. Notifications has been raised first, as it also appears in the menu (seen in Figure 57), so the app's features in the menu view and the dashboard view are in the same order in the new version, which is very logical. In the old version, the colored boxes that appear in the notifications have been removed from the new version because their meaning caused unnecessary confusion for test users. New feature, a new version of the app has been added to the bottom of the tap bar menu.
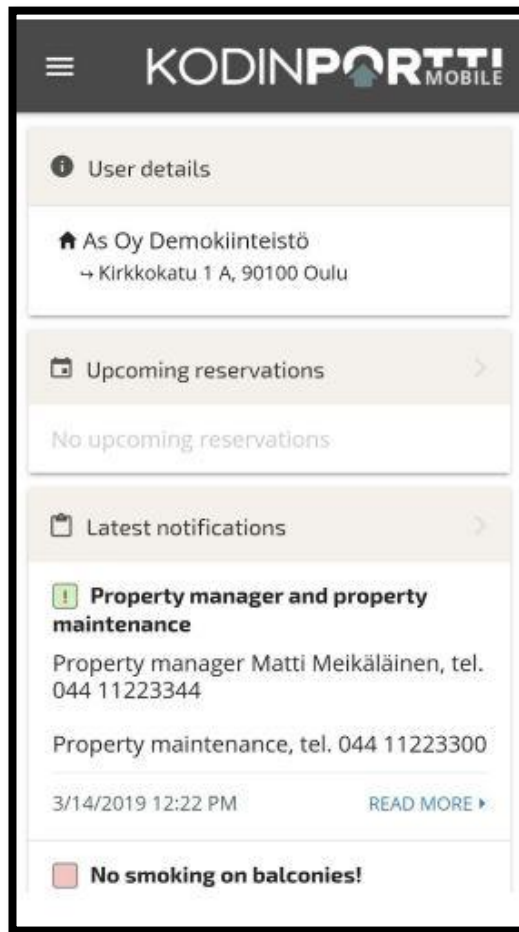
Figure 56. Old dashboard view.
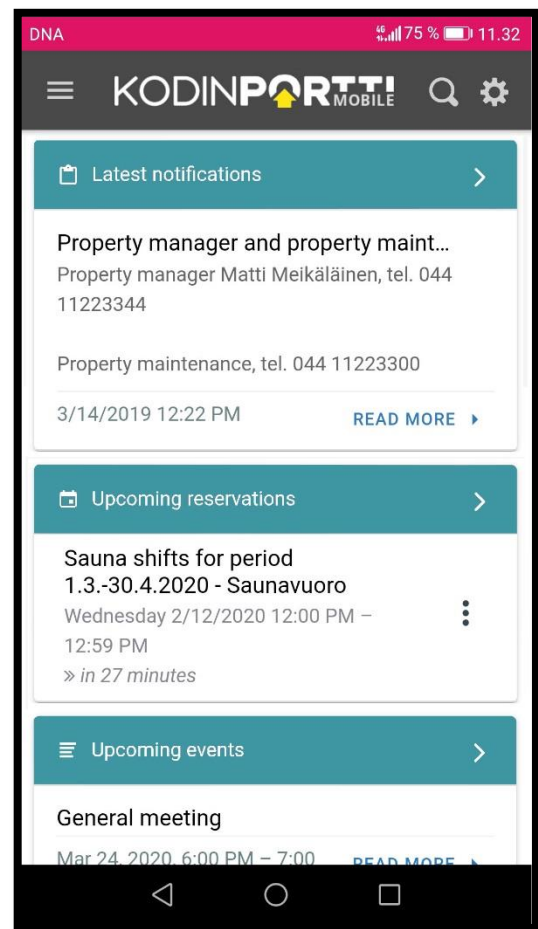
Figure 57. New dashboard view.
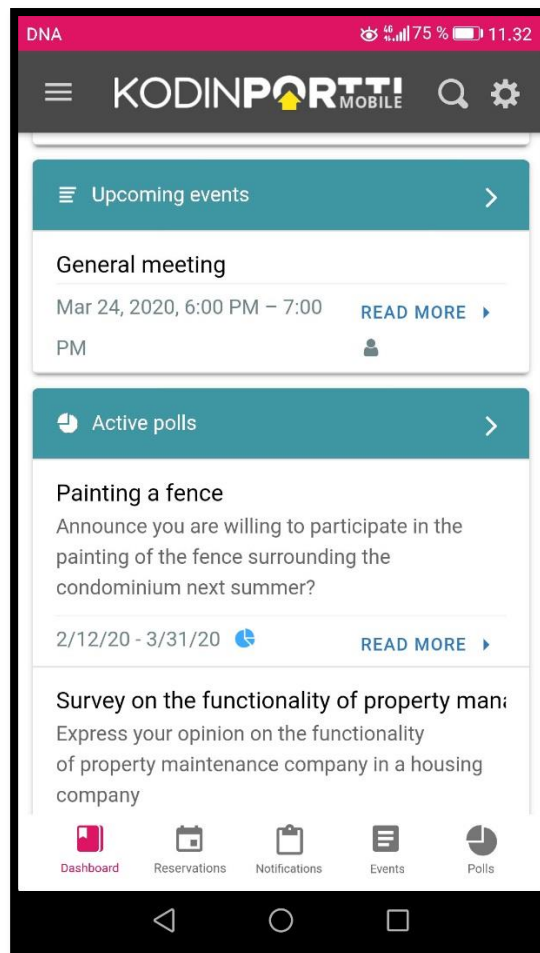
Figure 58. New dashboard with the tab menu.

The tap bar menu at the bottom (Figure 58) is nowadays quite common in mobile applications and facilitates user navigation within the application. The tab bar menu displays the most popular functions of the application and the menu is displayed whenever the user scrolls up the screen.

7.5 Side drawer menu

The app's side drawer menu's contents have gone through a bit of reorganization compared to old menu (Figure 59) and a couple of new features have been added to new one (seen in Figure 60). Also, the spacing between the features are slightly compressed to make them appear on the screen at the same time. Some of the functions there are separated by lines to improve user perception. Welcome text has removed the top section and replaced with the user information transferred from the dashboard. Apartment folder is placed on top with user information, because it contains apartment-specific information such as home appliance manuals and other information referring to a specific apartment, so it could be considered close to the user's personal information in the menu. **Apartment folder**'s nomination got some critics during the usability tests and "**apartment section**" was proposed its name instead. In the opinion of the undersigned and the chief engineer of the application, at least the above suggestion does little to make the name more user-friendly. Perhaps "**apartment info**" or "**home's folder**" could be the right names, but in the undersigned opinion even those do not really improve the clarity of the name. So hopefully relocating the feature would improve user friendliness. A new feature in the menu is the introduction of chat, as usability tests revealed that users would find it great if the application could communicate directly with, for example, a service company, a

property manager, or even the housing association's board. The chat function could make it possible for the housing association to determine what kind of connections it wants to establish under the function.

Settings and help have moved in the new version because it seems more logical that the user is first provided with settings if they want to change the way the application works and if the settings don't help then the user can find a solution from the help feature. Settings icon is also changed to describe more clearly the settings, because the setting icon is also placed next to the title in the new version to make it easier for the user to switch to, for example, the language settings.
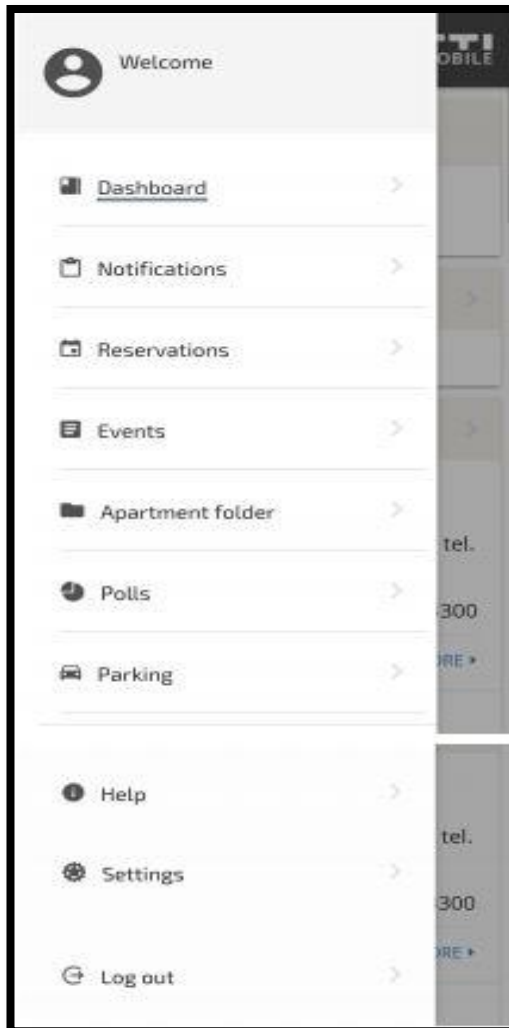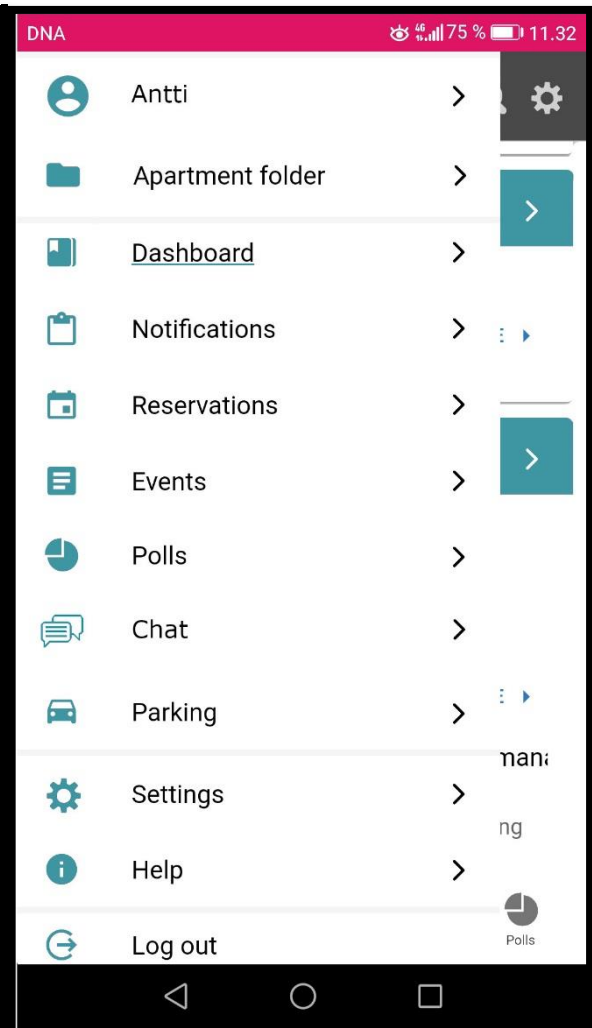
Figure 59. Old menu.   Figure 60. New menu.

Property manager and property maintenance contact information could be placed on several different location in the app like also in the help feature, so that the user can find help from there, for example, if the key is lost or in another emergency situation concerning the household. Help feature should offer help in both the use of the app and in housing issues. For example, the help feature could add a list of the 10 most frequently asked questions about the application and the housing association. Such an increase can significantly reduce so-called unnecessary customer service calls.

7.6 Settings

Changing the application's settings caused problems for testers due to a separate save button (seen in Figure 61). Users are not used to separate save buttons in mobile apps, so the unnecessary save button has been removed from the new version (Figure 62).
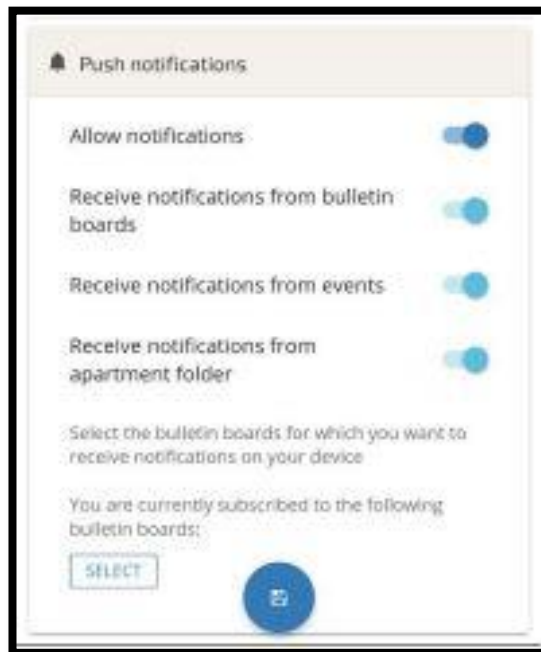
Figure 61. Old settings view.
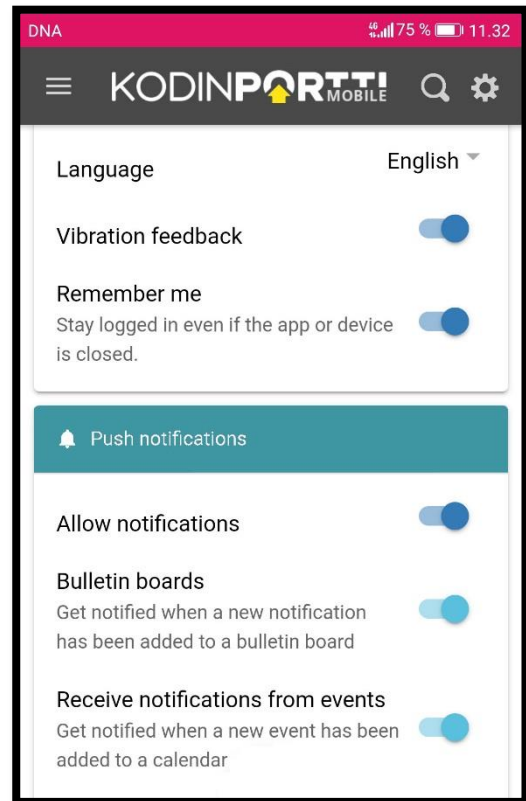
Figure 56. New settings view.

Also, the "select" button's purpose was found to be unclear and confusing for the users, so in the new version all the other actions, except language selection, in the app's settings happens using the blue colored switch buttons.

7.7 Other improvements to the app

As the test results showed, there is also other improvement targets found to do for the application, like the testers hoped that there would be possibility to give also feedback in free written form in the app's poll function. Many of these findings, however, go beyond the scope of this thesis, but they are mentioned below.

It was noticed during the usability test that the language can suddenly change, even language settings are not touched. PDF files loading was considered difficult for users because it required too many clicks and the PDF did not open in the application but opened, for example, in the background in a web browser, causing it to be overlooked by users. With push messages had some loading issues from server side. Ajax/JavaScript architecture need to be updated. Because when testers test the app, they figure out problem for instant loading the notification panel. Heuristic evaluation brought out that from sauna and gym function user cannot swipe back when making reservations.

Reservation dialog showed the reservation start date and time, but not the end time and more customization possibilities were hoped in the app.

8.   Discussion

The purpose of this thesis was to improve the usability of Kodinportti Mobile application using the traditional usability research methods such as Nielsen heuristic evaluation and usability testing. Also, the goal of the study was to design concept model based on the results.

8.1 Answer to research question

The research questions for the thesis were; can usability test provide information that makes the mobile user interface more user-friendly and what kinds of development suggestions will heuristic evaluation and usability test produce? Usability testing group made already during Nielsen heuristic evaluation observations that were further validated in usability tests, such as usability issue during login and language selection was difficult to find if the user must search for the language options in a foreign language. Usability tests revealed also several issues in usability, such as, the log in issue, saving settings, menu reorganization and users were missing more help and support from the app. Also, test users were missing more visuality in the app, for example, in the form of colors and images. As Sinkkonen (2006) mentioned that visuality can make design clearer, this makes it easier for the user to grasp the whole and pick out the key points. The choice of colors also paid attention to what Lankoski and Kirvesmäki (2002) mentioned in their article about the cultural significance of colors, so the application used so-called broken colors. The usability test also produced new feature suggestions, such as a chat function for the housing company residents and changing Kodinportti logo to a home button, which offers easy way to user to get back to the starting point and as de Parros et al. (2014) pointed out that the start screen can be safe point where the user can return. The new color used in the Kodinportti logo was selected yellow because, according to Hoober and Berkman (2011) yellow color is usually referred to reflect interactive feature in the app.

8.2 Analysis of different stages of thesis and the result of the work

Prior to the actual research work, the relevant literature was collected to get the necessary information and tips for the different stages of the work. One of the main themes of the work is usability and the literature offered guides that were good to keep in mind while planning usability tests and redesigning the app's layout. One good point for was that usability is not just one aspect it is the starting point for everything when speaking of product quality (Marghescu, 2009). From Nielsen (1994) quality parameters for Kodinportti Mobile's usability especially efficiency, learnability and satisfactory were mostly in mind during the project, because having a good user experience makes it easier for people to learn and more to learn. By learning how to use, the application's use is efficient, and the users are satisfied. These above-mentioned Nielsen (1994) usability parameters also strongly refer to another big theme in the work that was researching and developing the app's user experience. As with usability, in this thesis, the concept of user experience is largely based on the ISO 9241-11 definitions, where one of the user experiences mentioned is comfort and to maximize it, the result of this work has also been sought within the idea of bringing the pleasure in addition to practicality as Rajanen et al., (2017) state the idea of the aims of UX design. For especially the design part of thesis literature provided very good tips, for example, that is important that the information of the app is presented relevantly to the user to achieve good user experience. Particularly

in mobile app designing it is important that there is space enough between different items, that unintended presses are avoided (de Parros et al. 2014). (Kalimo, 1995; Sinkkonen, 2006) and where the gaze of the user is usually first targeting when user opens the app (Sinkkonen, 2006). All in all, the literature on the subject was available quite comfortably, except the literature on mobile usability and mobile user experience is quite limited, still, even though mobile devices have been a part of our daily lives for years.

As already explained in Chapter 4, the study follows Hevner and Chatterjee (2010) DSR framework. Below is described how Hevner and Chatterjee (2010) seven-point DSR guideline have been implemented in this work. 1. Design as artefact: the artefact developed in this study is the concept for new user interface of the Kodinportti Mobile application. 2. Problem relevance: It was noticed that the old user interface has room for development and with the new interface, the application could better serve its users. 3. Design evaluation: The methods used in the evaluation of the research are methods well known in the field and well established in the design of the user interface, such as Nielsen Heuristics and usability testing. 4. Research contributions: The research contributions are the concept of user interface in commercial use of Kodinportti Mobile and for science community research provides findings in the field of re-designing process of the mobile user interface and improving mobile usability and user experience. 5. Research rigor: Research was conducted using design science methodology and user centered design approach. The knowledge base for research and design was obtained from field's previously published literature, which helped to create guidelines and evaluation methods for the process. Designed artifact was built using these guidelines and methods, and all the building steps are reported. 6. Design as a search process: The design process utilized it means from its field's existing literature and evaluations and tests conducted. 7. Communication of research: The study opens the causes and consequences, considering the technological understanding of a potential reader, for example by opening the abbreviations used in the text and illustrating the design in addition to the text. Alongside the Hevner and Chatterjee (2010) DSR framework the study strongly relies on user-centered research method where the actual design process is described in a very similar way to DSR framework, but the UCD process emphasizes end-user consideration at all stages of the process (Shneiderman et al., 2018). UCD process is highlighting the fact that the user is always at the center instead of technology (Rubin & Chisnell, 2008).

The planning of the testing was carried out together with the usability testing course group, and after a couple of meetings and a few exchanges of messages, all the testing plans, methods and goals were agreed with group. Nielsen heuristics were chosen as one evaluation method because they were familiar to all members, so it was quite obvious decision that it will be conducted first before the actual usability testing, so that the group member can try first find by themselves find as much as possible usability problems from the user interface (Nielsen & Mack, 1994) and get familiar with the app. So, after that, the progress of the work remained the responsibility of the group.

Usability test results were very much as expected compared to what I had noticed in the application myself, so the results yielded to improve the functionality of the application and its features and improve the user experience. In the test report, I would have wanted more detailed descriptions of each test session in order to get a better picture of how a certain person responded to the test. The report focused more on pulling together the results. Important note and possible limitation of the work was that analyzing the results would be easier and faster if the designer is taking part in the practical testing by itself. Because understanding the literal interpretations made by others may not be perfect, especially since the text used in the report is not the mother tongue of anyone. So, it is very possible that misinterpretations, for example, in the interpretation of the results

might occur. Re-designing would also be easier and faster, if the person who is in charge of the design would be involved in the design of the testing and the actual testing itself. I also think it would be important for the designer to get a more detailed and, above all, personalized view of the tests from the design point of view. So, based on my experience, I can't recommend such an arrangement to others. Thus, this observation leads to the following: Interaction design process is more efficient if the designers participate in all four basic actions; verifying requirements, designing, building prototypes and evaluating (Preece et al., 2011 & Shneiderman et al., 2018)

In the design phase, not all issues reported by the test team were addressed, and efforts were made to address the biggest and most obvious flaws in the application. Also, there was findings of usability issues that concerned the technical designing in the app. There were problems with the implementation of the new layout prototypes because there were years using last time some image editing software. The GIMP now used in layout design is a free version that there were no previous experience using, so the actual design left room for improvement in implementing new version of layouts. So, designers' incompetence with design software can be counted as one limitation in the work. Personally, I would improve the visual elements such as images and color. These would further improve the user experience. But, all in all, usability research gave results that help to improve Kodinportti Mobile's usability and user experience and sketch of the redesigned layout was made. Also, as an extra one empirical observation concerning the interaction design process was done, so I think the research achieved its goal.

8.3 Future work

Next, the work itself should be technically implemented based on a new concept plan, after which another iteration should be started. Thus, a valid version of the application would be fine-tuned for users. Of course, it would be interesting to see what new usability and user experience problems the tests would reveal in the next iteration of the application. In the future, there is certainly room for usability and user experience research in the field of mobile applications in general, because there is still quite a little literature available. Since, in this study the usability testing was decided to do as a field test instead of the lab testing, the impact of the environment on the mobile app user experience would be interesting research topic and especially knowing with this study what the difference between the results of the study would be if the study had been done in a laboratory when tests and queries were conducted at home in this study. Also, the research of design process would be the topic for future research, because I personally saw it as a contributing factor on the whole process that I did not participate in usability testing and reporting its results.

9.   Conclusion

This Master thesis purpose was to improve Kodinportti Mobile's usability and user experience in order to make the application more user friendly. For this purpose, the application underwent a usability research, which included heurist evaluation and usability testing. Based on the results of the research, a new user interface was designed for the application, which considered the usability issues raised.

The basis for the research was created by reviewing literature in the field regarding usability, user experience, usability testing, user-centered design, and specific mobile user interface design issues. Usability research was conducted cooperation of students of Oulu university usability testing course. Usability research was designed and the goals for testing was set up with the group responsible for practical testing. Before the usability testing test group did the heuristic evaluation for the app and then started conduct the usability tests. After the usability testing session were finished group gave away a report of the results of the tests and that ended their contribution to this project. According to test report, usability test included total 15 participants and their age ranged from 18 to 72 years. Tests were conducted as field tests each participant in a familiar and comfortable environment, such as at home or in a café. The tests were performed on the mobile devices of the test participants. Work continued analyzing the results, leading to decisions as to which of the reported results is worth noting when designing a new version.

Results revealed several flaws in the usability of Kodinportti Mobile app. Users had for example, difficulties log in to app, saving settings, menu reorganization to make it clearer for the user and the user's help functions were needed. Also, user wanted more visual elements into the app. So, there was room for improvement in issues concerned both usability, user experience and new features was suggested. Most of the problems encountered in the tests were addressed in the new version of the UI concept, but some of the problems concerned more technical features of the application, such as the PDF download problem, or some terms used in the app which did not appeal to users, no more descriptive match was found. On the other hand, the realization of the new user interface was hindered by the designer's own incompetence with the software, which prevented, for example, the creation of a better user experience in the new version.

All in all, the work done can be welcomed, as it managed to find from Kodinportti Mobile usability and user experience issues for improvement by the means of heuristic evaluation and usability testing. In addition, a cohesive design for a new user interface was developed that addresses the problems found in the tests with the old version. In addition to these, from the design process became such an observation that it is good for the designers to be involved at all stages of the process from the start to end. This way, the design process can be completed swimmingly and without larger misunderstandings, which can affect the result.

10. References

Abras, C., Maloney-Krichmar, D., & Preece, J. (2004). User-centered design. *Bainbridge, W. Encyclopedia of Human-Computer Interaction.* Thousand Oaks: Sage Publications, 37(4), 445-456.

de Barros, A. C., Leitão, R., & Ribeiro, J. (2014). Design and evaluation of a mobile user interface for older adults: navigation, interaction and visual design recommendations. *Procedia Computer Science*, *27*, 369-378.

Dumas, J. S., & Redish, J. (1999). *A practical guide to usability testing.* Intellect books.

Hassenzahl, M. (2008, September). User experience (UX): towards an experiential perspective on product quality. In *Proceedings of the 20th Conference on l'Interaction Homme-Machine* (pp. 11-15). ACM.

Hevner, A., & Chatterjee, S. (2010). *Design research in information systems: theory and practice* (Vol. 22). Springer Science & Business Media.

Hiltunen, M., Laukka, M., & Luomala, J. (2002). *Mobile user experience*. IT press.

Hoehle, H., & Venkatesh, V. (2015). Mobile application usability: Conceptualization and instrument development. *Mis Quarterly*, *39*(2).

ISO 9241-11: *Ergonomic Requirements for Office Work with Visual Display Terminals (VDTs) - Part 11: Guidance on Usability. International Standard Organization*, Geneva (1998)

Jokela, T., Iivari, N., Matero, J., & Karukka, M. (2003, August). The standard of user-centered design and the standard definition of usability: analyzing ISO 13407 against ISO 9241-11. In *Proceedings of the Latin American conference on Human-computer interaction* (pp. 53-60). ACM.

Kalimo, A., Pettersson, M., Sinkkonen, I., Suikola, E. (1995). Graafisen käyttöliittymän suunnittelu: opas ohjelmistojen käytettävyyteen. Tietotekniikan kehittämiskeskus. Systeemityön ja standardoinnin kehittämisyksikkö. Suomen atk-kustannus.

Kieffer, S., & Vanderdonckt, J. (2016, April). STRATUS: a questionnaire for strategic usability assessment. In *Proceedings of the 31st Annual ACM Symposium on Applied Computing* (pp. 205-212). ACM.

Kirvesmäki, L., & Lankoski, P. (2002). Henkilökohtainen navigointi, periaatteita käyttöliittymien ja käyttökokemusten suunnitteluun. *Tampere. Kirjapaino: Klingendahl Paino Oy*.

Kodinportti. (n.db) Esittely asukkaalle. Retrieved January 29, 2019 from http://www.kodinportti.fi/fi/esittely/asukkaalle

Kodinportti. (n.dd) Kodinportti taulun ominaisuudet. Retrieved January 29, 2019 from http://www.kodinportti.fi/fi/ominaisuudet/kodinportti-taulut

Kodinportti. (n.df) Kodinportaali ominaisuudet. Retrieved January 29, 2019 from
http://www.kodinportti.fi/fi/ominaisuudet/kodinportaali

Kodinportti. (n.da) Kodinportti mobiili ominaisuudet. Retrieved January 29, 2019 from
http://www.kodinportti.fi/fi/ominaisuudet/kodinportti_mobile

Kodinportti. (n.de) Kodinportti Models. Retrieved March 26, 2020 from
http://www.kodinportti.fi/en/models, 26.3.2020)

Kodinportti. (n.dc) References. Retrieved March 26, 2020 from
http://www.kodinportti.fi/en/about/references

Kraft, C. (2012). *User experience innovation: User centered design that works*. Apress.

Mack, R. L., & Nielsen, J. (1994). Executive summary. J. Nielsen and R. L.Mack,
eds.Usability Inspection Methods.John Wiley and Sons,New York, 1–24.

March, S. T., & Smith, G. F. (1995). Design and natural science research on information
technology. *Decision support systems*, *15*(4), 251-266.

Marghescu, D. (2009). Usability evaluation of information systems: A review of five
international standards. In *Information Systems Development* (pp. 131-142).
Springer, Boston, MA.

Neil, T. (2014). *Mobile design pattern gallery: UI patterns for smartphone apps*. "
O'Reilly Media, Inc.".

Nielsen, J. (1993) Usability heuristics.In Nielsen, J. (Ed) Usability Engineering.
Academic Press. 115-164.

Nielsen, J. (1994a). *Usability engineering*. Elsevier.

Nielsen, J. (1994b). *Usability inspection methods. Conference Companion on Human
Factors in Computing Systems,* Boston, Massachusetts, USA. 413-414.
doi:10.1145/259963.260531

Nielsen, J., & Budiu, R. (2013). *Mobile usability*. MITP-Verlags GmbH & Co. KG.

Oulasvirta, A. (Ed.). (2011). *Ihmisen ja tietokoneen vuorovaikutus*. Gaudeamus,
Helsinki University Press.

Preece, J., Rogers, Y., Sharp, H., Benyon, D., Holland, S., & Carey, T. (1994). *Human-
computer interaction*. Addison-Wesley Longman Ltd.

Rajanen, D., Clemmensen, T., Iivari, N., Inal, Y., Rızvanoğlu, K., Sivaji, A., & Roche,
A. (2017, September). *UX Professionals' Definitions of Usability and UX–A
Comparison Between Turkey, Finland, Denmark, France and Malaysia. In IFIP
Conference on Human-Computer Interaction (pp. 218-239).* Springer, Cham.

Rajanen, M., & Rajanen, D. (2017). Usability benefits in gamification. In GamiFIN (pp.
87-95).

Rajanen, M., & Rajanen, D. (2018). Heuristic evaluation in game and gamification
development. In *GamiFIN* (pp. 159-168).

Rajanen, M., & Rajanen, D. (2020). Usability as Speculum Mundi: A Core Concept in Socio-technical Systems Development. *Complex Systems Informatics and Modeling Quarterly*, (22), pp. 49-59.

Rubin, J., & Chisnell, D. (2008). *Handbook of usability testing: how to plan, design and conduct effective tests*. John Wiley & Sons.

Shneiderman, B., Plaisant, C., Cohen, M., Jacobs, S., Elmqvist, N., & Diakopoulos, N. (2018). *Designing the user interface: strategies for effective human-computer interaction*. Pearson.

Sinkkonen, I., Parkkinen, J., Kuoppala, H., & Vastamäki, R. (2006). Käytettävyyden psykologia. *Helsinki: Edita Prima Oy*.

Usability.gov. (n.d.) What & Why of Usability. User-Centered Design Basics. Retrieved April 5, 2019 from https://www.usability.gov/what-and-why/user-centered-design.html

User Experience Questionnaire (UEQ). (n.d.) What does it measure? Retrieved April 25, 2020 from www.ueq-online.org

Appendix A. Questionnaire

Give your rating for each task ease of use or difficulty on a scale of 1-5 (1 = very easy… 5 = very difficult). If you have more to add, please comment in the field below.

	1	2	3	4	5
1. Sign in	[]	[]	[]	[]	[]

_____

_____

	1	2	3	4	5
2. Property management feedback	[]	[]	[]	[]	[]

_____

_____

	1	2	3	4	5
3. Sign into yard work party	[]	[]	[]	[]	[]

_____

_____

4. Finding the key and lock company information

	1	2	3	4	5
	[]	[]	[]	[]	[]

_____

_____

5. Booking sauna shift   []   []   []   []   []

_____

_____

6. Finding ventilation unit manual []   []   []   []   []

_____

_____

7. Setting Push-notification off   []   []   []   []   []

_____

_____

8. Sign out   []   []   []   []   []

_____

_____

How well do the following statements match your opinion about the application? Give points for each statement on a scale of 1-5 (1 = totally agree… 5 = totally disagree). If you have more to add, please comment in the field below.

	1	2	3	4	5
App is easy to use	[]	[]	[]	[]	[]

_____

_____

The information in the app is easy to find

	1	2	3	4	5
	[]	[]	[]	[]	[]

_____

_____

In my opinion, the application has the necessary functions related to the housing

association	[]	[]	[]	[]	[]

_____

_____

The app's appearance is pleasant	[]	[]	[]	[]	[]

_____

_____

The text content of the application is easy to understand

[]   []   []   []   []

_____

_____

I'd love to use the app again   []   []   []   []   []

_____

_____

Comments to application developers:

_____

_____

_____

_____

Thank you very much for participating to test!

Appendix B. Consent form

Thank you for participating in the usability test!

Kodinportti is a digital touch screen for housing association's building lobby. Kodinportti consists of touch screen, Kodinportaali and Kodinportti Mobile application. It serves the residents daily with diverse functions, gathers up-to-date information for the residents and performs the functions of bulletin boards, resident lists and booking booklets. Kodinportti is developed by DreamIt company.

The subject of the test is Kodinportti Mobile application, which enables the residents of a housing association to manage their housing and apartment related matters on a mobile device. By participating in the testing, you are involved in evaluating the success of the implementation of the application. The purpose of the usability test is not to test the user, but to test the usability of the application, so take it easy!

The test leader will give you tasks to perform, which you are trying to perform in the application. Once you have completed the task, please inform the test leader. The test includes eight tasks and a final questionnaire. It takes about 15 minutes to complete the test and the final questionnaire. To get the most out of the test, we ask you to express your thoughts, opinions, feelings as loud as possible during the test. Test team members are not system designers or developers, so you don't have to try to please them.

The test is filmed and / or recorded. Recorded material will not be published anywhere. The material is used anonymously to improve the future of the system. You have the right to interrupt the test event at any time if you feel like it. If you interrupt, the collected material will be deleted and not used.

Do you have any questions?

My consent to the test   :

Signature_____

Clarification of the name

_____

Date_____

Age _____

Device used in the test _____