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Universal Design of mobile applications: Using a participatory approach to investigate travelling

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Abstract

Mobile devices and networks are spreading throughout the world, and mobile applications are increasingly becoming a more important part in our every day life. This thesis address accessibility and ease of use in applications by looking into Universal Design (UD), including the influence users may play in the design process of such an application through a Participatory Design (PD) process. Themes related to UD, Interaction Design (ID), context-aware computing, and the PD approach are emphasized in order to address this.

The goal of this thesis is to highlight three important matters. First of all, it aims to gain an understanding as to how PD as an approach and design practice is comparable and useful when related to the concepts in UD.

Furthermore, it will examine and reveal issues of usability and accessibility corresponding to the use of the application RuterReise, a travel planner used for travelling with public transport in the city of Oslo.

By having established both a theoretical and an empirical foundation, the final goal is to examine how a new design proposal can be developed with users to address these issues and create a more universal application. The focus will be on the actively involved users, context-awareness and important design principles.

These matters have been highlighted by providing a theoretical background which addresses the themes at hand. An extensive in-situ investigation of the application with various user groups, has been conducted to form an understanding of their needs and requirements. By conducting a workshop with participants with discussions and a prototyping session, these issues were addressed and evaluated using a participatory approach, and the foundation for a design proposal was established. This was further developed by the researcher, how later received feedback from the participants on this proposal.

The findings show a tight connection between the principles of UD and PD, and that PD through its elements of democracy and equal power, mutual learning, creation of a independent fora for discussion, and through user influence and participation in the design process, provide the necessary means to ensure an accessible and a universally usable application.

Furthermore, the gathering and analysis of the data, showed several issues in the application RuterReise. The issues highlighted specific themes related to the different stages in the travelling process, and showed problems that were experienced by the users in their real-world context.

The creation of a design proposal with direct user participation through a participatory approach, showed how users can actively affect these matters and learn from each other.

Moreover, the research highlights how the cooperation between stakeholders makes it possible to create a common solution, and that PD in a practical manner can be applied to increase accessibility and usability by giving influence to more vulnerable groups in the society. In the proposal, contextualisation and personalization to different needs and situations played a key role, and were among the concepts used to address the user needs.

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1 Introduction

Mobile phones are important for many people in their everyday life. In our busy lifestyle, we are moving between different contexts, bringing our devices with us to and from various locations. Whereas the early mobile devices sought to be a mean for communication, the introduction of the smartphone has transformed the device into a provider of multitude of services. It now allows us to pay our bills, book travels, or watch online videos, while remaining connected to the outside world. In a sense, the mobile device has become a "Swiss army knife" in which the goal is to provide us with a variety of tools and functionality, in the manner described by Satyanarayanan (2005).

Within the smartphone, the main functions and tools are provided through mobile applications, which are small, individual and usually isolated software programs specifically programmed to run on mobile operating systems. These offer similar services to what we are used to from computers. However, on the web, our websites need to conform to standards and guidelines for accessibility (Difi 2014*a*), which are developed from W3C (World Wide Web Consortium). While similar rules are starting to be put in place for mobile applications (WAI et al. 2008, W3C 2015*b*), no explicit ground rules have been set for this technology.

Furthermore, recent research points to how guidelines and requirements are not sufficient to assure accessibility. Power et al. (2012) have shown that only about half of the accessibility issues blind users experienced on certain websites could be resolved by adhering to WCAG rules and standards. Similarly, Newell et al. (2011) have argued for designers to establish more empathy with their user groups through ethnographic studies and theatrical techniques, and use this to establish requirements, rather than simply relying on standards and guidelines. In relation to such results, it becomes evident that an investigation into other means that can improve accessibility and usability for both web and mobile applications, is needed.

In addition to becoming more complex and rich in functions, mobile devices have become more lightweight and transportable than previously, an element which we are increasingly utilizing. A rapport issued by the Institute of Transport Economics (Julsrud et al. 2014) which examined the use of mobile communication tools while travelling, showed that 83 % of those who participated in the evaluation, had a smart phone with them, an indication of the way the smartphone has integrated into our society and way of living.

Observing the issues of accessibility in relation to the established web technology, the need for an equivalent study into the same issues with regard to mobile applications becomes apparent. The results from the rapport mentioned previously, also indicate that this is an area which can explored further. Besides the research of Dickinson et al. (2014) who conducted evaluations of tourism applications and their functionality, no other study has to my knowledge addressed specifically travel applications.

This thesis examines these aspects further. Specifically, I examine the design approach of Participatory Design (PD) and compare it with UD to see whether PD is beneficiary and can contribute to the creation of universal designed products in ICT (Information and Communication Technology), such as mobile applications, that are usable and accessible to all. An investigation into the travel planner *RuterReise* is conducted to assess its abil-

ity to address usability and accessibility problems, before using the results in a co-design approach with participants in order to address these concerns.

Before outlining the specific research questions, I want to explain the motivation for conducting this study.

1.1 | Motivation

To understand the importance of accessibility, we need to understand what it means for users. In 2006-2007 a report to the Norwegian parliament, titled "An Information society for all" was delivered from Norwegian Ministery of Government Administration and Reform (2006). The report addresses several aspects regarding ICT, among these the goal of digital inclusion and ensuring that everyone have the possibility to obtain the skills necessary to use technologies and services, and reducing the differences in the society through the use of ICT. In the report, one paragraph stand out in particular:

> Universal design shall contribute to inclusion, in that the same principles applied to design are to be applied vis-à-vis all people, irrespective of functional ability. It is important to avoid special or alternative adaptations for people with reduced functional ability and instead, as far as possible, to seek solutions that work well both for people who have a functional problem and those who do not (Norwegian Ministery of Government Administration and Reform 2006, p.26).

Having been fortunate enough to participate in a project with deaf participants in a course at my university, I have been able to gain an understanding of what the lack of accessibility entails for vulnerable user groups, and gain insight into some of the challenges users with disabilities face. The aim of the project was to design a prototype of an alarm system for the participants houses, which could improve their living standards. As I grew more fascinated and interested in examining the challenges and obstacles users with disabilities experience daily, it gave me insight into the importance of this work, the knowledge these users have, and how our society can benefit from this. The statement above is to me a reminder of the responsibility we as researchers and designers have in exposing issues and creating designs which are inclusive to all.

In combining these aspects with the experiences I gathered from a course on the development of mobile information systems and services, and my interest in mobile applications and the mobile context, I see the study in this thesis as a small personal step in ensuring a more inclusive mobile context for impaired users. I believe more knowledge is required to further develop our mobile applications, and have used my interest to make a small mark in this field. I hope you find this research as interesting as I do.

Having expressed the driving force for conducting this thesis, the following section will specifically express the research questions.

1.2 | Research questions

While the introduction provided a brief overview, a more specific description of the goals of the thesis needs to be established. The first goal of the research is to evaluate how PD can contribute and be used in combination with Universal Design. Hence, the first research question is:

- **RQ1: In what way can characteristics and qualities in Participatory Design be used together with the concepts of Universal Design?**

Secondly, to reveal issues with mobile applications and gain an understanding of the user experience, an ethnographic study is needed. The second research question is therefore:

- **RQ2: What will an in-situ investigation, focusing on universal usability and accessibility for a mobile travelling application, reveal in terms of issues and problems for users?**

Finally, by having established a theoretical backdrop in RQ1, and uncovered user problems in RQ2, one may be able to address the matters in question by creating a new design proposal and asses its affect. Thus, the third research question is outlined as follows:

- **RQ3: How would a new design proposal that addresses the results in RQ2 through the combination of a Participatory Design practice and context-awareness, contribute to the design of a universally designed travelling application?**

The aim is to provide developers, users and researchers with new knowledge on how we should approach inclusive design and create more universal and accessible mobile applications.

In the next section, a synopsis is given to provide a framework for further reading.

1.3 | Outline of thesis

This thesis is outlined in the following manner. The current chapter has given an introduction to the project, highlighting the research questions, and my motivation for focusing on these aspects.

In **Chapter 2**, a literature review is presented. It describes the theory and research related to the research area and questions. The main topics are Interaction Design (ID), Universal Design (UD), Participatory Design (PD), including focus on the mobile context and contextual awareness. Each of these are described in detail with regard to historic development, methods and processes, and its underlying descriptions and principles. This chapter is extensive in order to provide a broad overview of fields in question and the relations between them. The chapter concludes with a section on related projects which gives the reader a notion of the related research projects.

In **Chapter 3**, the methodology of the research is addressed. It explains the use of qualitative and quantitative research, and the concept of ethnography. It continues by describing the methods of participant observation and semi-structured interviews as means of gathering data, and the context of their use. The chapter also refer to the concepts of future workshop, prototyping, and heuristic evaluation mentioned in Chapter 2. These were the methods used for the data gathering in this thesis, and the chapter explains how these methods were applied in practice. The chapter concludes by addressing the ethical issues of research, particularly with regard to the participation of disabled users, and how I have handled this.

In **Chapter 4**, the context of the research is outlined. It describes the company Ruter and the project "Mobile Applikasjoner Underveis" in detail, before highlighting the functionality and features of the mobile application RuterReise on several devices. The chapter concludes with outlining the choice, recruitment and range of diversity in terms of participants, and the technology and devices they used.

In **Chapter 5**, the main findings of the data gathering are presented. This chapter is rich and comprehensive in order to provide a broad examination of the issues in the application. The main themes and issues are highlighted through the three phases of a user journey. The chapter continues by describing the results of the workshop and the following post-workshop interviews. It concludes with the results from the heuristic evaluation of the application in order to further highlight relevant technical issues.

In **Chapter 6**, a design proposal is put forward which aims to address the results presented in chapter 5, and present a possible solution to these issues.

In **Chapter 7**, a discussion of the findings in relation to relevant research and theory is presented, and tries to highlight the results with regard to the research questions at hand.

Chapter 8 is a conclusion of the thesis where I summarize the objectives and findings of the research, and discuss briefly necessary research and development for future work.

It should be noted that while the thesis is written in English, some quotes from Norwegian researchers and all the quotes from the participants are in Norwegian, as to not distort their meaning through translation. The questions from the observations and interviews seen in Appendix A and B, and content of the consent form in Appendix D, is also in Norwegian, as this was the language used by the participants.

In addition, as English is not my native tongue, I am aware that certain misspellings

and errors may occur. In my opinion, research should be available to as many people as possible. Writing the thesis in English is one method for achieving this. It further allows me to improve my fluency of this language.

Having finished outlining the framework of the research, the next chapter will address important research, theories and findings related to the fields in question.

2 | Related Research

The following sections will highlight literature and research that are relevant for investigating universal design in mobile applications. Specifically, themes regarding ID, PD, UD, and context awareness will be addressed. The first section is an account of the development of theories and concepts that have lead up to the ID practice and its principles. It will also address the topic of users, and the different models that can be used for the design process when creating ICT solutions.

2.1 | From ergonomics to Interaction Design

To gain an understanding of design in ICT, it is wise to look into its the principles for design and its usability. Norman has described how design is complex and cover many disciplines and notes how it can be seen as an act of communication, where the designer needs to gain an understanding of the person he is communicating with. The design must convey to the user the operations and actions that can be performed, and through feedback notify the user what the device is doing at any particular moment (Norman 2002).

To create useful and understandable products, he describes some key principles:

- **Conceptual models:** We use our minds to understand and form meanings to the things happening around us. To understand the use of an element, we need to have a conceptual model for how it will work, to avoid making errors. To ensure this, there must be communication between user and designer. This communication is through the device, and its conceptual model. Both the location and operation of a control in the device requires a conceptual model, a clear and obvious relationship between them in order for the user to understand what an effect and action a control has. If the designer does not provide this model, the user is forced to create one himself, leading to errors. Thus, the conceptual model is an important element in this process, and is a crucial element for creating good design.
- **Feedback:** Users must be able to observe the effect of an action and understand that something has happened, not wonder whether something went wrong. This element is critical.
- **Constraints:** The inclusion of constraints is intended to make it easier for users to use a device by providing fewer choices and options, which may also prevent errors.
- **Affordance:** The designer should make sure that appropriate actions are made perceptible, and that inappropriate actions are hidden from users to avoid mistakes being made.

What Norman suggests is to inform our interfaces by psychology and through the design of artifacts from our everyday life. Looking at the topic of ICT, the origins of creating such artifacts can be traced back to the development of Human-Computer Interaction(HCI) and the discipline of human factors and ergonomics. As a branch of applied psychology, its focus is on assisting and enhancing the design of artifacts. Having originated from studying work practises early in the 20th century, the practice gained increased

attention during and after World War II as it was used to evaluate weaponry which was increasing in complexity (Baecker et al. 2000).

In early research on human factors, the focus was on interfaces which were to be used in control rooms and to monitor the processes of manufacturing. Laboratory experiments were conducted to measure psycho-physiological reaction of the participants. The result was numerous guidelines and checklists for creating interfaces for such environments (Fuglerud 2014).

Baecker et al. (2000) has given an account of the early history of HCI. In the 60s, the users who interacted with the computers were programmers, and HCI was viewed to primarily be a programmer-computer interaction, a discipline often noted as the psychology of computer programming. Many researchers therefore began to use methods from psychology to understand programmers and their design of computers.

However, in the 70s, the user mass changed as an increasing amount of non-programmers began directly interacting with computers. As the personal workstation was developed by Xerox Palo Alto Research Center through prototypes such as Alto, there were also development in the areas of graphical interfaces, applications and local area networking. Combining this with the later development of the "Reactive Engine" and the "Dynabook" by Alan Kay, the notion of a personal computer gradually emerged. It would immensely increase the consumers availability of computer power and the usefulness of the computer. The popularity of the Apple Macintosh, which was the first commercial success from using the Xerox human interface, is proof to how users desired a more user friendly interface for their computers (Baecker et al. 2000).

Rosson & Carroll (2002) further explains that as the user mass increased in its diversity, user interfaces became a significant part of software engineering. The customization and installation of applications were simplified, and more emphasis was put on the needs and preferences of users. Thus, the element of usability emerged, in order to measure the system quality with regard to learning, ease of use and satisfaction. The human performance became an important aspect, and the intention was for this to be improved through laboratory experiments. The goal was to create an optimal performance through reducing keystrokes and execution times. However, the experiments showed that optimization cannot form a solid foundation for usability, as it is too narrow and does not necessarily provide user ease or satisfaction. In addition, the set up and execution of the laboratory experiments proved expensive and slow, and its findings were often too general to be of significant value.

Furthermore, as cognitive scientists, psychologists and other researchers began using computers for their research, they used their own experiences from using this technology to start research programs. These programs aimed towards understanding the learnability users had from using computers to solve problems. Cognitive scientists were very influential in this work, and focused on complex tasks such as editing of texts, spreadsheets and databases. This initial research showed the shared interest between computer science and cognitive science, and opened up the era for the discipline noted as HCI (Rosson & Carroll 2002).

Karat & Karat (2003) has noted that later, the focus of the field was altered towards the context of use and the user itself, and was broadened in terms of what design for usability should entail. The use of computer technology was spread to other parts of the world,

and other traditions who focused on a broader study of work, began influencing HCI. The participation of workers was being emphasized, especially in Scandinavia where workers increased their involvement in the design process of the workplace and their tools. This meant the keywords PD and user-centered design(UCD) became relevant for HCI conferences as well. The use of ethnography and study of human activity took a more dominant role, and users now had a influential involvement beyond being watched in lab experiments.

HCI has evolved from focusing on interface between the computer and the user, to acknowledging the importance of designing for interaction and user experience, in order to fit the technology to the user needs. As the change in technological development have increased, so have the user mass and the context in which the technology is used. The emergence of the term used for designers from human factor specialists to usability experts and user-centered designers is additional proof, as the interest has grown towards understanding user needs and using these to inform the design. One definition of such a process is to denote it as an iterative process for developing usable systems, through the involvement of its potential users. But the term design is treacherous, and will present different meanings to different people. What constitutes as good design is not only to create a product to a fit a purpose, but include considerations into aesthetics and factors that may contribute to its value (Karat & Karat 2003).

The story of HCI is clearly a story of many disciplines and approaches. The object of bringing these together relate to what Rogers et al. (2011) denote as Interaction Design(ID). Though its similarities with HCI are many, the authors argue that the main question is on the scope related to term. The scope of ID is wider, and addresses both the theory, research and practice of designing user experiences for all forms of technologies, systems and products (Rogers et al. 2011). The amount of disciplines related to this field becomes evident when looking at the illustration in Figure 2.1, and highlights the difficulty of defining the term as it widens, and becomes an umbrella term.

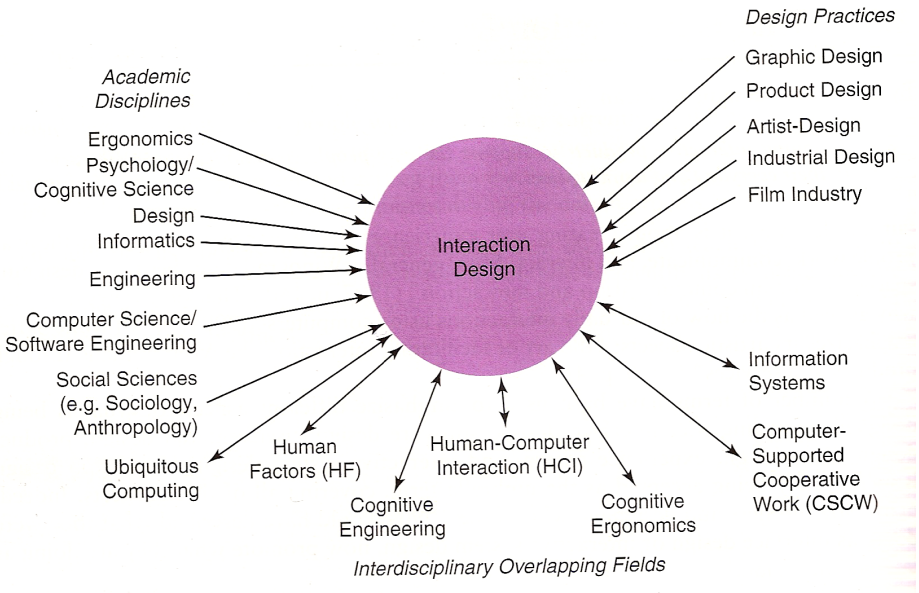


Figure 2.1: The various disiplinces connected to interaction design (Rogers et al. 2011).

The complexity in ID increases when examining the various definitions used. Rogers et al. (2011) defines ID as *"designing interactive products to support the way people communicate and interact in their everyday and working lives"* (Rogers et al. 2011, p.9), in which the goal is to promote user experiences by using methods, techniques and frameworks which designers may use to interact with users.

Winograd(1997) has used a broader definition in describing ID as *"designing spaces for human communication and interaction"* (in Rogers et al. 2011, p.9).

Another definition is given by Löwgren & Stolterman (2004), who outlines the discipline in the following manner:

> Interaction design refers to the process that is arranged within existing resource constraints to create, shape, and decide all use-oriented qualities(structural, functional, ethical, and aesthetic) of a digital artifact for one or many clients (Löwgren & Stolterman 2004, p.5).

Whether the designer chooses to focus on the product or the qualities of it, seems to be an individual standpoint. The main goal is to enable for user experiences, examine how the product performs, and is being used by users in real life. As such, the user experience addresses the overall feel and satisfaction of a product and its usability, and its sensations (Rogers et al. 2011).

However, the concept of user experience can have various meanings to different researchers. Law et al. (2009) survey with researchers defining user experience showed that while it is hard to define this concept, most agreed on it being dynamic, context dependent and subjective. The author suggest defining user experience as an individual rather than a social aspect which materializes when interacting with a product, system, service or object.

A broad definition is given by Nielsen & Norman (2015) in the notion that *""User experience" encompasses all aspects of the end-user's interaction with the company, its services, and its products."*

The ISO 9241-210 standard (ISO 2010) outlines a different perspective and definition, which is by Law et al. (2009) noted to be in accordance with the view of their respondents regarding the subjectivity of user experience, describing it as a *"person's perceptions and responses resulting from the use and/or anticipated use of a product, system or service"*

Regardless which definition one chooses to adapt, the essential focus is on the user and their experience with the product.

However, Rogers et al. (2011) have described how the design of usable products, is not down to designers creating good user experiences. Thus, user experiences are not designed themselves, but are evoked by how the users experience the design and use of a product. A way that can help designers to evoke positive user experiences, is to acknowledge the importance of usability, functionality, content and aesthetics. These can be used to understand the behaviour of a product, and how users utilizes it. Through conceptualizing and understanding the current user experience, designers are able to understand the nature of the problem space and express it. (Rogers et al. 2011). But, despite several frameworks and theories being developed, there is no common tool to use to ensure positive user experiences. Instead, it seems designers will have to choose the one most suitable to their standpoint and research.

What I believe should be the key aspect in ID, and which highlights a recent change in the overall intention behind a design process, can be summed up in a quote by Sanders & Stappers (2008):

> We are no longer simply designing products for users. We are designing for the future experiences of people, communities and cultures who now are connected and informed in ways that were unimaginable even 10 years ago. (Sanders & Stappers 2008, p.10)

Before going into the principles in ID, we first need to look into the aspects of usability and user experience goals.

2.1.1 | Usability Goals and User Experience Goals

I have earlier noted how researchers began to focus on the concept of usability, but without fully explaining what this concept involves. A general description of usability is provided by Rogers et al. (2011), who explain that usability is to make sure that the product is easy to learn, simple and effective to use, and at the same time is viewed to be enjoyable by the user. The ISO 9241-11 (ISO 1998) has defined 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."*

The same definition is mentioned by Bevan (1995), who explains how usability is synonymous to quality of use, in which the product meets its specification and can be applied to the real world. Bevan has further argued that the aim for usability should be for the user to achieve their intended goal when using a product. Usability is as such not only related to the ease of use, but includes the utility provided, the reliability of the product, and its computer efficiency, which will require trade-offs.

Nielsen (2012) has described usability as a quality attribute that is used to assess how easy it is to utilize a user interface. He highlights five key components when defining usability; learnability, effiency, memorability, errors and satisfaction. Another important quality attribute connected to the concept of usability, is the utility, describing the functionality of the design. Nielsen explains that the combination of the two will determine the usefulness of an interface.

Of the key concepts and features mentioned in outlined definitions, ease of use, utility, satisfaction, and effectiveness stand out in particular.

When identifying the objectives for a interactive device, a division is made between usability goals and user experience goals. The aim of usability goals is to focus on the product adhering to one or several criteria or goals, for example whether a product is easy to learn or effective to use. The intention is to equip the designer with means for determining the different aspects of a product, including the user experience of it. The usability goals are commonly broken into six separate goals (Rogers et al. 2011):

- Effectiveness: Is viewed to be a general goal aimed at deciding how well a product is accomplishing what it is suppose to do.
- Efficiency: Describes the capability of a product to support users in conducting their tasks.

- Safety: Aims to protect the user from dangerous conditions and undesirable situations when using the product.
- Utility: To what extent the product will provide the right functions and enable the users to perform their desired or necessary task(s).
- Learnability: Refers to how easy it is to learn to use the system at hand.
- Memorability: Refers to how easy it is for a user to remember the use of a product once he/she has learned it.

The goals may also be seen as usability criteria that facilitate a check of the usability with regard to an increase or decrease in the performance from users. In these assessments, quantitative indexes are used, for example by counting the number of errors made by users to check for increased productivity.

On a more personal level, we find the user experience goals where the users emotions and experiences of using the product are expressed in their own terms. The concern is on untangling the essence of the user experience, for example, whether an element is visually pleasing to the user. These goals are usually subjective qualities and describes the experience of a product from the users point of view. The intention is to give users means to express themselves and their opinions in various terms that can support the multifaceted nature of their experiences. By providing similar terms, users are able to subtly alter their opinions as their experience varies. Some common terms used to describe an experience is fun, enjoyable, boring, unpleasant or helpful. It is important to mention that usability is vital to both the quality of a user experience and its various aspects, for example, how appearance can affect how usable a product is. Thus, the distinction between the two goals is not clear-cut (Rogers et al. 2011).

Having explained the concepts of user experience and usability, the following section will highlight the design principles used in ID.

2.1.2 | Design Principles

I mentioned earlier the overall principles of design outlined by Norman (2002). With regard to ID, similar principles have been adapted. Their role is to aid the designers in their thought process and provide the necessary space for the user experience to take place. As general abstractions, design principles are intended to orient the designer's towards thinking about different aspects of their design. The principles have been developed from a mix of experience and theoretical knowledge together with rationality, and is intended to provide designers with a list of what to include or avoid in a interface. However, their role is not to explain to the designer how to design the interface, but to ensure that they have provided certain necessary features. The most common core principles that have emerged are quite similar to those expressed by Norman (2002), and Rogers et al. (2011) has outlined some of the key concepts.

- **Visibility:** As the visibility of possible actions and functions increase, the more likely it is that users will know what to do. On the other hand, if the functions are not visible, it will be more difficult to locate and understand their use.

- **Feedback:** Relates to the aspect of providing feedback to users, and concerns the sending of information about completed actions and events to notify the user of the result of an action, enabling them to continue with their activity. This feedback could come in various forms (audio, visual, tactile, etc.). The combinations of feedback from various activities are an important influence on the users visibility, and their ability to locate and understand interactions.
- **Constraints:** The goal of using constraints is to determine means that will limit the available interactions a user has at a given time, for example, in a user interface. One example is to deactivate menu options through shading them. Constraints prevents the users from choosing the wrong options, and lowers the possibility of them making mistakes. Lowering the number of available options and interactions may also reduce the user's perception of the problem or information space.
- **Consistency:** Refers to the idea of designing interfaces where the similar tasks of the interface are operated and achieved by using similar operations and elements, for example through the use of rules without exceptions. The goal is to not make actions arbitrary, which allows for users to make mistakes when they do not remember the operation. A consistent interface is easier to learn and use, as users only have to learn a single operation that applies to all elements. Note that adhering to this concept becomes more difficult as the complexity of the interface increases.
- **Affordance:** Explains how the attribute of an object allows for the user to know how to use it. For example, a door handle suggests pulling, cup handle promote grasping and keyboard mouse invites users to push the mouse buttons. Providing perceptional and obvious affordances means the user will know how to use the object, and is used in ID to create interfaces elements which are so easy to understand that a person will know the possible actions they provide.

It is important to note that creating products based on these design principles often involves a trade-off between them, as providing for one principle means other principles will suffer from it. An example is how creating constrains may make information less visible (Rogers et al. 2011). The designer may therefore have to prioritize and select the principle that is most important for the interface. As such, it is difficult to focus an equal amount on all aspects.

However, the principles are to be viewed as steps a designer may take to provide a good user experience, in a similar way to how the designer has to choose between the various design processes to use, which the next section will address.

2.2 | The process of designing

The previous sections have noted how ID has moved from focusing on computers and machines to the user who operates them. To design a product or system will require interaction with people. Thus, a user-centred approach is preferred, where users and their goals is what drives the development of the product. Three principles which are seen as important in achieving this, have been outlined by Gould & Lewis (1985).

- Early focus on users and task: The designers need to understand who their future users will be. This can be done by studying their cognitive, behavioural and anthropometric characteristics as well as other aspects of their personality, and by examining the nature of the work which the users will conduct.
- Empirical measures: The intended users should at an early stage in the development process use simulations and prototypes to carry out real work. The performance and reactions from this work should be observed, recorded, and analyzed.
- Iterative Design: When problems are reveal by user testing, they must be fixed. This requires an iterative design process with a cycle of designing, testing and measuring, and redesigning, repeated as often as deemed necessary.

Fuglerud (2014) has noted that while there are various interpretations of UCD, there seems to be a common understanding on these principles. The adoption of these principles will in turn make the user's skills and decisions relevant to the activity taking place, which will support the user.

In terms of the practice of ID, four activities have been listed as important; establishing requirements, designing alternatives, prototyping and evaluating. The four elements are meant to inform each other and are to be repeated throughout the process (Rogers et al. 2011). Each of them are addressed in the following sections.

Establishing Requirements

To design a product which can help users, one needs to know the intended target group and the support the product should provide. The needs of these users are what shapes the basic requirements of the product, and are used as the foundation for the design and its development. However, as establishing these requirements is an iterative activity, the various subactivities will inform and affect each other, and be clarified and re-scoped throughout the process. A requirement is a description of the action and performance of an intended product and should be as clear as possible. Requirements are usually divided into functional which states the actions of the system, and non-functional stating the constraints and developments of the system. Though various types of requirements can be elaborated on (functional, data, social, organizational), the two main elements primarily highlighted in this research are the aspects of usability and user experience goals. In addition, the environmental aspect as to what context the interface is operating in, and the technical requirement of compatibility (Rogers et al. 2011), will become relevant in terms of UD. The understanding of the requirements and needs are done through gathering and analysing data, using methods such as interviews, questionnaires, direct observations, focus groups and so forth. The execution of such methods will not be further explained here, instead I refer the reader to the chapter on methodology for an insight into the methods used in this research.

Designing alternatives

This process can be broken up into two activities, conceptual design and physical design. Conceptual design is to produce a conceptual model for the design, more precisely to describe in an abstract draft what users can do to a product, and what concepts they need

to understand to be able to interact with it. In terms of what technology to use, these decisions should be made after having decided on the nature of the problem space, in order to understand and to conceptualize the current user experience, and its possible improvements or alterations. Some key elements are the establishment of the usability and user experience goals, in order to understand the problem space. By having explicit assumptions or claims that a designer has to support, one may highlight bad design ideas, which can lead to these being reformulated. Physical design on the other hand, focuses on the details of the product, such as the structure of screens and menus, colors, images and the design of icons (Rogers et al. 2011).

Both of these play a part in the latter stages of prototyping.

Prototyping:

When designing, we create interactive products for users to engage and interact with, which is accomplished through prototyping. A prototype is seen as a design expression, allowing the stakeholders to explore how suitable a design solutions is. In a prototype, certain characteristics will often have gained focus and attention, while other aspects have been de-emphasized. A prototype can serve various purposes. It can act as a communication device between team members, allow for the discussion of ideas, and help designers to explore the design. It may also provide answers and help designers in choosing between various alternatives.

There are two forms of prototyping; low-fidelity and high-fidelity. Low-fidelity prototypes are typically paper or card-board based, and are used as simple and quick solution for exploration of ideas. When used with techniques such as sketching, storyboards or index card, they are also able emulate interactions. High-fidelity will use the same materials and will look similar to the final product, and can be useful to pitch ideas and address technical issues. It is important to note that the nature of prototyping will lead to compromises in design, and that the objective is to be able to create a prototype quickly in order to test certain aspects of the device (Rogers et al. 2011).

Evaluation

An evaluation is seen as a process of determining the usability and acceptance of a device or its design in terms of various criteria, such as the number of errors when using it, its ability to reach a set of requirements, or its appeal to the user. As evaluators gather information on the experience of users, the aim is to improve the design by focusing on the usability and the user experience when interacting with a product. As to what to evaluate, this will vary in terms of what is being developed, its stage of completion, whether its a prototype or a complete system, and the goals of the organization. When to evaluate depends on the item that is being created. If a new product is created, a lot of time may be put into establishing the user requirements, which are later transformed into sketches, screens or prototypes, and evaluated to provide important feedback for the implementation of the user requirements. These requirements can then be modified accordingly. The evaluation during a design process to check for such compliance towards user needs are known as formative evaluations, and is conducted throughout the design process. An evaluation of a finished product is summative, and addresses the success of the developed

device or product (Rogers et al. 2011).

There are several settings that an evaluation can be applied to. Evaluation can be done in a natural setting to decide its use in the real world by using field studies, or in a controlled setting with laboratories, where the designer measures user behaviour or test hypothesises by applying, for example, usability testing. An evaluation may also be conducted in a setting without users, where the researchers criticize and foresee the most obvious usability issues with evaluation methods such as inspections, walkthroughs or heuristics. A combination of various evaluation methods is often conducted to provide a richer understanding of the issues (Rogers et al. 2011).

The four phases outlined should not be seen as separate entities working in isolation. They are intertwined with each other as the result in one phase will influence other phases, indicating an iteration to this user-centered approach (Rogers et al. 2011). This iteration will become important when discussing the various models for conducting the design process.

2.2.1 | Models for the design process

Understanding the relations between the activities mentioned earlier, and being able to observe the development process is a vital aspect. To help them achieve this, designers can used the phases to form what has been described as a lifecycle model for the design process, representing the various activities and their relations. In HCI, various lifecycle models have been developed, such as the Star model (Hartson and Hix, 1989) and the international model ISO 13407. Different models will have different levels of complexity and composure. This will vary according to the size of the project, both in terms of the number of developers needed and the different systems the project needs to employ. It is important to note that any lifecycle model is a simplification and an abstraction of the reality, which will only include details that are relevant for that specific task. Using such a model in practice requires the addition of details relevant to that event and culture (Rogers et al. 2011).

Rogers et al. (2011) have proposed a lifecycle model for ID, which can be seen in Figure 2.2. Note how the project starts by defining the requirements, either from evaluations or previous iterations of the product. From this, one may create alternative designs that address these demands and requirements. The alternatives are expressed and developed through prototypes, and are subsequently evaluated to provide feedback to designers. The feedback may uncover new requirements and issues that needs to be established and addressed, prompt designers to design new alternatives, or begin the implementation of the final product. Several alternative designs may be in development at the same time. The implicit goal is for the design idea to materialize into the final design of the product, by having it be developed through a series of cycles.

In a similar model, Löwgren & Stolterman (2004) have further noted how one must consider the context or situation of the design as well, where the design is initiated and is being conducted. They present a more abstract overview of the design process and describe three levels of abstractions. When being presented with a design situation, a designer will emerge with a vision of a solution to the the problem at hand. The emergence of the vision often depends on the experience of the designer. This is not a specification

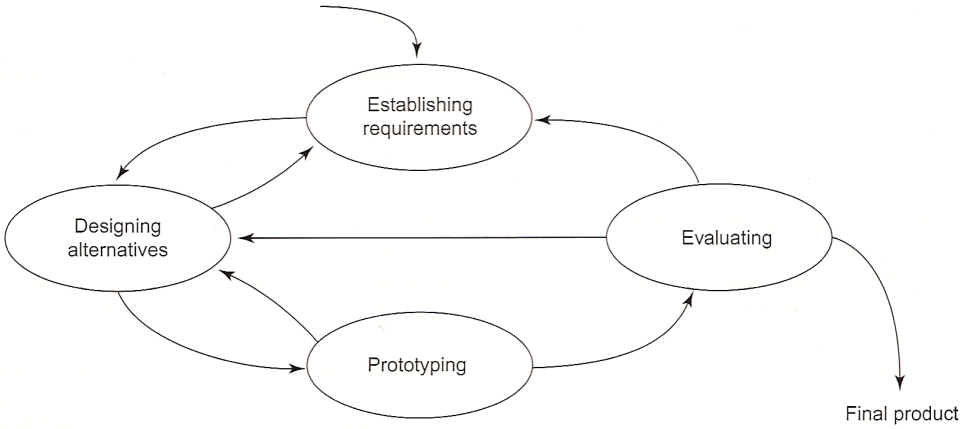


Figure 9.3 A simple interaction design lifecyle model

Figure 2.2: The lifecycle process in interaction design (Rogers et al. 2011).

but an attempt to structure a response to the situation (Nelson and Stolterman 2003)(in Löwgren & Stolterman 2004). As such, there may be several conflicting visions, competing for the attention of the designer. This may appear to be a fault in the process which leads to a blind alley for the design, but instead, this actually contributes to strengthen the visions and ideas of the designers, enabling them to hold various and opposing ideas when conducting the work.

The next stage is to externalize this vision through an operative image. By using initially simple sketches, metaphors and analogies, the design gradually takes shape, becoming the basis for the development of the product. This process is driven by the dialectic relationship the operative image has with the situation and the vision(s). Since there are tensions between these three elements, the designer must be creative by diving into the situation and its complexity with an open mind in order to facilitate creativity. The goal of the operative image is to bridge the gap between an abstract vision and the specific situation. Any of the elements may change over time, and changes in one area will affect other elements, as the operative image is refined and altered. The operative image will usually be more concisely defined once the visible design work takes place. As the image receives new challenges and demands, it will continue to increase in detail and completion. The fact that the image is operational, makes it possible for the designer to manipulate, simulate and visualize the changes, which enables for communication.

When the operative image appears to be sufficiently detailed, the project moves to the phase called specification, in which the image serves as a blueprint for the final design to produce a concrete artifact. However, new issues may arise during this construction phase, leading to new design situations. The design process can therefore be described as dialectic, as all three phases constantly influence and affect one another. This complex relationship of change and development is what Löwgren & Stolterman (2004) denote as the design process. The process and its components are displayed in Figure 2.3.

The two design processes outlined differ in their use of terminology, and Löwgren & Stolterman (2004) approach seem to be more abstract and fluid in its transitions. In addition, this model has added the change the designer experiences during the design process,

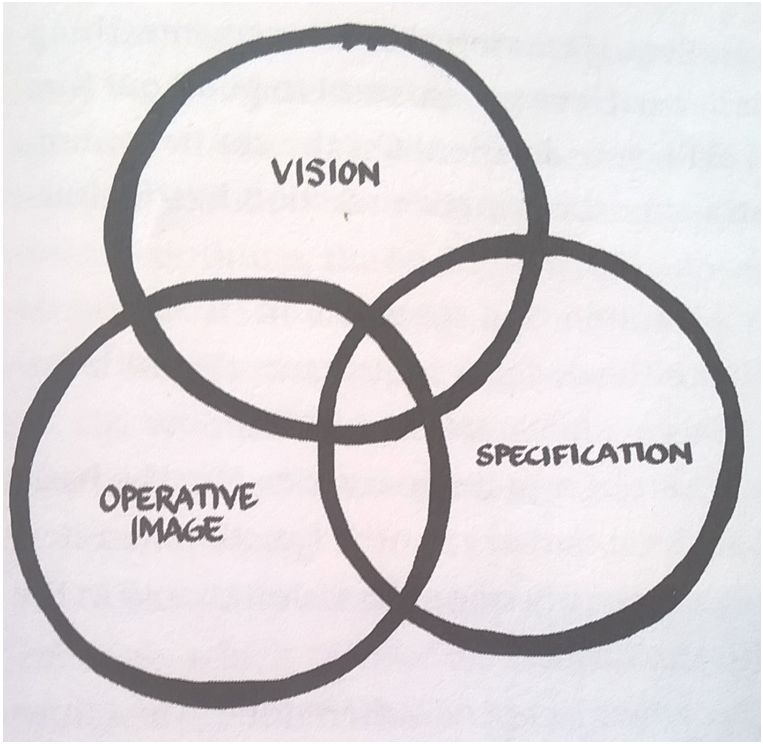


Figure 2.3: The process of design as proposed by (Löwgren & Stolterman 2004)

which should be highlighted. When taking the stance of thoughtful design, designers need to have a deeper understanding of what they are designing for. A design situation is established in parallel to its first design proposals, thus given a set of problems, one tries to formulate a solution. Schön(1987) (in Löwgren & Stolterman 2004) has done research into the actions and consequences in professional design fields. He describes an approach in which a conversation appears between the designer and the situation, where the questions from the designer are formulated through actions and moves rather than words. The response from the situation allows for adaptation of the designer's own actions. This can be described as reflection-in-action, by both applying new design actions and being able to reflect on the actions that was taken, the designer can adapt their own actions from the responses they receive from the situation. Using this, the designer's goal is to learn while trying to create a solution by using the existing knowledge of the situation.

This process of learning requires the input of other stakeholders, especially the users affected by the solution, which is the topic of the next section.

2.2.2 | Users

The previous section have used the term user frequently, without explaining it properly. The word user can be interpreted in different ways, and the involvement of the right user groups are essential to ID and UCD. A simple definition is to classify it as people who directly use a product to achieve a certain task (Rogers et al. 2011).

Eason (1987) (in Rogers et al. 2011) have split user involvement into three categories. Firstly, we find *primary* users which are frequent users who will have first hand experience with the system. Secondly, there are the *occasional* user who primarily use the system through intermediaries. Finally, one must acknowledge the *tertiary* user, who are indi-

rectly affected by the purchase or introduction of a system.

A broader definition is to look at who has a stake in a product. Kotonya and Sommerville (1998)(in Rogers et al. 2011) note stakeholders as those that are afflicted by a new system and can influence its requirements. The number of stakeholders involved will be larger than what is generally considered users, as it includes development teams, and their managers, designers, users, and so forth (Rogers et al. 2011). Alexander & Robertson (2004) have examined the concern of developers in involving the right stakeholders and their problems with user involvement. Their survey highlighted the issues of commitment from managers, the stakeholders lacking the necessary skills and focus to create solutions, locating the right stakeholders, maintaining the interest of stakeholders, as well as other reasons such as lack of communication.

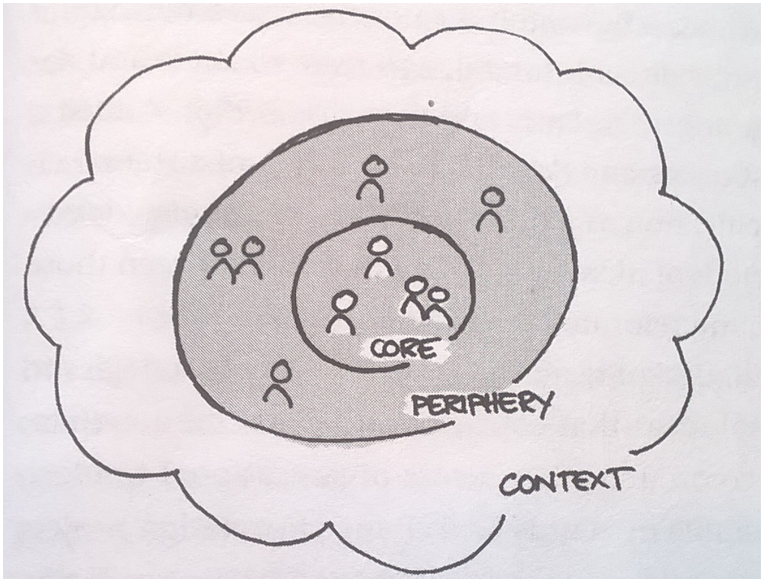


Figure 2.4: Layers of users involvement (Löwgren & Stolterman 2004).

An outline similar to that of Eason is given by Löwgren & Stolterman (2004), who argue that design is a social process, that requires the need for various competences. This indicates a desire for several stakeholders. The requirements of these stakeholders must be managed and organized. The model presented is a three layered structure, seen in Figure 2.4. At the core, we find the designer, working with users or clients directly involved in the process. Outside is the periphery, which include users and clients who are not actively participating in work, but are affected by its outcome, and may indirectly influence it. The final layer is seen as the context. Here, we find the environment and surrounding society which is not involved in the design process, but may still indirectly influence it. Though simplified, this model provides an overview of the complexity in managing a design process. Successful design will require the designer to recognize the relationships between these circles and be able to manage the process within each of them, as all parties will have an affect on the development of the final design.

The goal of any design process will naturally be to create a product which can provide user satisfaction. The attempt to ensure this brings up the issue of the various types of users to design for and their abilities. As such, the concept of Universal Design becomes relevant and will be addressed in the next chapter.

2.3 | Inclusive Design: The confusion of terminology

The following chapter is an extensive account into the field of inclusive and universal design. An overview of the different terminologies and definitions used in this field and their similarities is presented, with the primary focus being on the practices and concepts of UD. Subsequently, underlying principles and approaches for creating universal products are provided, followed by an account of the guidelines and standards that have been designed in order to achieve accessibility on the Web. Finally, a section is presented to highlight the historic development of the mobile network, device and technology, and its relation to the concepts of accessibility and UD.

An overview of the field

Designing for all users can be interpreted differently. Inclusive design approaches can be described as a term which encompasses the means of producing ICT solutions that are to be used by a broad and diverse population, including users with disabilities, reading and writing skills difficulties, elderly users or users with low ICT skills, etc. Among some of the approaches with these goals we find universal design (UD), design for all (DfA), user-sensitive inclusive design, ability-based design and so forth. Though the overall goal is similar in all approaches, they vary in perspective, terms and their emphasizing factors (Fuglerud 2014). The two that are most relevant to this research are UD and DfA.

Before elaborating on these, it is important to highlight the explicit issues these design practices attempt to solve. Though I assume the reader has some notion of what constitutes as a disability, I have in this thesis chosen to adhere to the descriptions by Fuglerud (2014), who refers to this as a handicap or disability in form of a loss, damage or deviation in either biological, physiological or psychological manner, noting it as a property belonging to that individual. Seeing as the environment for this research is in Norway, and as Fuglerud's research examines the Norwegian society, it seems natural to address the topic in the same manner. Fuglerud has further remarked on the move from focusing on the disability as a disease in an individual aspect, to focusing on a disability as a social model as described by Oliver (1990) (in Fuglerud 2014). In this model, disability is not a continual aspect, but can occur through a person's encounter with society when facing of lack of right or access to areas. A model which emphasize this relational aspect is the gap disability model, illustrated in Figure 2.5. It was first published by Ivar Lie in 1989 but had been used in teaching at least a decade earlier (Ness 2011) (in Fuglerud 2014).

The gap model specifies how a disability will develop as the practicalities of a life of a person becomes limited, due to a gap between that person's abilities and the expectations and requirements of the environment or society. In the model, which Fuglerud (2014) has simplified based on the paper on the dismantling of disabling barriers from the Norwegian Ministry of Labour and Social Affairs (2003), the disability gap is indicated by the red curly bracket. The barriers are the conditions which limits the person from participating in the society, indicating that a disability should be seen in relation with its surrounding environment. As such, the focus is not only on the function or ability of a person, but includes other factors which may be altered to decrease requirements or enhance functionality in order to reduce the disability. The design approaches are to be seen as strategies

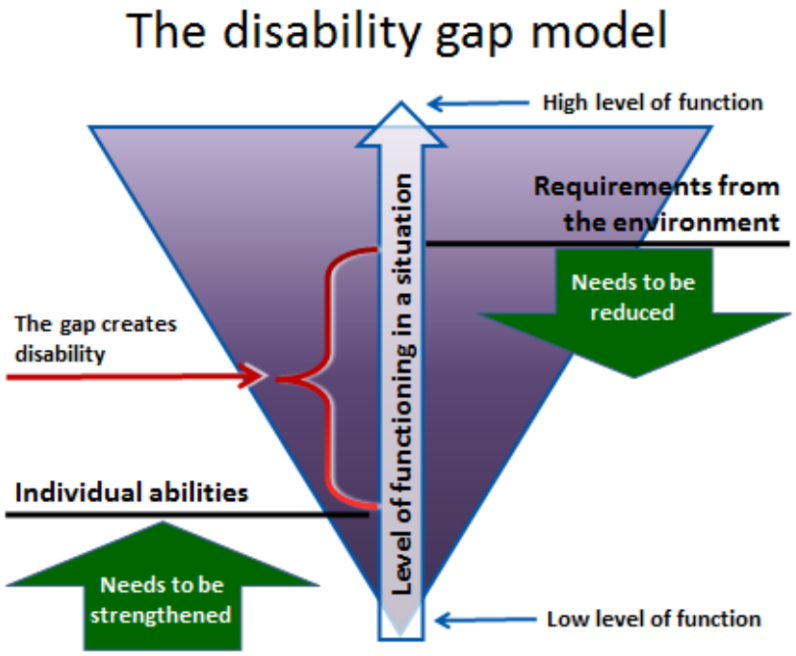


Figure 2.5: The disability gap model as illustrated by Fuglerud (2014)

to achieve this and lower the barrier of using ICT, as indicated by the green arrow to the right. The use of assistive technology is intended to increase the capabilities of users, and can be viewed in the green arrow to the left. By applying an inclusive design approach, the goal is to try and close the disability gap and provide for a high level of functionality, as seen in the illustration (Fuglerud 2014).

Thus, a disability can be interpreted as a impairments created by the environment and society, or due to some form of loss or impairment in the individual. Regardless, it will be a disability experienced by that individual person.

One of the several design approaches to address these issues through inclusive design is Universal Design (UD). First introduced by Ron Mace who founded what is known as The Center for Universal Design at the North Carolina State University (NCSU) in 1989, UD was used in the following manner:

> ...describe the concept of designing all products and the built environment to be aesthetic and usable to the greatest extent possible by everyone, regardless of their age, ability, or status in life (Center for Universal Design 2008).

On the goal of UD, Mace(1998) is stated to have said:

> Universal design seeks to encourage attractive, marketable products that are more usable by everyone. It is design for the built environment and consumer products for a very broad definition of users (in Darzentas & Miesenberger 2005, p.407).

As a term, UD has various definitions. Mace has been credited the following definition which is also referred to by the Norwegian Ministry of Environment (2007, p.7) and

Connell et al. (1997). It states the following: *"Universal design is the design of products and environments to be usable by all people, to the greatest extent possible, without the need for adaptation or specialized design."*

In Article 2 of the Convention on the Rights of Persons with Disabilities by the United Nations, the definition is altered to include the concept of assistive technology:

> "Universal design" means the design of products, environments, programmes and services to be usable by all people, to the greatest extent possible, without the need for adaptation or specialized design. "Universal design" shall not exclude assistive devices for particular groups of persons with disabilities where this is needed (United Nations - Enable 2014).

Lid (2013) have further noted that UD is both a concept and a political strategy that has evolved from a focus on removing barriers and enabling environments for all. By referring to and using the UN convention, UD is seen to have democratic values which acknowledge equal citizenship for all. Her broad definition is the following:

> The object of Universal Design is to plan and manufacture goods, buildings, outdoor spaces and facilities to be usable by all people to the fullest possible extent. (Lid 2013, p.203)

In the legal aspect, Lid (2013) describe how UD is based on the values of participation, non-discrimination, equality and equal opportunities.

This is highlighted in the law on discrimination and availability (DTL), which defines Universal Design in the following manner:

> Med universell utforming menes utforming eller tilrettelegging av hovedløsningen i det fysiske forholdene slik at virksomhetens alminnelige funksjon kan benyttes av flest mulig (Stortinget 2009) (in Tollefsen et al. 2013, p.17).

An interesting point is how earlier definitions in the Norwegian laws did not account for the use of technology and websites in terms of UD. While the Anti-Discrimination and Accessibility Act had the intention of implementing regulations through §11 in regards to UD, ICT and the requirement of universally designed solutions (Tollefsen et al. 2013), it is not until recently that this has taken effect. In 2013, the injunction of Universal Design for ICT solutions (Forskrift om universell utforming av informasjons- og kommunikasjonsteknologiske (IKT)-løsninger) came into effect. In §1, it states the following purpose:

> Forskriftens formål er å sikre universell utforming av informasjons- og kommunikasjonsteknologiske løsninger, uten at det medfører en uforholdsmessig byrde for virksomheten. Med universell utforming menes at utforming eller tilrettelegging av hovedløsningen i informasjons- og kommunikasjonsteknologi er slik at virksomhetens alminnelige funksjon kan benyttes av flest mulig. (The Norwegian Storting 2013)

The Norwegian Agency for Public Management and eGovernment (Difi) has acted in accordance with this, stating that by 1st of July, 2014, all new websites and automates must follow the rules on Universal Design for ICT services, while existing services will need to abide to the same demands by 1st of January, 2021 (Difi 2014*b*). These demands apply both

to public and private activities. This means all websites and their web content are expected to pass at least 35 of the 61 criteria that are given in the WCAG 2.0 guidelines (Difi 2014*a*).

The concept of guidelines and use leads us to the important issue of accessibility. It is at this stage important to stress the difference between UD and accessibility. While UD is aimed at providing for products and surroundings to be used by usable by all people to their largest extent, accessibility is seen by Rogers et al. (2011) as the degree in which an interactive product is accessible to as many people as possible.

The guide from the the International Organization for Standardization (ISO 2014) describe accessibility in a similar fashion by referring to a definition used in earlier ISO guides (ISO 26800, ISO/TR 9241-100, ISO/TR 22411). The definition used is:

> ....the extent to which products, systems, services, environments and facilities can be used by people from a population with the widest range of characteristics and capabilities to achieve a specified goal in a specified context of use. (ISO 2014, p.3)

As such, accessibility is aimed specifically at a technological product or device, and can be seen as a tool to achieve Universal Design.

In the standard from ISO, the difference between UD and accessible design is noted as small, as the terms are being used interchangeably. The latter can be described as having the design focus on various types of users, in order to maximise the number of potential users who can use the system in different contexts. The standard further notes how the terms accessibility and usability overlap, and refer to earlier standards who have emphasized this connection in their definitions. In these standards, accessibility is referred to as both the ease of use in terms of efficiency and satisfaction, and the success and effectiveness of the use (ISO 2014).

The importance of accessibility should not be underestimated, given the amount of users it affects, and the vital role and benefits accessibility on the Web and in ICT solutions, can have on their life situations. This will become an even more crucial aspect with the increasing number of people with disabilities. Accessibility is also important with regard to the moral aspect in developing ICT solutions, and how the improvement in accessibility enhances usability for all users (Theofanos & Redish 2003). Fuglerud (2014) has further noted a close relationship between usability and accessibility, supported by her own research and the findings from other scientists.

It appears that a common definition for what constitutes as UD is blurry, and that the term can have several focus areas. The complications of the issue increases when examining its similarities with the approach Design for All(DfA). Introduced by the European Design for All e-AccessibilityNetwork (EDeAN 2007), they aim to integrate elderly users and users with disabilities into the ICT society through the following process:

> This will only come about as a result of designing mainstream products and services to be accessible by as broad a range of users as possible. This approach is termed "Design for All" (EDeAN 2007).

Fuglerud (2014) notes that the goal of DfA is to support the user's access to the environment, the services, and to improve usability in products. Darzentas & Miesenberger (2005) explains how DfA is a graded concept which can allow for both standardization and

wide use of products by the majority of users, as well as adapting these products to users with specialized devices and their ways of interaction. In their research, they point to a pyramid for inclusive design introduced by Nordby (2003), which highlights the various levels of accessibility in ICT solutions. This pyramid can be viewed in Figure 2.6.

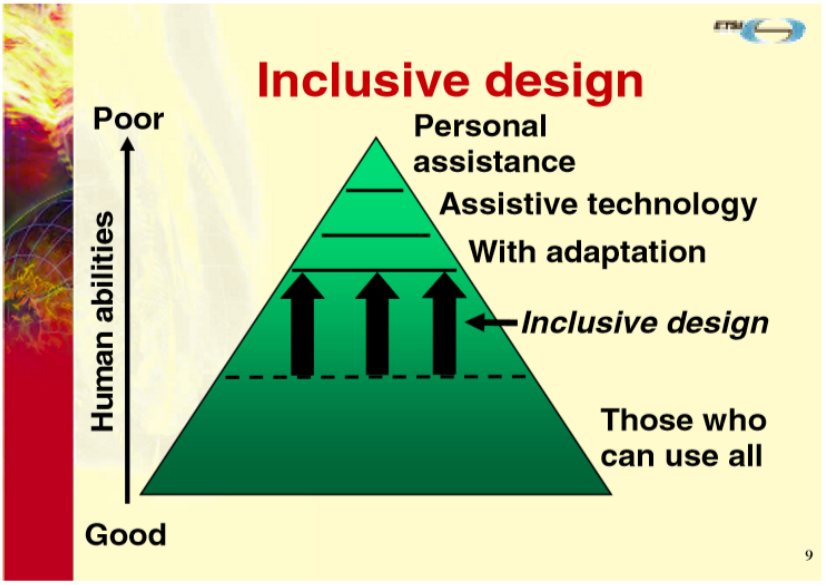


Figure 2.6: The usability pyramid of Nordby (2004) as illustrated by Darzentas & Miesenberger (2005)

As we see from the figure, the bottom part of the pyramid illustrates the majority of users, who are able to use all of the available features without assistive technology. As the human ability and user mass decreases, the adaptation and need for inclusive designed products and services increases, to include those users who are not able to use the solution without assistive technology. Darzentas & Miesenberger (2005) explain that DfA is not advocating for a design that benefits users with certain disabilities and creates issues for others, but to find solutions that provide for all users. Assistive technology can used to provide an extra layer of handling or presentation, which in turn can bridge the gap between the user and the normal interface. They state the following regarding the purpose of DfA: *"The goal of Design for All therefore is to push the boundary between 'Those who can use all' and 'With adaptation' as far up as possible"* (Darzentas & Miesenberger 2005, p.407).

At this point, it is worth highlighting how a term is often simply another way of describing the same aspect. This have been pointed out by Darzentas & Miesenberger (2005) who describe that what they coin as "Design for All", is an attempt to describe something which has different terms in different countries, for example USA (Universal Design), Great Britain and Ireland (Inclusive Design) or Germany (Barrier-free Design). The common element is the qualifier accessible. This is used in all of the terms to describe products, systems or services which have considered all types of users and circumstances. The same issue have been mentioned by ISO (2014) who in their notes remark that:

> Terms such as universal design, accessible design, design for all, barrier-free design, inclusive design and transgenerational design are often used interchangeably with the same meaning (ISO 2014, p.3).

Perhaps the explanation on the confusion of terms is best underlined by the following statement: *"Universell utforming er ikke en egen designretning , men en metode eller teknikk for å veilede og påvirke formgivningsprosessen"* (Aslaksen et al. 1997).

As such, it appears the main concern is the perspective one chooses to adapt. Given that this thesis is written from a Norwegian perspective, it seems natural to adopt the term of Universal Design which is used by the government. Thus, I feel the views presented on UD are suitable to use in this research, and have chosen to adopt this terminology in my research.

Having established the terminology and practice used for this thesis, the following section will present some of the principles relevant for UD.

2.3.1 | Principles for UD

Having discussed UD in terms of definitions, laws and user relations, it is appropriate to continue with a few of its principles. Early on, some core principles were laid out as ground rules. These have been described by Connell et al. (1997) who outline seven principles with regard to UD:

1. Equitable Use: The design is useful and marketable to people with diverse abilities.
2. Flexibility in Use: The design accommodates a wide range of individual preferences and abilities.
3. Simple and Intuitive Use: Use of the design is easy to understand, regardless of the user's experience, knowledge, language skills, or current concentration level.
4. Perceptible Information: The design communicates necessary information effectively to the user, regardless of ambient conditions or the user's sensory abilities.
5. Tolerance for Error: The design minimizes hazards and the adverse consequences of accidental or unintended actions.
6. Low Physical Effort: The design can be used efficiently and comfortably and with a minimum of fatigue.
7. Size and Space for Approach and Use: Appropriate size and space is provided for approach, reach, manipulation, and use regardless of user's body size, posture, or mobility.

Each of these have additional guidelines and examples attached to them. While these principles originally applied to outdoor places and architecture, they can still apply to ICT and use of websites and applications. We all expect websites to be useful and simple to use. Thus, we expect to find the necessary information in an easy and effective manner. As architects and site constructors must design and create for a wide range of user, so must designers and developers create a Web for all users. There is no reason for a blind user or a user with dyslexia to not have the same option of using the Internet as any other user, or to exclude the elderly from the Web but not from entering a park. Looking at the principles in the context of theses reflections, I see no reason why the same principles should not be included when designing for ICT services. As such, we need to address the development approaches and theory that can be used to create universally designed ICT solutions.

2.3.2 | Approaches for UD

In the subsequent sections, different ways for ensuring the creation of universally accessible and usable products are highlighted, among those the integrated approach, and how the different levels of society may influence the design process. The topic of viewing disability in relation to a specific context, is also emphasized.

Integrated approach

Previously, there was a distinction between creating specific equipment for disabled users and creating products suitable for the largest numbers of users possible. Dong (2007) has highlighted the important shift in this approach by addressing the blurring boundary between these two sections of development. Referring to the work of Benktzon (1993), a user model is presented in the form of a pyramid, where users are divided into three levels; at the bottom level, we find the fully-able users with no or only minor disabilities. The middle level represents users with more severe disabilities and reduced muscle strength, while the top level represents users with severe disabilities, who often require help with their daily activities. What Dong (2007) proposes is that there is an integration and merging between the "top-down" approach which focuses on creating purpose built products for user with severe disabilities at the top of the user pyramid, and the "bottom up" approach where one tries to develop for as many users possible at the bottom level of the pyramid, before extending to specific user groups on other levels afterwards. While the two approaches have previously been used in parallel, their boundaries have been blurred. This has opened up for a paradigm shift to an integrated Universal Design approach where the main focus is on recognizing the diversity of users. The arrival of cheaper assistive technology is also seen as an important step in creating products that can be seen as universal by becoming available to the masses, as assistive technology will make the ease of adaptation similar to that of personalization.

The research of Fuglerud (2014) has further highlighted the necessity of an integrated approach which emphasizes on empirical and contextual learning, and the creation of knowledge.

However, the approach described by Dong does not account for the influence other actors besides developers, can have on these issues. To address this matter, we need to look into the ways society can have an impact in the creation of UD products.

Levels of influence

The previous section addressed a practical approach on achieving UD and accessibility, highlighting the issue from a development point of view. A more theoretical standpoint is given by Lid (2013) who by using the UN definition, describes the need to understand disability as a relational model of both person and environment. Such models use both the medical perspective where the focus is on the individual issues of diagnoses, illness, treatment and rehabilitation, and the social model where the disability is seen through the oppression in the society towards individuals, and the focus is on the environmental factors with regard to politics, law, discrimination, architecture and oppression.

Emphasizing the lack of reflection of the inherent theoretical content in UD, such as to how a disability appears and the human concept, the social model is not seen by Lid (2013)

as a sufficient base of knowledge for UD, who calls for a more extensive model regarding disability in UD. She fears that overlooking the human experience will diminish the content of the field into focusing on the technological knowledge of the various barriers, and how to avoid these.

As the relational model conceptualizes disability as a result of interplay between person and environment, it integrates knowledge from both the medical and social perspective. It focuses on what is seen as a person-environment mismatch, described in what is called the gap-model. In this model, the disability is noted as a gap which emerges and become highlighted in a specific situation. Such gaps can be used to develop questions to research on and gain knowledge from. This notion of gap used by Lid (2013) is similar to the model mentioned by Fuglerud (2014).

Lid proposes to use the relation model to focus on three levels that influence discrimination of users with disabilities, as seen in Figure 2.7. The first is the micro level in which the knowledge of the individual is needed to understand their specific perspective. A design should be evaluated from the perspectives of different users. On the macro level, the knowledge gained from user vulnerability is used to inform on a political and legislative level, who can accommodate for the disability as a human condition. The last level is the meso level, where physical barriers are preventing individuals from being part of the society. If technical standards and regulations overlook impaired users, disabilities can materialize, as the requirements fail to adhere to their rights as a citizen. Thus, the concepts of accessibility, usability and UD can be addressed through the three levels of influence. These levels are to be intervowen, and having favourable decisions on the meso and macro levels will improve the lifes of individuals on the micro level, as the disability emerges from the interaction between the individual user and their social environment, and can be analysed in accordance with the relation model.

Macro level	Concept of human, legislation and social justice: Universal Design
Meso level	Projects and technical standards: Universal Design
Micro level	Individual experience: Accessibility and usability

Figure 2.7: Three levels of influence for UD according to Lid (2013)

This interplay of different levels has been backed by Fuglerud (2014), who through research in various projects uncovered issues in the implementation of technical features. She suggest defining a basic set of interactions for users to learn that are both accessible and usable. The developers can then use these when designing their services, including the help functionality. For this to work, the various social levels of Lid (2013) have to be included, particularly on the macro and meso level.

Furthermore, Fuglerud explains that in order to create solutions that are compatible, robust and accessible with assistive technology, a coordinated effort between the macro, meso and micro levels is required. This will make it possible to address issues such as finding the available technology, finding ways to make this technology accessible, and make it easier to reveal the individual experiences from the usability and accessibility issues.

Having explained some of the approaches related to UD, the next section will look into

the context of the disabilities when attempting to address the goals of universal usability and accessibility.

Context and disabilities

In any development process, the context of the user should be addressed. Fuglerud (2014) have noted this and state that even though models in UCD do acknowledge the importance of context, they tend to focus on the capability of a impaired user independently from their situated context, which is where the problems occur. As such, using these models will not provide information on needs and behaviour of such users in their context, and cannot be used to solve actual issues. One method that can help designers to better understand such problems and needs is through direct situation-based contact.

This is supported by the work of Vanderheiden (2000) who advocates that although a disability is a limitation, it is not the only form, as there for each disability is an equal situational constraint which has the same demands. He points to several cases that exemplifies this, such as how no vision for blind users is similar to being in the dark or using the mobile phone while driving, and that lack of dexterity is similar to being in a bouncing vehicle. Other examples are how being a deaf user is similar to working in a very loud environment, or how the lack of cognition in a person, is similar to that of a person which is panicking. As such, each disability can be transferred to equivalent situation-based disability.

To address these situations, the author uses the aspect of universal usability, which is defined as: *"A focus on designing products so that they are usable by the widest range of people operating in the widest range of situations as is commercially practical"* (Vanderheiden 2000, p.32).

Shneiderman (2000) further notes that accessibility is not enough to support efficient use of computer services when he explains the arrival of universal usability as a concept, and that universal usability faces the challenges from the diversity of users and technology, as well as the lack of knowledge among users. His proposal to address these issues is to have a large range of use cases to force designers to consider various designs and provide innovations that can aid everyone.

The arguments from Fuglerud (2014) correspond with this notion, as she describes how inclusive design can be seen as creating designs that are intended for the mainstream market, yet accessible and useful to all. She explains that this challenges the mantra of Gould & Lewis (1985) on “know your user”, and also serves as a paradox, since it is not possible to know every user when designing for everyone. Thus, a first hand experience and knowledge of the different user groups are required in order to design inclusively for all. This is especially the case regarding impaired users and their challenges in the use context, and the knowledge of such issues can be gained through direct user interaction and observation in that context.

Fuglerud goes on by referring to previous research by Fuglerud and Sloan(2013)(in Fuglerud 2014) on how thorough knowledge of the needs of impaired users and their issues in a specific context is vital to innovations for inclusive design, and that this insight can be acquired through user engagement and use of ethnographic methods. Thus, a notion on what is to be viewed as inclusive design in practice will depend on the context, and requires a holistic approach (Fuglerud 2014).

Harper (2007) advocates that since every person is an individual, designing products which can be used by the widest range users possible cannot be achieved or sustained. It requires generalization of users, which leads to exclusion of specific users.

While Harper seems to agree with the statement from Vanderheiden (2000) that no products can be universally usable given the range of abilities and situations for each individual, he disagrees with the notion that universal usability is to be viewed as a function where the aim is think of all users and situations, and that this can be used to create a flexible and practical product which can address different users and conditions.

As such, Harper believes that using a DfA approach for universal usability is not possible. He explains that by focusing on the needs of everyone, one ends up providing for the needs of no one. Instead, a design-for-one approach is proposed, in which the systems will bow to the desire of the user and remove the responsibility from the engineer having to account for every design issue manually. This will be done by having the system respond in a implied manner, and remove the user constraints put in place as the system tries to address the perceived interaction of every user. DfA will then only be necessary when attempting to fill all the disability gaps a technology has created in a poor interface.

Vanderheiden (2000) has focused on the prioritization of features, according to how their absence will create difficulties for specific user groups and situations. To achieve universal usability, he advocates for five important principles which have similarities with the WCAG 2.0 principles; making sure the information from the device is perceived, ensuring that the user can operate the device, facilitating the navigation of information and controls, including the ability to understand the content, and if these objectives are not achievable, making the product compatible with tools used by users that maximizes the fulfilment of these goals.

However, such an approach will probably increase the complexity of an interface as well. Fuglerud (2014) has noted that increased flexibility through functions and having different modalities, combined with assistive technology and personalization, can increase the complexity in the resulting system. Lacking consistency in services will add complexity for users, who will have different experiences and knowledge. This will in turn reduce the usability and cognitive accessibility. The issue of increased complexity is a challenge for all user groups, especially those with cognitive impairments. Given this matter, the goal of reducing complexity and retaining the flexibility requires focus and attention.

This relation between designing for different situations and the inclusive design approach becomes particularly relevant in the design of mobile services and other types of technology used in our everyday life, since these technologies are used in a variety of situations, in which using different types of assistive technologies are not considered as beneficial (Fuglerud 2014).

A final mention should be given to Fuglerud's notion that the involvement of users are necessary to fulfil other goals than those achieved through the impersonal user models, profiles and automatic evaluation tools, as involving users can provide social, cultural and political aspects which are important to address and communicate.

Having concluded this section with mentioning guidelines for universal usability and accessibility, the guidelines for accessibility on the web will be addressed further.

2.3.3 | Accessibility Guidelines for the Web

The organisation in charge of creating web standards is the World Wide Web Consortium (W3C 2015*a*). Their focus is to develop the Internet to its full potential by creating protocols and standards that can ensure long-term growth. One of their primary goals is to facilitate for human communication, commerce and sharing of knowledge by making this available for all people, regardless of hardware, software, infrastructure, language, culture, location or their physical and mental ability (W3C 2015*d*). One of their initiatives which addresses this issue is the Web Accessibility Initiative (W3C 2014*b*), who develops international guidelines and standards for web accessibility, support material to help implement and understand web accessibility, and other resources.

Through this initiative and the Web Content Accessibility Guidelines Working Group (WCAG WG), W3C have together with other organisations and individuals developed a shared standard for accessibility on the web named the Web Content Accessibility Guidelines (WCAG). This aims to address the needs of individuals, organizations and governments. The primary target audience are developers of web content, web authoring tools, web evaluation tools or others in need of a standard regarding accessibility on the web (WAI 2005*c*).

In the current version of the standard called WCAG 2.0 (W3C 2008), there are the four principles of accessibility to adhere by; perceivable, operable, understandable and robust. Each principle have a set of guidelines that address that specific principle. There are in total 12 guidelines, which have the goal of making sure content is accessible to as many as possible, and can be represented in various forms according to the sensory, physical and cognitive ability of the user. Each guideline have success criteria written as statements that can be used to test and see if the web content is abiding to the conformance rules and requirements (W3C 2014*a*). The content is said to conform if it meets the requirements in the success criteria of the WCAG 2.0 standard. Note that the standard has three levels of conformance with various criteria. The levels range from the levels A, AA and up to AAA which is the highest level. The reason for having three levels of conformance, is to adapt to various situations that may require or allow for greater accessibility (W3C 2015*c*).

Compared to the previous version of the WCAG 1.0 standard, the WCAG 2.0 standard is said to apply to different Web technologies, and its guidelines can also be employed to future technologies. Moreover, where the WCAG 1.0 standard was focusing on checkpoints in guidelines that were prioritized and used to check for conformance, the WCAG 2.0 standard is based on the design principles of Web accessibility, with underlying guidelines that have testable success criteria and levels for conformance that the web content needs to adhere to (WAI 2009).

The principles and guidelines from WCAG 2.0 standard are outlined below (W3C 2008).

- **Principle 1: Perceivable - Information and user interface components must be presentable to users in ways they can perceive.**
  - Guideline 1.1 Text Alternatives: Provide text alternatives for any non-text content so that it can be changed into other forms people need, such as large print, braille, speech, symbols or simpler language
  - Guideline 1.2 Time-based Media: Provide alternatives for time-based media.

  - Guideline 1.3 Adaptable: Create content that can be presented in different ways (for example simpler layout) without losing information or structure.
  - Guideline 1.4 Distinguishable: Make it easier for users to see and hear content including separating foreground from background.

- **Principle 2: Operable - User interface components and navigation must be operable.**
  - Guideline 2.1 Keyboard Accessible: Make all functionality available from a keyboard.
  - Guideline 2.2 Enough Time: Provide users enough time to read and use content.
  - Guideline 2.3 Seizures: Do not design content in a way that is known to cause seizures.
  - Guideline 2.4 Navigable: Provide ways to help users navigate, find content, and determine where they are.

- **Principle 3: Understandable - Information and the operation of user interface must be understandable.**
  - Guideline 3.1 Readable: Make text content readable and understandable.
  - Guideline 3.2 Predictable: Make Web pages appear and operate in predictable ways.
  - Guideline 3.3 Input Assistance: Help users avoid and correct mistakes.

- **Principle 4: Robust - Content must be robust enough that it can be interpreted reliably by a wide variety of user agents, including assistive technologies.**
  - Guideline 4.1 Compatible: Maximize compatibility with current and future user agents, including assistive technologies.

It is worth noting how the W3C specifies that the content may not be usable to people with a variety of disabilities, even if the success criteria are conformed too, and that qualitative heuristic and usability testing is recommended. They advocate for including users with disabilities in the test group when conducting user testing of the content, in order to understand how users with different disabilities use the web (W3C 2014*a*).

Fuglerud (2014) highlights the importance of the users being able to perceive, understand, navigate and interact on the Web, and their ability to contribute to the Web through their use. She criticizes the fact that WCAG 2.0 guidelines do not emphasize on using methods that can achieve usability, despite having highlighted themselves the aid users can provide (W3C WAI Users 2005)(in Fuglerud 2014).

Though other guidelines for web content have been developed, for example the guidelines of Theofanos & Redish (2003) on how to create websites that can be used with a screen reader, the WCAG standard seems to have become a cornerstone for designing systems, websites and applications that can be usable and accessible to all.

W3C have also created guidelines for tools, among these the ATAG (Authoring Tool Accessibility Guidelines). The authoring tool is a software that enables developers, designers, writers, etc to produce web content, and the ATAG guidelines are used to explain how the

tool itself can become accessible in order for user with disabilities to create content, and to help the authors create accessible content that meets the requirements of WCAG 2.0 standard (WAI 2005*a*). Another important set of guidelines are the UAAG (User Agent Accessibility Guidelines) which describes how to make user agents such as web browsers, assistive technologies and media players accessible to users with disabilities, and increase their access to the web content. UAAG guidelines may also be used in the evaluation of various user agents (W3C 2005).

The accessibility on the Web relies on several components, and it is essential that these can work together. Some of these important components are the content, the browser and media player, the assistive technology, the users and developers, and the authoring and evaluation tools. These various components relate to each other and are interdependent, for example, a developer will usually use authoring tools to create content which the user can interact with through browsers, media players or assistive technologies. The idea of the implementation cycle is that when a accessibility feature is present in one component, for example, authoring tools, the other components are likely to implement it, as their interdependency requires it in order to make the Web accessible to everyone. Hence, the implementation of an accessibility feature in one component makes it more likely to be adapted by other components. The cooperation and interdependency between content, developer, and user, is viewed to be essential for making the Web accessible to users with disabilities (WAI 2005*b*).

However, researchers that evaluated prototypes against the WCAG rules, discovered that the prototypes did not conform to the required guidelines. Possible reasons for this was the lack of knowledge or priority among the developers, but in some cases the problems discovered by the users were not violations of the WCAG guidelines or issues that could be resolved by implementing the features so they abided to such rules (Fuglerud 2014). The research from Power et al. (2012) that only about half of the accessibility issues on certain websites can be resolved by WCAG rules, is supported in the work by Fuglerud (2014). She fears only having tools for user-modelling and automated tools to evaluate accessibility rather than using participants with impairments, and advocates for the necessity of user involvement to fulfil other purposes. Fuglerud describes the lack of personality and character in user models, and believes this should be examined and communicated. Referring to her own experience of moving from an indirect observant to an active participant with users, she explains how she gained new understanding and insight with regard to visually impaired users, and how the participants highlighted new aspects that influenced the use situation. Using this experience together with the reflections and experiences of other researchers, she argues strongly that working with actual people is more educational, enlightening, engaging, motivating, challenging, and more rewarding than simply using checklists and user models.

The current guidelines that have been presented, are in relation to content on the web. The same guidelines should be examined in relation to mobile applications and websites, to give the reader an understanding of the same aspects with regard to content on the mobile device. To do so, we first need to look at the development of the mobile technology and its current situation.

2.3.4 | The mobile context

In understanding the development of the mobile phone, one can in many ways compare it to that of the pocket watch. Both grew out of being status symbol to become a commodity of the everyday man. An example of this is how mobile subscriptions passed the one billion mark in 2002. In similar fashion, they have both evolved from being a stationary object in our houses and streets to being carried anywhere, by anyone. A collective account for the mobile phone would naturally address the development from wireless telegraphy of Gugliemo Marconi up to the present day of smartphones and wearables (Agar 2003). However, this is both out of the scope and relevance of this research. Instead, I would like to focus on the development of NTM and later GSM in Europe, and how this has led us to the smartphones of today.

The NTM (Nordic Mobile Telephone) group was founded in 1969 with engineers from Norway, Sweden, Denmark and Finland, with the goal of creating a cellular phone system. As the engineers worked for state-governed businesses, each government was actively involved, and customer surveys were conducted to ensure user satisfaction. The system was launched in 1981 and was a great success, so much that the original NTM 450 by 1986 had grown to its full capacity, and a new system called NTM 900 was launched with a higher capacity. As the stakeholders had decided on the technical details before launching, it was now possible to roam and use the same phone from Helsinki to Oslo. By 1987, about 2 percent of the Nordic population were subscribers. However, the technology was primarily used as a tool by truckers, engineers and construction workers, and had not expanded to extensive private use. Many other countries in Europe had at the same time built their own national mobile cellular systems, which were both more expensive and were inferior in quality when compared to the NTM system. Other countries had bought NTM services from the Nordic countries, which were expensive and required new terminals to be set up. In both cases, there were a low amount of customers that was using the technology (GSMA 2015).

In 1982, the Confederation of European Posts and Telecommunications (CEPT) established GSM (Groupe Speciale Mobile) to design a pan-European mobile technology (GSMA 2015). The main goal was to see if it was possible, both technically and politically, to develop a European wide digital cellular phone system. Creating a digital system would make it possible to both offer new services, such as data transmission, and have the possibility of making a pan-European statement of collaboration to the world (Agar 2003). In 1985, the European Commission(EC) endorsed their support to the GSM, and was followed by the head of state in the European Union a year later (GSMA 2015).

Throughout the 1990s, the development in this project was staggering. In 1991, the first call was made on the GSM system through Radiolinja in Finland, followed by the sending of the first SMS and the signing of the first international roaming agreement a year later. The first hand portable terminals became available in 1993. By 1994, the number of GSM subscribers had surpassed one million. The following year, this was increased to 10 million subscribers, as SMS, fax and data services was introduced, and the first North American network was opened. In 1996, the number of subscribers had increased to fifty million. In 1997, one hundred countries were using the system globally. In 1998, the number of subscribers has doubled to one hundred million (GSMA 2015).

The success story continues the following decade. By 2001, the first 3GSM network started to go live, colour screens were introduced and five hundred million users subscribed to GSM. The next year, over 95 percent of the countries in the world had GSM networks, camera phones were launched and Multimedia Messaging Services(MMS) were introduced. By 2004, GSM had over one billion users. Having introduced EGDE networks in 2003, the first HSPA network was launched in 2005, followed by HSPA+ in 2009. In 2008, GSM had over three billion connections, there were 191 HSPA networks live, and four billion global mobile connections. The LTE standard was released the following year and by 2011, the number of global mobile connections had increased to six billions (GSMA 2015). Looking at the results GSM has achieved, the development in the network is remarkable, both in terms of technology, standards and innovation.

However, this evolution does not tell the development of the phone itself. Rather than focusing on the traditional "dummy" phone that grew out the development of GSM, I turn the attention to the introduction of the smartphone. The smartphones are an integration of the functionality of the PDAs into a voice-centric handset, making it possible to communicate both through voice and text, as well as accessing information while travelling. They allow for synchronization of content with other devices and services, such as email and contacts, and increases the user productivity. In addition, custom applications can run on the device, and the device will have built-in Wifi and Bluetooth, or these features will be offered through expansion cards (Ahson & Ilyas 2008).

The first mobile phone that many recognize as the first smartphone was the Simon Personal Communicator by IBM. It provided a monochrome touchscreen to tap on, with icons for e-mail, calculator, calendar, and so forth. The device offered predictive typing to the next input, mobile applications, and additional features, among these the option of plugging in a memory card to have maps or music available. However, as most of the networks for mobile phone in the early 90s were set aside for voice communication and not data, there were no fast networks to transfer additional features such as apps, and there was no web browser available that could be used on the device. In the end, the product was not a success, and IBM and their partner Bell South chose to end the development of the device (Sager 2012).

When the iPhone was released over a decade later in 2007, it had a digital camera, a widescreen display and innovative input functionality. In addition, the iPhone provided synchronisation with computers and internet services, for example syncing music and video from the iTunes store, or syncing contacts, calendars, photographs, email accounts, etc. The device used a quad band GSM system and had Wi-Fi and Bluetooth functionality built into it. Its Wi-Fi and EDGE options made it possible for the device to automatically connect to the Internet (Honan 2007). In summary, it offered much of the same functionality as Simon, but was helped by the infrastructure of data transmission and browsers being available, especially as mobile applications became influential. The success has been phenomenal, as the latest iPhone 6 version sold over 10 million devices in the first week of release (Apple.Inc 2014). Currently, the two main mobile operating systems for smartphones are iOS and Android, who by 2014 had 96.3% of the market (IDC 2015). It is further estimated that by 2016, two billion people will have a smartphone device (eMarketer 2014). The adaptation of the smartphone can in that sense be seen as a revolution both in consumerism and technological development.

As the number of people with smartphones increases, the device is faced with new demands and requirements from different users groups. The smartphone and its applications will need to address the demands of all types of users, including visually impaired, hearing impaired, elderly, users with dyslexia and so forth. The developers of both Android and iOS have tried to address this by including accessibility options and functions such as the possibility to increase text size, to zoom in on elements, to invert colours, and by providing support for Braille lists. The most important function is perhaps the text-to-speech functionality offered through the screenreaders Talkback (Google.Inc 2015*c*) and VoiceOver (Apple.Inc 2015*b*) which are built into the mobile operating systems of the devices. These functions work as an extra layer by reading out the text on the screen, and allow for easier navigation in the interface (Tollefsen et al. 2013).

However, these functions cannot be seen as sufficient means in the attempt to bridge the gap between the software and the disability of the user. To highlight this issue further, requires an examination of how standards and guidelines can be used to achieve accessibility to the content of mobile websites and applications, which the following sections will highlight.

Guidelines for mobile web

The term mobile accessibility refers to the notion of making websites and applications available to users with disabilities, who are interacting with this content through mobile devices. It does not have separate guidelines, as the W3C believes that the mobile aspect has been handled in the existing WAI guidelines, in particular the WCAG and UAAG guidelines (WAI EOWG 2008). A recent draft on applying the WCAG 2.0 standard with the mobile content and applications, emphasize how these principles, guidelines, and criteria can be used with mobile web content, web applications, native application, or as a hybrid application between the two latter. Note that these are to be seen as guidance for developers and not requirements (WAI et al. 2008). The ATAG guidelines also addresses the software used to create mobile webpages and content, while the UAAG guidelines are used to account for the mobile web browser and user agents.

Other technical work from W3C relating to the mobile context are their recommendations in the Mobile Web Best Practises (WAI et al. 2008), used for the delivery of web content to mobile devices, and the Mobile Web Application Best Practises, which tries to aid developers attempting to create rich and dynamic mobile Web applications (W3C 2010).

In light of these efforts, it seems that the W3C and the WAI believes the WCAG 2.0 guidelines combined with practices for mobile content and software, are sufficient in order to transfer accessibility from the web to the mobile context.

However, some do not agree that the WCAG and WAI guidelines are sufficient for providing the necessary mobile accessibility. Among the critics are Funka.nu, an organisation which started as project by the disability organisations in Sweden, and who works with accessibility in all aspects and formats of ICT (Funka 2014*a*). They have created their own guidelines for developing accessible mobile interfaces, with the critique that adhering to WCAG 2.0 guidelines is not enough to provide accessibility in mobile interfaces, as these guidelines lack the necessary development principles for such interfaces (Funka 2012).

The problems relate to technical issues in terms of using interfaces with assistive technology, and providing pedagogical accessibility towards all users, particularly technology beginners, elderly people, and users with visual,cognitive or motoric issues. The Funka guidelines were developed by identifying, testing, and analysing interfaces, including user testing with users that have disabilities (Funka 2014*b*).

The lack of accessibility guidelines for mobile devices and contexts has also been noted by Fuglerud (2014), who describe the need for advice to ensure accessible design in these situations. She suggests using a combination of staying with the regular standards and guidelines, but be sensitive to the needs and context of the user.

It should be noted that some actions have been taken with regard to mobile applications, which will be discussed in the next section.

Guidelines for mobile applications

Schulz et al. (2015) notes that the primary focus for the Funka guidelines is on the mobile website, while they may apply to applications as well. They advocate for the use of best practices when creating accessible mobile applications, where one important suggestion is to involve users with disabilities in the research to advise in both the development and evaluation of the application. This seems to be the biggest alteration from the other guidelines.

Other suggestions from Schulz et al. (2015) address the more technical and visual aspects, for example, the contrast used for colours, the choice of typeface, the language, the alternative text used for the visual information, having different cues for the important information, providing good labels for items, having media in several formats, testing the application with assistive technology, etc.

Furthermore, while previous guidelines on accessibility for mobile content primarily addressed mobile webcontent, the developers of both Android (Google.Inc 2015*d*) and iOS (Apple.Inc 2012) have established guides to ensure that developers of mobile applications, know how program and create accessible applications for their operating system. Developers creating applications for the Android system, are also able to use design patterns and guidelines set up by the Android developers. The application should comply to these guidelines (Google.Inc 2015*a*), which are similar to those mentioned by Schultz.

In addition, Google provides a checklist (Google.Inc 2015*b*) of recommendations and special considerations for developers to address, in an attempt to ensure accessibility in the mobile applications used in their system.

However, for all the guidelines and standards developed, the individual aspects and issues seems to have received little attention from producers and organisations, particularly with regard to mobile applications. While advocating for the importance of consistency, Fuglerud (2014) has emphasized that inclusive design is not achieved by focusing on standards and guidelines, but must be seen in a holistic manner where cultural and social factors are addressed.

Thus, in combination with examining the standard issues, there must be a design approach in use which promote user needs. As such, highlighting an approach in which the personal view of users has a vital role, as seen in the participatory approach, can address this issue.

2.4 | Participatory Design

One of the many disciplines covered by ID, is the design discipline called Participatory Design (PD). Its origins can be traced to the social, political and civil rights movements of the 1960's and 70's, in which people demanded influence in the decisions affecting them, and wanted to actively engage in collective actions that involved their common interests and values (Robertson & Simonsen 2013). In a political context, PD began as an answer to the changes of the society. In countries such as Germany and Austria, groups were actively trying to involve citizens in local issues, while in the USA, there were social issues which were addressed through grass-root actions (Kensing & Greenbaum 2013).

In terms of ICT, PD was pioneered in Europe and especially Scandinavia who focused on democracy in the organisation of the workplace in the 1970's, specifically examining the shift in workplaces as workers were being introduced to computers. The goal of introducing computers was to provide the community with improved tools which would help them extend their skills, and at the same time automate the repetitive work (Alexander & Robertson 2004).

Through the years, PD has matured to become a respected field in the design of ICT products and systems. As we can read from Figure 2.8 presented by Sanders & Stappers (2008) on the landscape of human-centered design research, in UCD, the user is viewed as a subject, while in PD, the focus is centered around establishing the user as a partner. This means an increased use of generative design research methods and tools and a focus on the "Scandinavian approach", rather than focusing on the concepts of usability testing, and human factors and ergonomics as in the UCD approach.

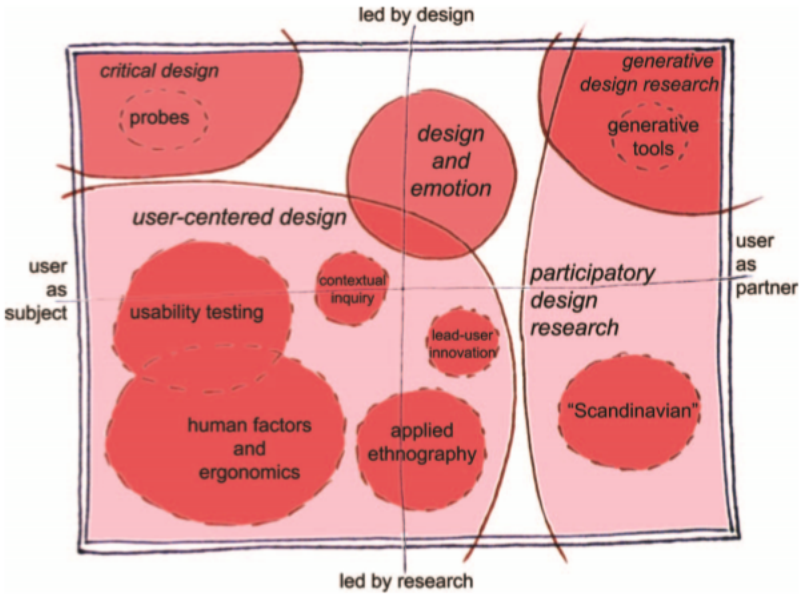


Figure 2.8: The landscape of human-centered design research in practice outlined by Sanders & Stappers (2008)

A specific definition of PD is given by Robertson & Simonsen (2013) who describe it as:

> a process of investigating, understanding, reflecting upon, establishing, developing and supporting mutual learning between multiple participants in collec-

> tive 'reflection-in-action'. The participants typically undertake the two principal roles of users and designers where the designers strive to learn the realities of the users' situation while the users strive to articulate their desired aims and learn appropriate technological means to obtain them (Robertson & Simonsen 2013, p.2).

The roles mentioned by the authors above are central to PD as they enables users of technology to have an influence on the design without knowing the technical language. By expressing their opinions through interactions with representations of the technology, this also allows them as non-professional designers of technology to define what they want from the process, by learning about the technological possibilities. These roles makes it possible to have the two parties inform each other, to imagine new technology, and to learn from the practices, domains and knowledge of others. Thus, it allows for a process of mutual learning for both designers and participants. It should be emphasized that PD as a practice is not defined by formulas, rules and definitions, but through committing to a set of core principles regarding design and participation. These principles are informed through the experiences of previous projects, and the methods, techniques and tools they applied. As designers, we can now adopt these tools and techniques to the design contexts which we participate in (Robertson & Simonsen 2013).

To understand the formation of these concepts, a review of the history of PD and some of the key projects in its development, is needed.

2.4.1 | The history

The idea of involving the workers into the decision-making regarding the technology that should introduced to their workplace, became apparent due to two main reasons. There was an increased management strategy at the time that aimed at reducing the power of workers through automatation and de-skilling, making them interchangable. There was also a particular aspect for Scandinavia, in the legislative power workers had gained through law and work agreements, giving them the right to get information and have partial impact on their working conditions (Kensing & Greenbaum 2013).

Two of the researchers who were pioneers in terms of investigating these issues, were Kristen Nygaard and Olav Terje Bergo (1975a, 1975b), who cooperated with workers in the Norwegian Iron and Metal Union (NJMF). They allowed the workers to voice opinions and influence their future working conditions by letting them have a say regarding the introduction of computers to their workplace. Nygaard became especially active in this work, stressing the importance of having a knowledge base when addressing the management on the way the technology is introduced (Kensing & Greenbaum 2013).

In the NJMF project,the workers became aware that their work process would deteriorate due to the management strategies and they wanted to influence their working conditions, and demanded information about the technology being introduced. Nygaard and Bergo had originally not planned to involve the users actively in the analysis process, but this had to be altered as it became evident that the workers did not see any relevant practical use for the researchers results. An important lesson participatory designers can learn from this, is how plans alters as the designer learns about the context and situation. The researchers therefore began building a knowledge base among the workers using action

research, where the aim was for the workers to share and discuss goals between themselves in order to take action and increase their influence with the managers. The design of the research aimed to build a learning cycle in which actions lead to new knowledge which generated further actions (Kensing & Greenbaum 2013).

From this research, two important elements central to PD was highlighted. First of all, a political aspect in that people should have the right to actively influence their own working conditions.

Secondly, that by actively including workers as participants, the foundation can be outlined for a process where experts and participants can gain knowledge by learning from each other. This knowledge can be used in the design process, and the concept of achieving this is denoted as mutual learning (Kensing & Greenbaum 2013).

However, the NJMF project did not propose any new technology, but a new process of design. Subsequent projects were therefore conducted to examine how new technology could be built on the values and interests of workers, in which participation of workers in the design process was a key aspect. They would make it possible to for achieve real changes to the work process, as it was deemed necessary to have an option which could oppose a monopoly solution and be an alternative technology to the technology distributed by the vendors. One of the projects which examined these aspects, was the UTOPIA project, a collaboration between Swedish Centre for Working Life, the Swedish Royal Institute of Technology and Aarhus University in Denmark working together with both a supplier and two newspapers. The goal was to create technological alternatives for graphical workers which could lead to quality products by having skilled workers and a democratic work organisation (Ehn and Kyn 1984; Bødker et.al 1987; Ehn 1988) (in Kensing & Greenbaum 2013).

The technological alternatives were developed in cooperation with a trade union, who acted as workers in the prototyping sessions, and conducted the mark-up and image processing of the work. These sessions was conducted in a laboratory, and the solutions was built on the workers needs and concerns. The control over the work process and the quality of the work were two major issues in that regard. While the concept behind the collaboration was to provide prototypes which could be converted into viable commercial products and be tested, both the management and the research agency were uninterested in changing the work and using the training developed by the project. Eventually, the union also began seeking other ideas. These are issues that are common in participatory projects, as workers and communities need to attend other issues as well (Ehn 1988) (in Kensing & Greenbaum 2013). Of the lessons learnt, was the creation of a space where workers could experiment and create solutions through prototyping, and researchers was starting to examine the difficult aspects of users and designers envisioning alternative solutions together (Kensing & Greenbaum 2013).

A project with similar intentions as UTOPIA, is the Florence project (Bjerknes and Bratteteig 1987, 1988) (in Kensing & Greenbaum 2013), who focused directly on the aspect of the workplace. The interest of the project was to create computer systems for the daily work of nurses by focusing on their language, skills and communication. This would make it possible for them to control the technology and their own work situation, including the testing of the solution in a real work environment. The participants were nurses from two hospitals in Oslo who cooperated with computers scientists and one anthropologist. The

nurses had not received a chance to have their voices heard, and the key concepts were therefore to enable them to voice their opinions about the importance of their work in a comfortable environment, and influence the development of the product. Among the lessons learned from the project was the important aspect of understanding how workers conduct their work, and listening to the people working in the field of question, elements which are still of vital concern in PD. The project also uncovered the difficulty of relations and power, as other stakeholders such as physicians and nurse assistants wanted to be included. This is an issue which is still relevant in today's organisations with the different views and power relations among stakeholders. As such, democracy among participants becomes an important aspect to consider (Kensing & Greenbaum 2013).

The results of these projects points to important concepts in PD, which are still highly relevant. A better understanding of what these lessons provide can be seen in what have been noted as some of the guiding principles for PD.

2.4.2 | Principles

Kensing & Greenbaum (2013) have described how a few grounding principles have been outlined as important features in PD:

- Equalising power relations - finding ways to give voice to those who may be invisible or weaker in organisational structures.
- Democratic practices - putting into play the practices and role models for equality among those some call 'stakeholders.
- Situation-based actions - working directly with people in their workplace or homes to understand actions and technologies in actual settings, rather than through formal abstractions.
- Mutual learning - encouraging and enhancing the understanding of different actors by finding common ground and ways of working.
- Tools and techniques - that actually, in practical situations, help different actors express their needs and visions.
- Alternative visions about technology - whether it be in the workplace, home, public place or elsewhere - ideas that can generate expressions of equality and democratic practices.

These principles are connected, and can be seen as results or actions which impacts each other, for example how the equalization of power relations is important to establish a democratic practice, or that democratic practices are rooted in the work of situation-based actions. Accomplishing this process will require the users to become a active participants in a genuine sense, moving them from being informants to becoming acknowledged participants in the project and its design process (Robertson & Simonsen 2013).

Other elements that are important aspects of PD, is the notions of co-creation and co-design (Sanders & Stappers 2008). The first refers to any act of creativity, shared between two or more people, and is a broad term. The latter is collective creativity that is used throughout the design process and is viewed as an instance of co-creation. Co-design can

be to combine the creativity of both designers and participants not trained in design, to work together in the development process. As such, co-design will then require creative action from all parties of the team; designer, client, researchers and the final beneficiaries who will experience the product (Sanders & Stappers 2008).

To relate these matters to the design process of PD, requires an understanding of the methods and perspectives used in this process.

2.4.3 | Method and Perspective

The previous sections about ID have presented two design processes for creating ICT products. In terms of PD and co-design, this has been partly altered. Sanders & Stappers (2008) describe how the process will start out as "fussy", with the pre-design or front end part of the process playing an important part in employing activities to explore and inform open-ended design questions. The term fussy is used to describe the vagueness and turbulent nature of this phase. The main objective of these explorations is to determine what should or should not be designed or developed, as the final deliverable and design criteria for the process is unknown. As such, it bears resembles to Löwgren & Stolterman (2004) process with conflicting and alternative visions for the design. The remaining phases of the model by Sanders & Stappers have more a traditional process, and have similarities with the design process from Rogers et al. (2011). The criteria help spark ideas, which are turned into concepts, which are further developed into prototypes. These are then processed after receiving feedback from future users. It is worth noting how the process stabilizes and becomes more concrete as it proceeds, as illustrated in Figure 2.9.

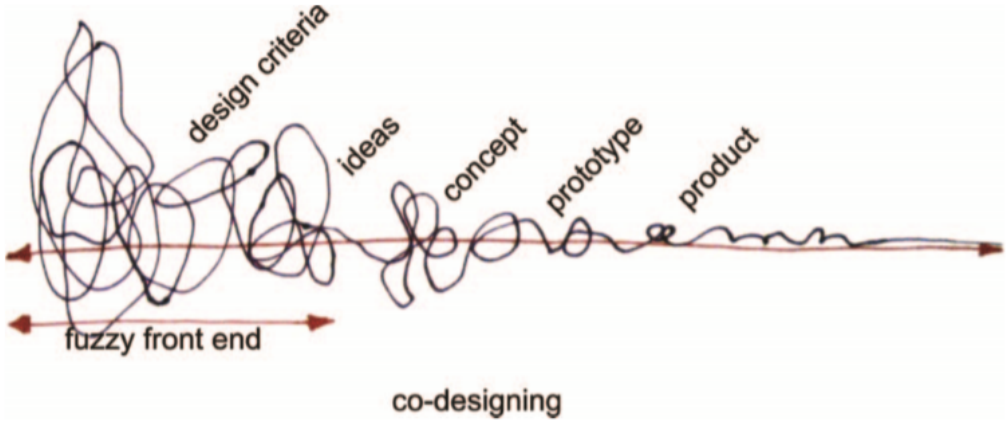


Figure 2.9: The design process presented by Sanders & Stappers (2008)

However, a design process will also require a set of instructions of how to conduct its activities. A method is seen a recipe of how to do a certain activity. In PD, this means using a set of principles and guidelines to conduct the design process in a methodological sense, where general guidelines and principles from empirical experiences are chosen and adapted to the situation and the project (Bratteteig et al. 2013). An outline given by Andersen et.al (1990), which is adopted and used by Bratteteig et al. (2013), states that a coherent method should include: an application area, a perspective, and guidelines which

are supported by the techniques, tools, and organizing principles for the project.

The *application area* is the type of development activities which the method is intended to be used in, and varies according to the system. The *perspective* is the world view which the guidelines are based on, for example to favour close user interaction to enable participation. The *guidelines* are seen as the recommended approach for conducting the design process, which in PD means deciding on a selection of stakeholders, decide how to involve users in activities, resolve conflicts, and so forth. A *technique* explains how to conduct an activity, while a *tool* is the instrument which supports it. The final component are the *principles for organising* to distribute and coordinate these tasks (Bratteteig et al. 2013).

For an overview of the choices made in this thesis with regard to these issues, the reader is referred to the chapters on methodology, and the focus area of the project. Though several methodologies for conducting participatory design have been developed (Bratteteig et al. 2013), these will not be addressed as they have not played an important part in this research.

Furthermore, it is important to remember that an ICT design means designing both the process and the result, which has been addressed by Bratteteig et al. (2013) based on the work by Andersen(1990). Specifically, this involves two forms of work; the design of the ICT system through system design, and the management of this process. Both of these focus on using activities which are aimed at both the current and future situation. In designing the performance of the system, designers needs to analyse the situation and design for the future, while at the same time realizing the design in a concrete system. By managing the process of development, designers have to evaluate the current situation of the process and plan for future circumstances, including having to regulate plans according to changes in the current situation. As such, the work process of ICT design consists of three concepts, the parallel aspect of product-process, the examination of the situation and planning for the future, and the reflection on issues to create changes. These are skills and knowledge designers needs to apply to their work. All of these activities and dimensions have been influenced by concepts in PD (Bratteteig et al. 2013).

Having noted some key aspects on the design process, the specific perspectives in PD should be addressed further, particularly with regard to three important perspectives.

Having a say

The importance of users being given the opportunity to express their opinions has been underlined several times, but not explicitly defined. An important aspect is the notion of *having a voice* by stating ones opinion vs the notion of *having a say*. The difference is highlighted in following description:

> Having a say means having something to say as well as affecting the outcome of an activity with what you say - i.e having an influence. To enable users to have an influence implies that the users need to be informed, they need to be given the chance to form and express their opinion, and they need to be given the power to influence the decisions in design (Bratteteig et al. 2013, p.129).

By allowing the users to have an influence, their voices and opinions begin to have an impact. To enable this, affects how the design process is organized, and the methods,

tools and techniques that are applied in the project. By granting this power to participants and making them part of the design process, they also become influential in deciding which problems to address. The emphasis is on the fundamental principle of sharing the decisions-making among all the participants involved in the process. By giving equal weight and respect to all participants, competencies and arguments, the participatory design process acknowledge the need for knowledge about both the use and the technical matters of a product. However, respecting different views and giving an equal influence to all participants, is not a simple task (Bratteteig et al. 2013).

Bråthen (1973) has mentioned that what we define as our world-view and its understanding is essential towards our decisions and the way we gather knowledge, and that this model forms our basis for understanding how to apply this information. Through organizing, filtering and processing this information into a context, we can gain knowledge. When the information is processed through a specific model, it gives the originator of the model a symbolic power, and adopting this model will cause a form of monopoly, as it will define the discourse and scope of the managerial affect. Thus, any new information will only improve the position of the originator (in Bratteteig et al. 2013). To address this issue, the discourse should be expanded to include areas outside of the model, which is the case in PD, where various stakeholders are included through applying practices of use and not formal representation (Bratteteig et al. 2013).

An important principle about addressing power issues has been noted by Schön (1983) (in Bratteteig et al. 2013), who described that the setting and solution to a problem are intertwined and cannot be separated into phases. This has lead to the use of explorative methods in PD, with the aim of including different decisions about which problems to address (Bratteteig et al. 2013).

This element of participation and influence is further emphasized in McIntyre-Mills (2010, p.40) who state that:*"Participation enhances the capability of people to engage in the consideration of options and the implications of the different options for their lives."*

Furthermore, the participatory processes can be used to extend the democratic practice, by enabling people to state their point of view, and at the same time allow them to consider the implications of their ideas before making a decisions. As such, the choices can form the basis for decisions in policies and be used to communicate with designers (McIntyre-Mills 2010).

To enable users to have the power to make decisions regarding the design, will require both technical and contextual aspects to be part of the discourse. When the evaluation of the design is extended, and the technical decisions are made in cooperation with users, the users themselves will feel responsibility for the design. By having power, one gains responsibility. However, these concepts require mutual respect and trust in order to be effective (Bratteteig et al. 2013), in which the notion of mutual learning plays an important role.

Mutual learning

The concept of mutual learning has been an important aspect since it was highlighted through the research of Nygaard and Bergo (1975a,1975b). To achieve mutual respect among parties, the various groups need to learn about each other and their interpretation of the information. By acknowledging that users know the most of the situation at hand and its

activities, they become the experts and professionals of the domain. For designers to understand this context, they must learn from the use practices of users in these situations, which makes ethnographic studies an important element (Bratteteig et al. 2013).

As no participant will have all the knowledge in a PD process, this is split between the designer's knowledge of technology and the process of design, and the user's understanding of the use context. The focus is on the intertwining of the aspects of technology and human activity, as their inter-disciplinarity is what constitutes the necessity of mutual learning, and everyone involved needs to know the areas of the other participants to acknowledge and respect their abilities. An understanding of the knowledge and perspective of others provide for a discussion on equal terms, which will help participants make valid arguments in the decision-making process. Hence, both designers and users learn from each other, and this concept of mutuality between actors is what separates PD from other design disciplines (Bratteteig et al. 2013). Bødker (2004) has further explained that focusing on mutual learning will affect the organisation and execution of the project, including the tools and techniques to use, and the function and form of the object being designed (in Bratteteig et al. 2013).

Having established the importance for sharing of knowledge between participants, the concept of user involvement and their cooperation with designers to create a solution based on their values, should be highlighted further.

Co-realisation, values and roles

An important principle related to concept of mutual learning, is the aspect of user involvement in design together with designers, noted as *co-realization*. Given the issues users face when imagining future solutions, PD provides a way for users to visualize these through techniques such as prototyping, where the artifact makes it possible to enable co-construction and learning as stakeholders share experiences on the consequences of introducing the design solution in a real-world context. This has been a part of PD methods for a long time, and by providing a tangible artifact rather than an abstraction of the design solution, it becomes easier to imagine the impact of the design proposal and the proposed functionality (Bratteteig et al. 2013).

The aspect of inviting users in does not mean all users should be co-designers, this depends on their level of expertise in the field, their dedication, and their level of creativity which can be divided into doing, adapting, making and creating (Sanders, 2006b) (in Sanders & Stappers 2008). Those users with a high level of expertise and passion in a given domain, such as physicians and nurses, are examples of participants who may become co-designers (Sanders & Stappers 2008).

Halloran et al. (2009) has argued for using the values from users as a tool in the codesign process. Their research illustrates how these values can be expressed by the users themselves and is altered from their experience with prototypes and concepts in the design process. The values may also be used to form the relationship between designer and users, and which can a mean for designer to aid users in their engagement.

Furthermore, when involving users as co-designers, the role of all actors changes. In a user-centered approach, the user can be portrayed as an object of study for a researcher, who through theoretical expertise, interview and observation, develop knowledge of the user that is reported to a designer, who by adding technological insight and creativity try

to generate ideas and concepts. In co-designing, the user is seen as the expert of the experience, contributing with knowledge, ideas and development of concepts. The researcher helps the user to achieve insight by providing tools for expressions, and will collaborate with the designer on providing equipment for creating ideas, and the designer is influential in shaping these. Note that the researcher and the designer is often the same person. A similar change in roles is seen in the researcher who moves from a translator role to a facilitator who attempts to help and encourage users to express themselves in accordance to their creativity level, by providing means of involvement and relevant theories to the domain in question. The designers are important in providing the visual thinking, managing the creative processes, locating missing information and make important decisions without complete information. These skills will gain relevance in issues with a broader scope and complexity (Sanders & Stappers 2008).

Having explained some of the important perspectives and principles PD adhere towards, the next section will highlight some of the techniques and tools used to achieve this.

2.4.4 | Techniques and Tools

The use of techniques and tools has previously been mentioned in the section on methods in PD. However, some more accurate definitions are needed before elaborating further on these concepts. Using Andersen et.al (1990), a technique is defined by Bødker et.al (2004) as:

> a specific direction for performing a certain activity. It may involves activities for data gathering, processing and presentation, or project management. Techniques may be used independently of how the design project is planned (in Brandt et al. 2013, p.146).

Furthermore, Bødker et.al (2004) have stated how tools are *"suggestions for graphics, figures and models to support the processing and presentation of knowledge contributed by a technique"* (in Brandt et al. 2013, p.146). As such, a technique may be to conduct a prototyping session, whereas the tools are the means used in that technique to illustrate the future product. That is not to say that their appliance is independent and do not require consideration, for example whether they breach with the values and goals of a project. Remember that when selecting tools and adapting to a specific mindset, the main goal is not to do things the right way, but to be aware of how the selection of tools and techniques for the design practice will affect what is accomplished as the end result (Brandt et al. 2013). The next section will address how user practice and participation plays an important part when applying these tools and techniques.

2.4.5 | Participation through practice

As it have been emphasized several times, participation is an important aspect of PD. Another important concept is the everyday practices of users. Their practice and the practices of the other stakeholders, can be examined in dialogues of co-design by using tools and techniques. As the practices of the participants come together to conduct the design process, and create that which is being envisioned, something new is formed which extract

from the previous practices but remain distinctively different (Brandt et al. 2013). This can be thought of as a space, similar to that advocated by Muller and Druin (2012) (in Brandt et al. 2013) where the process through enactment becomes a "third space" which is owned by neither user nor designer. Using Lave and Wenger (2001), this space is instead thought of by Brandt et al. (2013) as a community of practice which is being created. Wenger (1998) have previously expressed that in communities of practice, participation is a complex process that involves all aspects of the participant, including both body, personality, actions, emotions, thoughts and social relations (in Brandt et al. 2013).

In PD, a correlation is observed between the concepts of telling, making, and enactment. This relation play an important role in the design process. What a community express by telling each other must be examined in relation to what is being created or enacted through the imagination and collaboration of the participants. As such, the successful PD project will be a community of practice under development, in which the practice gains momentum and presence through user creation, user expressions, or user enactment. This three concepts make the practice become viable and productive in terms of providing future experiences. A simple overview of the components involved and their relation can be seen in the Figure 2.9. Note how the tools and techniques of telling, making and enactment do not work in isolation, but are coherent throughout the process in order to keep the process alive (Brandt et al. 2013).

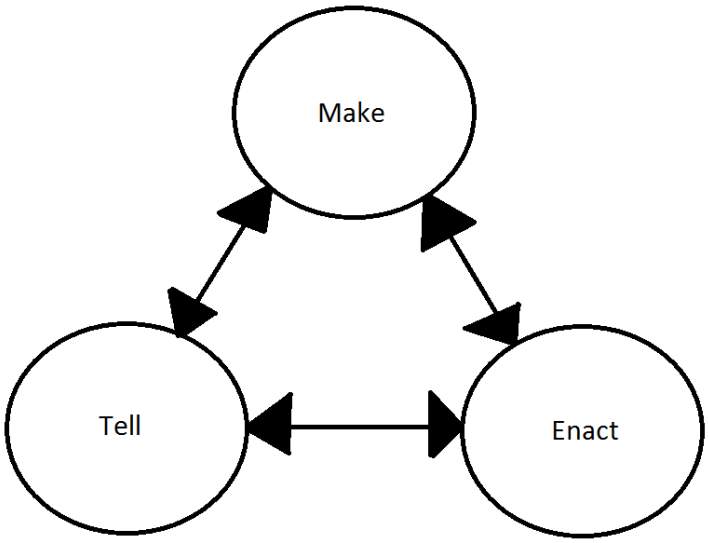


Figure 2.10: An illustration of the diagram presented by Brandt et al. (2013), in which the double-headed arrows show the connection between the elements of the practice.

Fuglerud (2014) has argued for finding tools and approaches which can engage users and stakeholders early on in the project, in order for them to participate in concrete, meaningful activities and discussions on the solution being questioned. To address this issue, a presentation of specific tools and techniques of each of the components in PD that enables this, is presented in the following sections.

Telling techniques

Telling techniques is an crucial part in understanding user context. Brandt et al. (2013) explains how the focus in the system design was altered to emphasize on cooperation and adapted to become an iterative process, where the knowledge of both the designers and workers became important aspects. Since these two parties had separate domains, there was a need for tools and techniques to bridge the gap and transfer knowledge between the two spheres. The author refers to several projects which developed means while trying to solve this issue, among those Ehn and Sjögren (1991) and Muller (1991, 1993), who used a game format with tangible representation of the design artefacts common to both parties. The goal was for the material to help participants express their everyday experiences, such as their flow of work activities, and use this to provide an arena for discussion which would encircle the experiences to the everyday context.

Kensing and Blomberg (1998) have noted the growing interest of incorporating ethnographic practices into the PD process, in which the goal is not to provide an account of the work practice, but present designers with opportunities for dialogues with the workers (in Brandt et al. 2013). Among researchers who conduct this type of inquiry for specific design purposes are Orr (1986, 1996), whereas Linde (2001) have looked into the role of narratives and their suitability in expressing and transferring social knowledge. They both conclude with the notion that the stories of the workplace domain rarely reach designers, but remain in that community of practice (in Brandt et al. 2013). As such, use of ethnographic method appear to be a useful practice to adapt when trying to learn about the user context.

As a mean to enhance and widen the conversation between the users and the designers, a perspective of change can be proposed and examined by highlighting well known aspects. The future workshop by Junck and Müllert (1987) is one technique which can be used to address this issue. The goal of the technique is to engage users in the change process. First, the participants will be placed in a brainstorming session, in which they in collaboration give points of critique on the present situation. No discussion or objections are allowed. In the next phase, this perspective is transformed to the opposite direction, in which participants discuss and try to develop a positive utopian perspective and vision, maintaining the important element of no critique. In the final phase, the participants use their vision as a platform, allowing them to discuss how they can take actions which would move them towards their vision, given the present situation. The success of the technique relies on the participants ability to criticize and create a vision in a common language. The technique is both robust and simple to use, but do not have formats or representations that point to the everyday context, which explains why several researchers have added other tools and techniques that reflect on the everyday practice of participants (in Brandt et al. 2013)

Making techniques

When we as humans make something, we use our hands together with tools to create it. From this, we are able externalize and build our thoughts and ideas into physical artefacts. These can be used for describing future objects or ways of living. Such activities can also be used for a collective exploration at an early stage of the design process, where the opinions expressed by other participants, tests our assumptions of future living. In PD, three

approaches have evolved to address these matters; Participatory prototyping, probes and generative tools. Prototyping uses the advantage from mock-ups and other low-fidelity prototypes in the early stages of the design process in which the goal of the design has been established. In traditional design spaces, prototyping have been used to portray future objects, and how we imagine their future use. In the emerging design spaces, the focus is now shifting towards understanding and interpreting the future (Brandt et al. 2013).

In terms of software, it has been noted by Floyd(1984) (in Brandt et al. 2013) that prototypes should be a tool for learning, and be classified. She proposes to divide prototypes into three classes; *exploration*, where the focus is on defining the requirements and features of the system, *experimentation*, which is used to determine whether the suggested system is sufficient, and *evolution*, where adapting the system to the changing requirements is the important goal. A few examples which highlights this, is how paper-prototyping has been used in HCI to visualize what the design of a user interface would look like (Benyon et.al 2005) (in Brandt et al. 2013), or how paper-prototyping and post-it notes provide a quick method for mocking-up an architecture of the domain (Brandt et al. 2013).

Gaver et al. (1999) have shown how probes can be used by participants to learn and reflect on their roles and experiences, and how a new design may affect these concepts, by providing designers with material that would both inspire the design and be based on the local society. The probes used were cultural and personal objects, such as postcards, maps, cameras and diaries. Mattelmäki (2005) have also shown how probes may be used to provide designers with information for aiding the participation and dialogue of participants (in Brandt et al. 2013).

The generative tools are an equipment provided by the designer, aimed at helping non-designers express their opinions and ideas on the future, and how they want this to be designed (Sanders & Stappers 2008). Though limited in the set of components, in combination they provide the possibility for an immense variety in terms of expressions regarding the future. Sanders and William (2001) have pointed out that some of the common elements to use are diaries, workbooks, bring home cameras, collages of images, etc. (in Brandt et al. 2013).

It should be noted that though the approaches are specific, they are not to be viewed as mutually exclusive.

Enactment as technique

Designers often struggle to produce design proposals that have the changes users want and to examine how the new design will influence future experiences. A tool for solving this is using methods that focus on enacting, where participants envision and act out a potential future in a context where such future activities are expected to take place. Through the use of ones body, concepts can be presented, explored or provoked through acting, improvisation and/or experimentation. The process of enactment use bodily and tacit knowledge to generate ideas and knowledge to the design. One specific technique that could be applied is similar to the notion of improvisational theatre as suggested by Ehn and Kyng(1991), in which the audience becomes active participants in making changes and alterations until they are satisfied with the outcome, a technique which can be adapted to PD (in Brandt et al. 2013)

Another element related to enacting are scenarios, where one tries to envision or enact the difference in future tasks and experiences compared to today. It is useful in both imaging new situations and as a instrument for learning and reflection among the participants. However, it is important to note that the main process in scenarios is the storytelling, and that scenarios may be written as text and enacted through visual means such as sketches, photographs or video as well. This combination of telling and enactment is very influential in the exploration of possible futures. One should also remember that as with theatre, enactment of scenarios requires a setting and use of several artefact that helps to establish the situation. The enactment of scenario could for example be in the actual user context, which would provide the most realistic experience on how to alter everyday activities (Brandt et al. 2013).

Having presented the various techniques and tools, the next section will highlight on the aspect of bringing these elements together.

Combining it

The practices of telling, making and enacting is achieved by mixing various tools and techniques. Recalling the notion of a third space where different stakeholders cooperate to imagine possible solutions, this has been noted by Ehn(1988) as a "meeting of language games", thus extending beyond being a collaboration to generate vast amount insights or negotiations of interests (in Brandt et al. 2013). This highlights how the role for the participatory practice is not established by using specific tools and techniques or the being aware of the various goals when collaborating, it is the fundamental question of what to accomplish and how to accomplish it. As such, design must be seen as an analysis of possible envisions when combining a network of various actors, in which the instruments used are tentative and tested, and where the goals are seen as temporarily. Through a continuous exploration, the actors are partaking in a new process which aims to combine various means and goals to provide a game where actors can imagine possible futures (Brandt et al. 2013). Hence, it is the entire process of this space and the elements involved in it which builds the practice of PD.

Having established the paradigm and principles of PD, the next section will present its relation to research in UD.

2.4.6 | Relation to UD

There are parallels between PD and UD which should be noted. Both approaches focus on participation as a pragmatic and idealistic manner which can be used to achieve efficiency, progress and satisfaction. Further similarities can be seen in how they attempt to abide to several social and moral obligations when applying their practices. Both focus on providing efficiency while at the same time helping and promoting democracy in the society, and conducting what is morally correct (Fuglerud 2014).

Furthermore, when developing universally designed products, issues and different interests among groups and stakeholders can arise. This has to be addressed, and is not only an issue that can occur with disabled users, but a general problem for all user groups. When examining the problem of cooperation for disabled users, one must also consider their relation to the needs of the remaining population such as elderly, people with a spe-

cific ethnic background, children and so forth, and be aware of the different interest and conflicts these groups present. A universally designed product will need to address these issues and environments as it is being used. With regards to the attention Participatory Design has given such issues and the lessons they have gathered from attempting to resolve these, the same concepts may prove relevant for UD, as more researchers of accessibility design shift the focus from guidelines to emphasizing on UCD (Fuglerud 2014).

Having given an account of PD as a design practice and its most important concepts, the context and context-awareness of a system are also important, and can influence the behaviour of the system. Though part of this has been mentioned previously, a more elaborate description will be presented in the next section.

2.5 | Context-awareness

While the previous sections has highlighted some important points of connecting context into the design practice, it was never fully elaborated on the actual meaning of the term and its concepts.

Context is described by Winograd (2001) as being adopted to computer science from the written language. Through language, a person will produce a text which is then interpreted by others. The text on its own does not display its meaning, but works as a hint for others to form an applicable meaning to it. That interpretation relies on what the text is attached with, namely the context.

(Dey et al. 2001, p.97) determine context to be *"...any information that characterizes a situation related to the interaction between users, applications, and the surrounding environment."*

Winograd believes that Dey et al. (2001) definition is too broad, and instead turns the attention to focus on the aspect of context in terms of communication, stating that *""Context is an operational term: Something is context because of the way it is used in interpretation, not due to its inherent properties"* (Winograd 2001, p.405).

He continues by explaining that the various features in the world become a context through its use. Thus, the concept of context-aware computing becomes relevant. Having established the context, he describes the concept of context-aware computing in the following manner:

> Context-aware computing might be better described as the design of computing mechanisms that can use characterizations of some standard aspects of the user's setting as a context for interaction (Winograd 2001, p.405).

This includes intuitive aspects relating to both the user setting (places, people, items, etc.) and the computer setting (network connections and protocols, stored information, etc.) (Winograd 2001).

Dey et al. (2001) uses a broader description and explain how the model of input characterized in context awareness will manage both implicit and explicit input which means that any application which reacts to input can be considered context-aware.

Schilit et al. (1994) have previously advocated for a more practical description in stating how context-aware systems will adapt their use to the location, nearby people and devices, and the alteration in these elements. This will make it possible to both inspect the environment and react to its changes. Three concepts are highlighted as important for the context; user location, other actors nearby and the available resources. The notion of context is therefore extended to include light conditions, noise levels, technical communication aspect, and the social aspects.

Brown et al. (1997) explains how context-aware applications are blurry and often blend with other applications. While such applications may be extended to include all applications which in some way account for concepts mentioned, the term is primarily attached to those applications where the context of the user is the driving force of the application, for example, a mobile application where the shifting context and the need for such behaviour makes it useful.

While some researchers seem to focus primarily on the location, Schmidt et al. (1999) see context awareness as having knowledge of the state of both the user, the device and

the situation and its surroundings, and only to a certain matter the location itself. Clearly, what can be described as context is disputed, and reaching a common definition is difficult, as have been pointed out by Razzaque et al. (2006). Having outlined some definitions regarding context, the authors describe context awareness a term which is used for referring to devices that contain information regarding the surrounding situation in which they function in.

This section has presented an overview of the different definitions of both context and context-awareness. I feel the definitions are quite similar with regard to the goal behind the concept, but differ in scope and the elements to include. As one of the important aspects of this research is to focus on the setting, location and user environment, I have chosen to adapt the theory of Schilit et al. (1994), Winograd (2001), and Brown et al. (1997), which I believe have both a general overview, but at the same time scope their theory to key elements which are also vital for PD and UD.

The final section of this chapter will present some related projects working towards universality and accessibility in mobile applications and other ICT products.

2.6 | Related Projects

There have been several projects working towards achieving universal design in the mobile context. Azenkot & Fortuna (2010) conducted several interviews with blind and deaf-blind users in an attempt to understand their use of the public transit system, and discuss user challenges. Some of the issues mentioned was not being able to locate bus stops, not knowing which bus to get on, or how to disembark on the right stop. To accommodate these challenges, they developed a tool for Android smartphones called MoBraille which makes it possible for Braille users to use features such as GPS and 3G network. The tool was developed using a participatory design approach, but the development process featured only one deaf-blind user.

Mi et al. (2014) has noted the inaccessibility many individuals have with using mobile technology, and developed a heuristic list for ensuring the design of accessible interfaces by reviewing existing standards and guidelines for design. Having validated these with users and extracted a set of requirements, the requirements were filtered using a participatory design method to create design guidelines. These were be put to practical use through an heuristic evaluation and usability test on various high-fidelity prototypes. The results provided information about what features to include in order to ensure an accessible interface, and resulted in a heuristic list that can be used by designers to ensure accessibility, especially for users with severe impairments.

Gkatzidou et al. (2011) examined the challenges of creating inclusive designs, and created a combined methodology of PD and agile development. In their study, open source widgets were produced to be put into learning settings and support learners that are impaired, before being adapted to a wider community. The researchers used the participants as active designers, and elaborate on the design process through the view of the users. A wide range of stakeholders were involved, ranging from disabled students, teachers, researchers, tutors/carers and design practitioners. The findings showed a demand for personalizing applications in order to improve the learning experience for disabled students, and the need for developing new widgets that are not beyond the technical skill of

teachers and tutors. Thus, a set of authoring tools are recommended in order for them to develop, modify, adapt and share their widgets. The researchers expect that an inclusion of various disciplines and stakeholders are needed to achieve this. While such an inclusion would provide a great challenge, they believe their approach could make it possible to tailor widgets to disabled students, and support personalization and customisation for all users.

Sahib et al. (2013) have examined the use of participatory methods with blind users using scenarios and dialogue to create a search interface and achieve user involvement. The findings show how requirements were established by the users. The researchers gained important feedback on the existing design, and were given ideas for how to improve the current design from the feedback they received from the experienced users. An important notion is the lack of related work the researchers found on the use of participatory design with scenarios and blind participants.

In terms of mobile interfaces and accessibility, there have been various findings. Kane et al. (2011) conducted user studies into the difference between blind and sighted users in terms of gestures in mobile interfaces. They discovered how blind users have different gestures, and prefer edge based gestures and tapping on virtual keys.

Giuseppe et al. (2009) developed a way of supporting blind users in using museum guides by complementing the tactile feedback of the interface with an audio channel. This was developed using an iterative approach of user evaluation and conducting further design refinements.

Neris de Almeida & Baranauskas (2009) have suggested to create interfaces for all, by allowing users to tailor the interface of software applications to their own needs and requirements, making it accessible to the largest possible audience. Denoting that present tailorable solutions do not consider the diversity of users, they propose a socio-technical approach. Using organisational semiotics and PD to define requirements and direct user participation, they developed a solution that adheres to the principles of DfA. The findings show that the practice made it possible to identify problems which may have been overlooked otherwise, particularly in terms of creating a tailorable solution.

This concludes the chapter of relevant research and concepts related to the thesis. Though this is an extensive outline of relevant research, I believe this is needed to provide the necessary image of the fields in question. In the following chapters, I will elaborate on my own research, starting with the selected methodology, and use of methods for data gathering.

3 | Methodology

In the following chapter, an account is given of the methodology and methods used in this research project. It starts by presenting the difference between qualitative and quantitative research, the concept of paradigms and methodologies, and the reasoning behind selecting ethnography as the methodology for this research project. An extensive account is given to the topic of ethnography, focusing on its origins, methods, the concept of embodiment, and the gathering and analysis of data to build valid research. The relation and use of ethnographic methods together with the participatory design practice is also addressed. This is followed by an account of the methods applied in this research, the reasons for choosing these, and how these were applied. The chapter will conclude with considering the ethical issues of conducting this research.

3.1 | Research methodology

There are two main branches of research that are used to gather data and ensure valid results, quantitative or qualitative. Quantitative research has its origins in natural sciences and the study of natural phenomenons, and applies methods such as surveys, lab experiments, and formal and/or numerical methods to verify a hypothesis or phenomena. The qualitative research approach has its origin from the social sciences and studies social and cultural phenomenons. By using methods such as action research, case studies and ethnography complemented with data sources of observation, interviews, questionnaires, etc., the goal is to understand people and the contexts in which they live in (Myers 1997). I have chosen to adopt to the qualitative form of research when gathering and analysing the data of my research.

Furthermore, Orlikowski & Baroudi (1991) have explained how all researchers have a philosophical assumption or belief as to what constitutes valid research. These assumptions will be indications for the researcher in terms of what research methods and techniques he/she believe to be useful for creating empirical results. This perspective or belief is often described as establishing an epistemology for evaluating and constructing valid knowledge. Following the research of Chua (1986), they suggest three different epistemologies which a researcher can adopt to: positivist, interpretive or critical theory. I have chosen to use the interpretive perspective, which states that everyone creates their own subjective meaning while interacting with the world. The goal is to understand the phenomena in question through the meanings that are being assigned to it. Rather than being descriptive, one aims for an non-deterministic approach and try to get a deeper understanding that can inform other contexts and settings. The phenomena is described within the natural setting of the participants. My reason for choosing this approach is that I believe each person will have their own opinion and reasoning about the world which will give new insight, and that a person's opinion cannot be built solely on facts and theories but must be experienced in a context. I see the interpretive approach as a more beneficial and fruitful endeavour for this research than using a lens in which the world is fixed and hypothesises can be tested with instruments as in a positivist manner, or by applying critical theory to criticize the status-quo and the social aspects of society, in order to highlight

its assumptions, and ideological or historical social practices (Orlikowski & Baroudi 1991).

However, to generate such knowledge will require a research methodology, which indicate the methods and techniques considered appropriate for gathering valid data (Orlikowski & Baroudi 1991). Thus, a methodology can be seen as the reasoning behind using a particular set of methods (Madden 2010).

As my research methodology, I decided to employ ethnography. The following paragraphs will highlight the concepts of ethnography, and show my reasoning for using this methodology.

Ethnography is primarily used to study a specific environment in-situ in a significant period, where a researcher immerses into the environment and tries to understand the phenomena in its applied context (Myers 1997). As a practice, ethnography aims to understand the humans as a group. It does this by placing the researcher in the same social arena as the participants, using the notion of direct contact and the idea that in order to understand others, one must do as they do and experience their daily activities and patterns (Madden 2010).

Blomberg et.al (1993) (in Blomberg & Karasti 2013) notes four principles in defining ethnography:

- Studying a phenomena in everyday settings: Hails from the view that to understand an environment, one must encounter it first-hand by gathering information in the setting in which the activity is conducted. This will also allow participants to have access to the people and instruments which defines their ongoing activity, while they respond to the researcher's questions in describing the activity.
- Using a holistic view: Describes the importance of understanding activities in reference to a larger setting and other related activities.
- Provide a descriptive understanding: The researcher is committed to describing events and activities as they unfold, without judging the efficacy of other people's everyday practices.
- Taking the perspective of members: The goal is to confront the logic behind the practices of people by using the perspective of the members. Describing activities in ways that are meaningful to participants, and using their form of language, will help the researcher to reflect the view from an insider perspective.

The goal is to observe users in their typical circumstances and situations where they interact with each other in routinely or ritualized ways often typical of that situation. The researcher should not to try to manage or contain the natural setting and field study by forcing the users to do things that they would not normally do (Madden 2010). As noted by LeCompte and Schensul (1999a:2) (in Madden 2010), the goal of the researcher is to become both an observer and a participant.

A key concept while conducting ethnography is the researcher and his/her embodiment. Coffey (1999) stated that "fieldwork is necessarily an embodied activity" (in Madden 2010, p.19). By doing what others do, a researcher is training his/her body, thereby acquiring another person's habitus and training their body to fit into the field (Coffey,1995;65) (in Madden 2010). It is also is important to build a relationship between the emic; the view of research participants and the etic; the researcher's point of view. This corresponds with

the view of combining inductive theories (building theories based on observations and interactions in the field) and deductive theories (testing out well-built educational theories used in the research field), hereby acquiring both an insider and outsider view of the field being researched. To achieve this, requires the researcher to beware of getting close enough to gain the etic perspective, yet keep a distance to remain a critical expert. The goal is to find a balance to give a reliable and critical account (Madden 2010). As such, the aim is to experience and learn about the structures and knowledge in the society, without disrupting the environment one is placed in.

There are several reasons for using ethnography as part of a PD project, especially when examining the similarities between the practices. Blomberg & Karasti (2013) has described several of these. First of all, the standpoint from ethnography on gaining the opinions and views of insiders, and to use their vocabulary, is similar to the principle in PD of mutual respect for the different knowledge of the participants. This important aspect indicate how the workers or users should be able to influence the design, and have a strong voice.

Secondly, just as ethnographers attempts to understand the participants at first-hand through natural settings and by gathering data in the activities of interest, PD attempts to provide opportunities and contexts in which participants can have direct interaction with each other, thereby learning from the domain of others and share knowledge. This will require the mutual respect for the knowledge of other participants, as mentioned previously. The designer will have the opportunity to investigate the work setting as well as creating situations which will let users experience the design possibilities and constraints (Blomberg & Karasti 2013).

Thirdly, the holistic view of gaining knowledge and understanding in a wider context, can be seen as a reminder of the responsibilities for participatory designers to also account for users that are not the main users of the design, and acknowledge that the design may affect other users than those directly involved (Blomberg & Karasti 2013).

Moreover, some may see the use of ethnography to describe the current situation as a way of describing issues before resolving them, which hinders innovation and the possibility for making changes to the present situation. This can be disrupted by having simultaneous and interleaving actions of data gathering of the current situation, which is disrupted by the development of mock-ups, probes, etc. that is used to highlight the future context and the new requirements for the work (Blomberg & Karasti 2013).

As researchers have explored these connections, there have been several attempts to integrate the two disciplines, either in terms of a reflexive relation, using ethnography as part of the methodology in PD, or using it as a mean to inform design (Blomberg & Karasti 2013).

Furthermore, Fuglerud (2014) has noted the importance of gathering detailed knowledge of impaired users and their disabilities in relation to their context, and that this is seen as an important concept of inclusive design. The author also describe how this knowledge can be gained by applying ethnographic methods and focusing on user involvement.

In light of these similarities and the attempts by others to combine ethnography and PD, selecting ethnography as my research methodology was a natural solution for me, especially given its solid foundation in previous research regarding PD.

While some critics may argue against selecting ethnography due to its association with long-term projects of living with co-residents, the term step-in-step-out ethnography with

short-term and/or residence is becoming more common (Madden 2010). Thus, it was suitable for my research as I was given limited time to gather data from the participants during the observations and interviews. In addition, the context was often shifting as the goal was to observe the user during travels, and any long-term observation or co-residence would therefore not provide any important data given the shifting context.

Having explained the methodology of the project, the next section will be a more detailed description of methods used to gather the data.

3.2 | Methods

A simple and explicit definition of a method is to describe it as a tool (Madden 2010), or as a recipe for how to conduct an activity (Bratteteig et al. 2013). Brewer (2000, p.2) has stated that "methods are merely technical rules which lay down the procedures for how reliable and objective knowledge can be obtained". As such, methods are seen as means for gathering valid data. In this research, I have used the following methods; participant observation, semi-structured interview, heuristic evaluation and a future workshop. In the sections below, I give a brief summary on the theory and employment of each of these, starting with the method of participant observation.

3.2.1 | Participant Observation

As ethnography is a practice within social science that tries to understand human groups, the researcher will be placed in the same space as the participants, and act as they do to gain their experiences. This is known as participant observation, and has become a fundamental aspect of ethnography. As mentioned earlier, in ethnography the study takes place in the circumstances of the participants, in which the researcher cannot control the events of the situation. The researcher has to talk, participate and observe simultaneously, and the sum of these actions form the basis of the participant observation. When conducting this method, it can prove difficult for the researcher to take notes when attempting to observe and participate at the same time. However, simple jottings, impressions and other data, can be noted and used as shorthand versions to make up what is called the participatory notes (Madden 2010).

It is this approach that I have adopted to my research. In this research project, I have conducted a total of six observations. The participants of the observations varied in both age, gender, life situation and disabilities. Two of them were blind, while the rest had no disabilities. I had prior to the observation set up a guide of questions to help me steer the conversations onto the topics of the research. These can be found in the appendix A.

The context of the observations varied, as the mobile device is a spatial tool, capable of being moved between different environments. The main idea was still to observe and participate with the users in their use of the application while they were travelling with public transport. I consulted the users beforehand to find out what areas and routes they used frequently. This allowed me to design a route for the participant in question, which included routes both familiar and unfamiliar to the participant. Thus, I was able to observe how participants used the application in two different environments containing various situations, which opened up the possibility to uncover situational disabilities. As

mentioned by Vanderheiden (2000), for each disability there is an equivalent situational constraint which should be meet with the same requirements. Observing and uncovering these is therefore not only useful for users with disabilities, but for all users.

To my surprise, I discovered during the observations that there were several versions of the application available for the Android operating system. Many users were not aware that a new version had been launched, and had received no notification of this. As evaluating only one of the versions could exclude important user opinions and issues, I decided to conduct the observation with the version used by the participant in question. Despite the latest version having some significant changes from previous one, I felt many of the same issues and user opinions were still relevant. On average, an observation lasted about one to one and a half hour. Each session was recorded, before being transcribed and analysed together with field-notes. The observations were a useful and exciting experience, and provided important data. However, to gain an insight on a even more personal level and in a simpler environment, the use of interviews can be a useful approach.

3.2.2 | Interview

Interviews are a common way of establishing knowledge. It is viewed to be one of the most important ways of getting to know others, for both ethnographers and other data collectors (Madden 2010). Bernard (2002) has noted how the spectrum of an interview will vary both in terms of formality and structure (in Madden 2010). Madden (2010) have further discussed the use of interviews, in describing what he denotes as the ethnographic interview, using the term from Spradley (1979). This type of interview is more informal and less structured, and is a common tool to use in the ethnographic practice. That said, an ethnographic interview is not a simple task, but a complex exchange which requires conversational norms and patterns to be productive.

Thus, the formulation of questions is important as they cannot be unclear, yet they must have enough space for the participant to explore their answers. Open-ended questions is therefore used to avoid yes and no answers. These type of questions also allow for the interviewee to expand and clarify in his/her answer, and for the interviewer to steer the direction of the conversation. For the interviewer, the focus must be on avoiding sidetracks, yet not guide the interviewee too much, as it could cause the researcher to lose important information (Madden 2010).

The researcher should also avoid the issues of direct, double barrelled and/or loaded questions (Madden 2010). First of all, the use of direct questions can offend and be seen as ill-mannered by the interviewee.

Furthermore, to use double-barrelled questions where two or more questions are wrapped into one, is considered to be an ignorant way of grouping several issues together, which the subject might see as separate questions.

Moreover, one should avoid the use of loaded and leading questions. A leading question may cause the participants to believe they should "help" the researcher, in which they agree to the implicit answer of the question without really considering the question. On the other hand, one should avoid "loading" the question in such a manner that the subject is trapped or do not respond at all, as any answer would incriminate them.

These are issues I have tried to adhere to when writing interview questions and con-

ducting my interviews. I conducted in total six interviews, two of which were scheduled as participant observations, but which were later altered. Each interview was conducted in an informal manner according to the concepts described by Madden (2010). Two interviews were conducted with elderly, visually impaired first-time users who were not comfortable enough to use the application during travels, but wanted to learn about about it and explore the application. These interviews became an exchange of knowledge between us in which I presented the functionality of the application to the participants and asked questions, while the participants used the functionality and responded with their opinions. Both of these sessions were recorded and transcribed. The questions used for these interviews were the same as those used in the observations, and can be found in Appendix A.

The remaining four interviews were conducted with the four participants of the workshop. The goal was to gain insight into their experience of participating in the project and receive feedback on a design proposal. These interviews lasted for about an hour each, but no audio was recorded as the interviews were conducted in a noisy environment. The interview questions for these sessions can be found in Appendix B.

To develop the design proposal mentioned earlier, I needed to gather more data from the participants, and allow them to help in the creation of an improved application that could address their needs. Thus, the use of the future workshop and its techniques became a relevant concept.

3.2.3 | Future Workshop and Prototyping

To get a deeper understanding of the needs and requirements of the participants, I arranged a future workshop with four participants. Afterwards, the participants had an explorative prototyping session to externalize the visions and concepts from the workshop. The concepts and employment of these techniques have been elaborated on in section 2.4.5 of the thesis. When selecting these methods, I attempted to achieve the goal of mutual learning and understanding among participants. Through discussions and sharing of opinions, the goal was for them to express their experiences as users and to externalize their values and needs, making them feel that they were an acknowledged part of the development process.

All of the participants in the workshop had been part of a participant observation. Though all of them were active users of public transport services in Oslo, they varied in terms of their experience with the applications, the mobile devices they were using it on, and their application version. The age of participants ranged from 24-55. One of the participants were blind, while the remaining participants had no disabilities.

The workshop was conducted in the following manner. First, we began going through the phases of the future workshop, starting with addressing the issues of the current applications in a critique phase, and imaging future solutions to these issues in a fantasy phase. After a 30 minutes break, we continued to do the final phase, which I have denoted as the realization phase, in which the participants were asked to adjust and discuss the possible solutions that could address the current situation.

A new 5-10 minutes break followed, before the participants were asked to discuss and prototype a paper mock of the visual appearance of a future application. To complete

this task, they were given post-it notes, paper sheets, pens and pencils and other design equipments. In total, the workshop lasted for about two and a half hours. The participants had prior to the workshop given consent through a participation form. They were aware of the session being recorded, and that pictures would be taken.

Some weaknesses regarding my use of these techniques should be addressed. use of these techniques should be addressed. First of all, several of the participants using the Android version of the application, were primarily criticising the previous version, since this was the version they were using. This meant parts of the critique being mentioned had been addressed in the latest version.

Furthermore, some of the issues regarding the applications were mentioned in the fantasy or realization phase, and parts of the suggested solutions were mentioned in the realization phase. This indicates that the boundaries of the process were not strict enough, or perhaps there was not set aside enough time for each phase. The realization phase thus became an partially extended discussion on the future solutions from the fantasy phase.

Finally, while the participants were able to agree on a common concept in the realization phase, they struggled to decide on which specific functions to focus on in the prototype session, and where to place the suggested elements. This indicates that these issues should been addressed earlier in the workshop. Instead, the same suggestion and element were often mentioned and discussed several times, rather than the participants deciding on its placement and visual appearance in the application.

Despite these issues, the workshop was still able to provide new understanding regarding the needs and requirement of the users, and through a diverse group in terms of life situations, I was able to generate data from users with various backgrounds.

While interviews, participant observations and workshops are vital means for gathering data from the individual perspective, one should also emphasize the purely technical accessibility and usability of the application. One way to achieve this is through a heuristic evaluation.

3.2.4 | Heuristic evaluation

To further assess the usability and accessibility of the application, I decided to conduct an heuristic evaluation of it, by evaluating the latest version used on Android, iPhone and Windows Phone. This is a common way to check the usability of a website or application. Nielsen (1995*b*) describes how an heuristic evaluation is done by a small set of evaluators to check the compliance of the interface against a set of usability principles, often noted as the heuristics. He states that one evaluator can rarely uncover all the issues in a interface, and seen as I was the only evaluator, some issues may not have been found. Nielsen (1995*a*) have also created a set of ten heuristics, which he outline as the rule of thumb to check for, and he views these to be general principles that ID needs to address.

However, these heuristics and similar adaptations of them, are not applicable to the mobile domain of native applications, as Joyce & Lilley (2014) has noted. They have developed a new set of heuristics to account for this issue, and I adopted these for my own evaluation. Their heuristics together with a set of guidelines from each of the WCAG 2.0 principles, formed the heuristics for my evaluation, and is displayed in Appendix C. The emphasis was on examining the accessibility and usability of the application. I did not set

a time limit for each evaluation, as I was the only evaluator. Instead, I attempted to find as many issues as possible. Though time-consuming, this provided valuable data regarding accessibility and ease of use.

Having described the methodology and methods of the project and how these have been applied, the chapter will conclude with a section on the important concept of ethical issues in research, and how I have addressed these matters in this research project.

3.2.5 | Ethical issues

As a researcher, I find that there are moral obligations and rules to follow. Madden (2010) have stated how ethnographers have to take important ethical decisions about their research when designing its structure, applying methods, negotiating in the field, and in analysing and writing up their data.

Furthermore, his discussion on doing what is right towards yourself, your participants and the research discipline, is interesting. Your participants have rights and should be aware of the intention and direction of the research, the use and storage of the data, and know that their privacy and confidentiality is maintained. They should also be aware of the time and effort required from them, know how the research may affect them, and know that they have the option of withdrawal at any moment.

During the research, I have taken measures to try and maintain these ethical standards and assure the privacy and anonymity of the participants. I see this as a very important concept, given that several of the participants in the project were part of vulnerable user groups. Prior to the data gathering, I reported the research project to the Norsk Samfunnsvitenskapelig datatjeneste who is the Data Protection Official for Research at Norwegian universities (NSD 2012). All of the participants were given a consent form prior to their participation, which stated the goal of the project, the type of data that was being gathered, and that no sensitive information regarding sexual orientation, religious belief or other personal information would be collected in the research. It also stated the different parts of the project they could chose to participate in. The content of this consent form can be found in Appendix D. The participants knew that they could withdraw from the research project at any moment, and were notified in advance about the expected duration of the observation, interview or workshop.

The elements of genders and age were recorded to give an overview of the user groups involved, but was not used in any other compromising manner. For users who were blind or visually impaired, the information was read out prior to the observation, in addition to being sent to the participants on email. The participants were also aware that the sessions were being recorded. The names of the participants were anonymized, and were replaced with aliases as keys. All information, recordings, emails and images were deleted after the end of the project.

With regard to ethical issues, it is worth reflecting once more on the aspects of etic and emic, and keeping this balance of involvement. An important part of this is the researcher's reflexivity. Babcock (1980:2) (in Madden 2010) has explained that reflexivity is a way of describing the capacity a language, thought or other systems of signification has in terms of turning towards itself, become an object, and refer to oneself. It is similar, yet different from the subjectivity and opinions of the researcher. There are several forms of reflexivity

in ethnography. The one I will mention and focus on is the null or basis form, which Marcus (1998:193) have noted as self-critique, and using the subjective and the idea of empathy in the research process (in Madden 2010). Though this is not solely an ethical issue, it may highlight some of the problems I have encountered during this process.

The previous paragraphs highlight the responsibilities and moral obligations a researcher has when using ethnography and ethnographic methods, and the importance of being able to reflect on these issues. In my case, I see in retrospect and in reflexivity that applying some of the methods proved quite difficult. As the participants varied in skill and knowledge of the application in question, my questions and interventions with the participants and their use of application, often led to a change in the behaviour of the participants, as I presented them with new knowledge or information. I was at times impatient and should on occasions have given the user more time to solve the problem they were having.

Furthermore, after listening to the recordings and reviewing the notes from the observations, I believe my formulation of the questions in both interviews and observations may have led the participants to answer in a specific way. Some of the questions were formulated in a leading manner, perhaps guiding the participants to answer the way I wanted. In addition, I might not have been attentive enough to my own position and situation in the project, and how my use of the methods affected the responses from the participants. Thus, I acknowledge my lack of awareness regarding my own position in the context, and that the balance of the emic and etic between me and the participants may have been unfavourable and unbalanced.

In addition, the type of questions I asked should in many cases have been different, as I should have asked follow-up questions and focused on the why rather than the what. I also believe the execution time set aside to complete the observation were in some cases too limited. Part of the questions were also expressed while not travelling, which may have affected and altered the data gathering.

The validity of data and results when using ethnography can often be observed by the researcher explaining the case and outlining the actions taken, in order to provide transparency (Madden 2010). The next chapter will therefore outline the case of the project to provide this transparency.

4 | Focusing on the travel aspect

The following chapter will outline the topics that I have focused on, and the framework for the thesis. Specifically, it describes the project which the research has been conducted in, and the mobile application in question. This includes the features of the application and the different operating systems it has been developed for. The chapter concludes with an explanation of the recruitment of participants and the difficulties of this process.

4.1 | Outline of the project

This thesis has been part of the project *Mobile applikasjoner underveis*, which investigates how mobile applications can help public transport become more attractive to users. A particular focus is to look at how users can utilize their travel time for purposes that are viewed as useful, less stressful and which can help in their personal development. The main purpose is to develop knowledge about what users want from their applications, and find out what a new solution could look like. The project is a collaboration between TØI (Institute of Transport Economics), Institute of Informatics at the University of Oslo, the Viktoria Institute in Sweden, and NSB (Institute of Transport Economics 2015).

The project is funded by several actors, one of which is Ruter who is responsible for the planning, ordering, marketing and coordination of the public transport in Oslo and Akershus. Their ownership is shared between the municipality of Oslo and Akershus county council. The transport is operated by several companies who work under contracts from Ruter (Ruter 2012*b*).

To provide customer service and information for the public transport in the Oslo region, the company Trafikanten was established in 1986, with Ruter as one of its main shareholders. Trafikanten become famous for its success with electronic services, which provide real-time information, web solutions and mobile applications for the public transport in Oslo. While Trafikanten had shared ownership until 2012, Ruter eventually bought the company as a whole and later that same year merged its website with trafikanten.no. In 2014, the two companies were merged together (Ruter 2011).

I have throughout the project attempted to come in contact with developers or managers responsible for the RuterReise application. Despite several e-mails, intermediaries, contacting a company who had worked with the development of the Android version of the application, and speaking to an employee of Ruter, there has been no response from Ruter. I am therefore not able to express their opinions or thoughts on the current application, or present their feedback regarding the results of the research.

Having described framework in which the thesis is conducted in, the next section will highlight the different versions of the application being examined, and their specific features.

4.2 | Ruter Reise

The topic of the thesis is the mobile application from Ruter called RuterReise. It is an application which gives its users real-time information, and can be used as a journey plan-

ner for the public transport of the Oslo region. The application can be used on Android, iPhone and Windows Phone devices (Ruter 2012*a*). The application design differs between the different platforms, as it attempts to be in accordance with the guidelines and standards set for each operating system. All of the applications require Internet access in order find and retrieve information.

However, two important aspects should be noted with regard to RuterReise. The first is that two versions of the application is available and in circulation for the Android operating system. Though the Google Play market only offers one application called RuterReise, several of the participants in the study were still using a older version with the same name, and had received no update or notification of a new version being available. It seems Ruter have released a new application with the same name without notifying the users of the previous version. While issues of compatibility with older devices may account for some of this, it seems strange not to make certain that your users are aware of the possibility of updating their applications.

The second aspect relates to the functionality provided by the application. This differs according to what operating system the user is using. On the latest Android version, the user can search for a given stop, find out the means of transport it offers, and what the various departures times are in real-time. A stop or route can be saved as a favourite in order to make it easier for the user to locate it. A search for an area will provide a route from your location to that specific area.

Furthermore, users can search for a route from start to finish by using the function "Finn Reise". This function offers the possibility to set a time for either the departure or arrival of the transport. The users can store the route suggestion, and will then receive a notification which will tell them that this route has been planned. In addition, there is a map function available which indicates what the user's current location is, and the various stops in that area. The map can also be used as a guide by the user, by highlighting the path the user needs to walk in order to get to the stops of the route. There are also several settings located under the Android option button, which allow the user to configure what routes and platforms they want to see, for example last used or most used. This button also offers the user the possibility to select the means of transport they want to use, alter the time set aside for transfers, see all the stops for a specific route, etc.

The same functionality and terminology are used in the Windows Phone application, but the additional options from the Android button have been placed in a menu in the bottom of the screen.

However, on the iOS and previous Android version, there are certain alterations. First of all, some of the terms have changed, such as "Finn Reise" which is called "Reiseplanlegger.

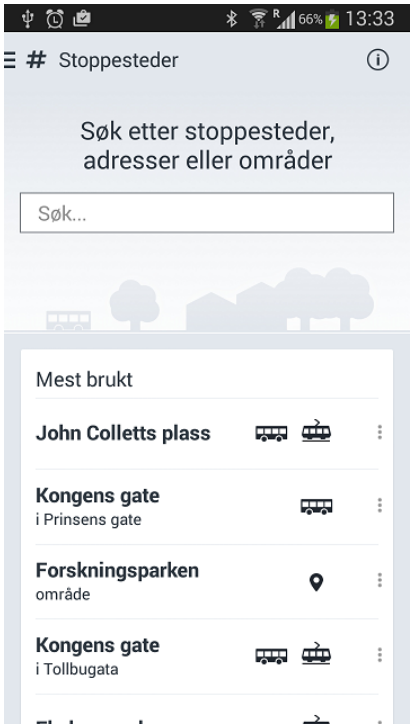
Moreover, the function used to set your journey as a favourite and saving your specific route, is not present in either version of the application.

In the iPhone version, the settings for the application has been placed in the phone settings, and the background colours, look and feel, and terminology used, differ from the latest version used for Android and Windows Phone. Much of the functionality seen in the Android option button has been removed, or moved elsewhere.

The previous Android version has the similar look and feel of the iOS version, but differ in terms of the placement and layout of the menu and other elements. When compared to

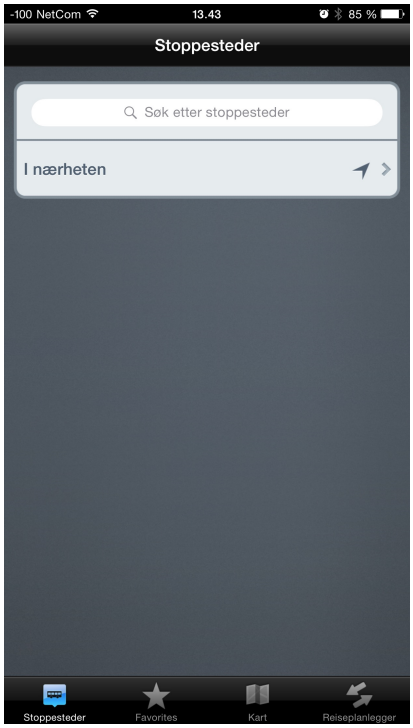
the latest Android version, the look and features of the two versions vary greatly, both in terms of functionality, layout, colours and the placement of various elements. The older version is therefore more inline with iPhone version. There is no option available to plan a whole journey, and the map has been "hidden" from the user, as it has been placed in the option button, together with many other features.

An illustration of the home screen of the application used on the different devices, is presented in Figure 4.1 to highlight some of the differences mentioned.

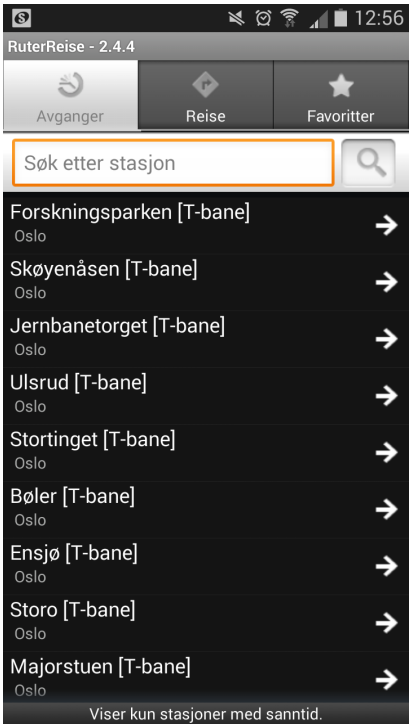


(a) Latest Android version

(b) Windows Phone version



(c) iOS version



(d) Older Android version

Figure 4.1: An overview of the home screen on the different devices.

In order to evaluate the application, I needed to find users who could participate in the research project. The next section will focus on the choice of user groups, the recruitment process of these users, and the issues I encountered in this process.

4.3 | Recruitment of participants

As I was conducting research on a mobile application with a focus on UD, I wanted to have a range of different users to participate in the project. As a researcher and designer, I understand the temptation some researchers have of attempting to involve all types of user groups in a project, and address their needs specifically. However, this is difficult to achieve and beyond the scope of this thesis. I have instead chosen to focus on two specific user groups which I believed would reveal both general and specific issues with the application; users with no disability and users with visual impairments. The reason for selecting these user groups is that I believe all users can enter situations in which their abilities to hear and move is limited. Recalling the examples of Vanderheiden (2000) on situational disabilities, similar issues may occur during public transport, for example, when attempting to use the application in the noisy environment of a bus stop or while being cramped into a mass of people on the tram.

With regards to vision, the aspect changes as the majority of users will have none or minor limitations in their eye-sight, and/or normally use public transport during daytime or in lighted city areas. Acknowledging this, I decided to include visually impaired users in order to gain insight into their needs and requirements for using the application. This meant I was also able to uncover requirements of other user groups in need of visual aid, such as users with glasses. Thus, I wanted to be able to explore the conceptual models of various user groups, and examine the issues they had when using the application.

Another interesting element was to see how the two user groups could collaborate in a PD project. Though some researchers have investigated the aspect of having users with disabilities be among the participants of a PD project, as highlighted in section 2.6, the combination of non-disabled and disabled users working together with a PD approach and focusing on the accessibility and usability of a mobile application, has not been highlighted as an important aspect in previous research. Given the principles of PD of sharing knowledge, experiences, and allow the users to influence the design of a product, I saw this as an excellent opportunity for the two users groups and myself as a researcher to learn from each other, and achieve understanding and cooperation between stakeholders.

As there are a significant amount of users who are visually impaired, I expected the process of recruiting from this user group to be easier than recruiting from other user groups with disabilities. However, this was not the case. I contacted several agencies and organisations responsible for the rights of visually impaired people. Though some responded quickly and were positive to the research, their test users showed little interest in participating. Being a bit frustrated, I took to social media and contacted other organisations focusing on covering all forms of disabilities, hoping their members might be more inclined to participate in the project. However, this gave the same result. I was eventually able to get the participants that I needed through my social network of friends and acquaintances, who put me in touch with users who were interested in participating in the project. This method was used for recruiting both disabled and non-disabled users.

My own experience and issues of recruiting participants appear to be similar to the experience of Fuglerud (2014) who noted the difficulty of achieving early user involvement and evaluation in practice, and highlights the limit of resources, the time and work related to the recruitment of participants, and the coordination of the evaluation as some of

the key aspects. She advocates for shorter development periods and conducting empirical evaluations with few participants rather than having long development periods with a large user group. I have adapted to this approach in this research.

There were in total 8 participants who took part in the research. Four of the participants were visually impaired or blind, while the remaining participants had no disability. Out of the participants, six agreed to a participant observation, while two visually impaired participants who were originally planned to be part of an observation, were after some consideration more comfortable with a more controlled interview where they could learn more about the functionality of the application. Out of the participants who were part of an observation, four also agreed to be part of the workshop, and agreed to a post-workshop interview. Of the participants, all of the users with visual impairments used iPhone, while the majority of sighted users used Android as their operating system. One sighted participant used Windows Phone at the start of the project, but had switched devices and was using iPhone at the time of the workshop.

The selection of participants and their devices are a weakness in terms of understanding how the Android and Windows Phone applications are used by visually impaired users, and how users without impairments use the iPhone application. Given that Apple has provided a screenreader with built-in Norwegian language for the iPhone, it appears this device is preferred by visually impaired users ahead of the screen readers in Android and Windows Phone, which makes this device very representative for this user group.

Another weakness is that there was only one visually impaired participant in the workshop, who was blind. This meant this person became very representative for this user group. Including other participants with these impairments, could have added to new personal perspectives and issues. This would also have been more in correspondence with the research from Fuglerud (2014) and Bratteteig et al. (2013).

The selection of participants varied in terms of age, though most of them were in their twenties. Their life situations also varied, as some were students or had children and were studying, while others were full-time employed and/or reaching retirement. Thus, they represent a large spectrum of the general population. Though the selection of participants is small, their contribution generated a large amount of qualitative data for me to analyse.

This concludes the chapter addressing the framework and area in which the research has been conducted. The following chapter will present the findings revealed from this research.

5 | Findings

This chapter addresses the findings from the data gathering. In analysing this data, I have applied an iterative approach of going through notes and recordings to find the main user issues, themes and situations, and highlight these. Similarly, the result from the workshop have been revisited several times in order to create a proposal which address user issues. The findings of this analysis process is presented in the next sections.

Rather than listing each finding as separate entities from a specific data method, I attempt to tie them to specific phase of the user journey. Though the finding itself may not have occurred in that phase, I have placed them accordingly to where they are most likely to occur. In examining the data, three phases of the user journey became relevant; the planning of a journey, the travel of a journey, and the reflection on the experience after a journey. Some of the findings show issues that can relate to several parts of the user journey, and have therefore been placed in a separate section.

Having divided the findings from the observations into phases, the subsequent sections present the results from the workshop and the heuristic evaluation.

The issues which are elaborated on are not to be viewed as an exhaustive list, but themes and elements identified through analysis of a vast amount of data.

To exemplify the different phases of a journey and highlight a possible experience for users travelling, I present a vignette. This is to illustrate some of the situations and issues a user might encounter.

5.1 | The themes of a traveller

Imagine the following situation:

> John is a middle-aged man, who lives in Oslo. He usually travels by car-pooling with others, taxi, and in certain cases, with public transport. Being blind, John has aversions against travelling by himself, and have had experiences of getting lost using public transport. At the same time, he wants to become more independent and not rely on the help of others.
>
> John has just found out that Ruter has released a new travel planner for Oslo called RuterReise. He decides to be brave enough to test this by himself. Using an iPhone device, he believes he will be able to use the screenreader functionality from VoiceOver to read out elements. He plans to travel from Majorstuen which is his workplace, to his home at Grunerløkka. Sitting in a quiet environment at work, he is able to use the application, though some time is spent learning to navigate and to understand the functionality of the application. John finds some of the terms in the menu difficult to understand, particularly with regard to what elements they contain, and what screen in the application he is on. Struggling to understand this, he eventually seeks help from a colleague, who helps him plan his journey. As this is a route he will travel quite often, John looks for a way to store the route, but is not able to do this. He notice that the application offers a

function called "Favoritter" and attempts to use this, but the application crashes. John becomes frustrated, and gives up trying to understand this functionality.

Having been able to retrieve a route to travel, John now wants to know what platform the first transport departs from. The application only reads out the number of the bus he is suppose to take, and not the platform which it departs from. John is not able to find this information, and is once again forced to ask a colleague, who gives him a description of the stop and the directions on how to get there. John starts walking towards the stop.

After some time, John is able to find what he believe is the right platform. He is able to check both the planned departure time of his route as well as the real-time information on the platform using the application, and discovers that his bus is arriving in two minutes. Approximately two minutes later, two buses arrives at his stop. John is confused as to which bus to board, as no information was given regarding their direction and final stop. He decides to enter at the front of one of the buses to check with the driver. Unfortunately, he enter the wrong bus, which the driver confirms. By the time he gets out, the other bus has left, and he is forced to wait for the next one.

Seeing as he lost his bus, he wants to check for a later departure time on the same route. He expects there to be some element of button or text to show him how to find this information, but only finds a pager element which he does not understand. While he spends a long time navigating the application, growing increasingly agitated and frustrated, he hears a bus arriving and checks with bus driver if it is the correct one, which it is.

Having travelled by bus, John know he now has to use a tram. But he has forgotten some of the instructions he received from his colleague. Luckily, he discovers that the search function can search from his position using the GPS functionality. He uses this function, and discovers that he has to walk 3 minutes to get to the platform. But there is no description as to where to go! Growing in anxiety, he tries to use the map functionality, only to find out that it is useless for his use. As a last resort, he is forced to ask other travellers passing by on how to get to the platform. He eventually gets a description as to how to get there, but get lost on the way. The other travellers explained to him how many of the platforms in this area have the same names, which can be an issue. Eventually, being cold, frustrated, tired, irritated and having increasing levels of anxiety, John gives up locating the tram and decided to take a taxi home. Finally, he arrives at Grunerløkka to make his dinner, relax, and to reflect over the issues he encountered.

The situation being described may sound too extreme or unlikely too be relevant, but unfortunately I do not believe so, given the data I have gathered. The following sections will address similar issues and themes found among participants at the various stages of their journey, starting with the problems that are relevant at any stage of a journey.

5.2 | All stages

The following subsection will present issues and themes that affects the user experience greatly, and are likely to occur in several of the stages of a journey. The main issues are terminology, feedback and navigation in the application.

5.2.1 | Terminology and feedback

The understanding the users had of the terminology of the application varied, but several of them showed issues in terms of relating to the language and words used in the application. This can affect various aspects of the journey. A few examples will help to highlight this.

One term which seemed to cause an issue, was "Stoppesteder". The participants had various notions as to what the view would provide, and the functions related to the term. One participant viewed it as a search page more than as a list of stops. Another participant was confused while navigating the menu and did not expect "Stoppesteder" to show the front page. Instead, a list of the available stops was expected. An interesting notion was given by one participant who expressed not being able to understand the term at first, and the need to learn what it provided. This correlated with the notion of a another participant who had become accustomed to it through training.

The incident which perhaps highlights the issue with this term the most, was seen in one of the interviews with a blind participant. The interviewee expected to be presented with a list of stops for the route being retrieved, given that the term "Stoppesteder" had been used. However, this was not the case. Furthermore, the interviewee appeared to believe that there were separate menus under each screens, and was looking for all the stops on a route or departures through "Stoppesteder" when entering a new view. This was a recurring problem. I observed how not remembering that this was the same element confused the participant, who did not find the expected results in the view when navigating. The participant stated afterwards that the association with the term, made it easy to think it would present a list. The participant stated the option could be to alter it to "Stoppested", or that one simply had to get used to it. These issues highlight the ambiguity of the term and how it can be associated to several meanings or functions from various users, which in turn leads to confusion and frustration.

In a similar fashion, there was an acknowledgement of one of the interviewees that the text being used a placeholder which was "Stoppesteder og adresser", was part in causing some confusion, as the functionality of the search bar was not expected.

Another issue was understanding the functionality of the term "Min posisjon" through vocal feedback, as I observed how one of the interviewees tried to interact and edit this. The participant seemed to be confused as to whether interacting with the element was necessary, and the application did not seem to convey the information that this interaction was needed to change to a specific starting location.

Having done this, the interviewee did not seem to understand what had happened, and was not told that a new view had been presented. I had to explain this to the participant, including what the next possible actions were. Having chosen "Min posisjon" as an option, the previous screen was shown, causing new confusion. After some discussion and

recurring errors, the interviewee expressed issues with knowing that "Min posisjon" had been selected. This incident shows how the lack of feedback and notification from the application can cause issues for visually impaired users. Although this was in a controlled environment with a first time user, the same issue can be relevant when using the application in other environments, for example, while being on the move. The uncertainty and confusion I think many visually impaired first time users can experience when interacting with this element, is highlighted through this quote.

Nei, det som...uhm...jeg trudde jeg måtte skrive et, et navn..på fra.

The issue of feedback to visually impaired users became relevant in other incidents as well. I observed how one interviewee's speed of navigating the screen, led this interviewee not to hear the feedback message of "Min Posisjon" being read out by the VoiceOver. After interacting with the element, the participant was confused as to when and whether a keyboard would appear, as no information about this was read out loud.

An similar issue of terminology and feedback was revealed in the description given by the screenreader to describe the elements in the menus. When the interviewees heard the word "fane" read out through the VoiceOver, this was not understood, as they were more used to the term "knapp" as the expected term. Thus, they were not aware if they could interact with it. In fact, one thought it was a headline, and not an element one could interact with.

Furthermore, it was noted by one participant that "Favoritter" was written and read out as favourites, an English term. Similarly, the back button was read by the VoiceOver as "nav-bar back" with a Norwegian pronunciation. I witnessed how this confused some participants and made them uncertain. They did not seem to understand the functionality that was provided. The use of English terms and pronunciation was noted as strange given that it was an Norwegian application.

While I observed the participants having issues related to the terms and feedback of the functionality, and this was also acknowledged by one participant, it seemed that the visually impaired participants had an aversion against criticizing the application. This was particularly evident in interview sessions, where there were continuous statements of having to learn the terminology and functionality of the application, including its menus. A situation which highlights this is when the interviewees are asked about "Stoppesteder" and their navigation and understanding of the view. They describe the navigation as "okay" and that the view and its functionality was easy to understand, which indicates a lack of correlation between their actions and answers. For example, as mentioned previously, before entering "Stoppesteder", one interviewee had expected to find a list of stops for a route, but afterwards, this participant now stated to have expected to find the elements what was under "Stoppesteder". Furthermore, later in the interview, after having done recurring misinterpretations of the term, the participant thought there was little information presented under "Stoppesteder". To me, this confirms the issue of an ambiguous term, but also how some participants restrain themselves from criticizing the application too much, and rather blame themselves. Their stated reasons for conducting many of the errors were their own lack of having a habit or routine for using the application, and that they needed to become acquainted with the application. From my observations, I note this as the participants being reluctant against criticizing the application, and not stating

more explicitly that the application did not address all their needs.

The incidents presented so far have revealed issues and problems for the visually impaired participants. However, similar issues occurred when observing sighted participants.

Through observations, I noted the confusion two sighted participants using the latest Android version experienced when adding a route to "Favoritter" and being told that a route was planned. The confusion and frustration I observed can be summed up in one of the participants following statements:

Det siar meg ingenting.

It became apparent that the term used was not understood and gave them no information of the action that was done. Even after explaining the intention and the use of this function, one of the participants was still confused.

Examining the data, the issues and problems participants faced became quite visible. In that respect, the words of one of the blind participants sums up how terminology and feedback should not disrupt, but provide learnability and cohesiveness:

Nei som regel når du har gjort da ein gong, så forstår du da

This section have attempted to highlight some of the difficulties of terms and terminology of RuterReise. Having covered the aspects of the application, it seems natural to address a related topic of navigation, which will be highlighted in the next section.

5.2.2 | Navigating in the application

Simple navigation of an application is important to find information in all phases of the journey. The general feedback of the participants was that the navigation was "okay" and understandable, despite the issues uncovered in the previous section regarding terminology. While no serious issues were explicitly expressed, I observed how several of the participants appeared to struggle while navigating between elements during the observation, which could indicate that the application does not have the intuitive navigation that users expect. At one point, this was in fact acknowledged by one of the participants. A reason for this could be related to the previous issues in terminology and feedback, as indicated earlier with the confusion of the term "Stoppesteder".

The issues of navigating became especially apparent in an observation with a sighted user, in which the participant were trying to retrieve a planned journey, not knowing that it was stored under "Favoritter". The participant also had issues with finding a function that had been used previously, which was located under the option button of the Android device.

A similar issue of navigation occurred with a participant of the earlier Android version, who attempted to set an alarm to be notified of the departure of a route. Though the participant was able to achieve this, neither the route nor the alarm appeared anywhere and the participant was not able to locate it and simply had to wait for the alarm to be activated.

Another observation that showed some of the difficulties of navigation, was when a participant attempted to add a route as a favourite. The participant wanted to have the possibility to do this through the favourites section itself, rather than having to search

and add the route after it had been found. These incidents show that there seems to be a misconception between the expected use of navigation, location, functions from users , and what the application can actually provide.

Other serious issues were related to visually impaired users, and was highlighted in the interview sessions. I had to help the participants to navigate the screen, as they struggled to find specific elements given the slow feedback of the application. This was in part due to the participants navigating too quickly in the application. An example which highlights this issue were the incidents in which participants tried to alter or select the departure from "Min posisjon" to a specific location. As the participants did not understand the feedback and what the application wanted from them, their navigation became more frantic and stressful. One interviewee attempted several times to interact with the headline "Fra", not knowing that the view had already been entered. This also lead the participant to lose track of the view, and the participant had to be instructed in order to find the function, and retrieve the necessary information.

Another example was seen in locating the search bar, which the participants navigated past several times. Not being aware of the search bar being present given its slow read out of the placeholder element, lead to much confusion and frustration.

The result of lacking the necessary feedback was further highlighted in the navigation of the search view. As no feedback was given to users of a search being conducted, the eagerness of the interviewees meant they started to navigate the view before the result was presented. This led them to navigate to the menu, which caused confusion.

Furthermore, I observed how extra navigation was needed to provide requested information. During the interview, one participant wanted to find the platforms for a route. This was not listed in the results of the search, and the participant had to navigate to "Stoppesteder" to find the station and the relevant information regarding platforms, which was viewed by the participants as a much more cumbersome way of retrieving the information. One participant later noted how the issues of navigation was due to a lack of memory, and stated the need to get the required knowledge in order to use the application. Again, this indicates an element of the participants blaming themselves rather than the learnability and usability of the application.

The incident with navigation issues which perhaps was the most interesting, occurred in the interviews, when the participants were asked to find a later departure for the same route. This proved very difficult to do. First of all, they struggled to find the pager element used to navigate to the next result, and were instead looking for a button. Having guided them to the location of the this element, they did not understand its functionality and whether it would present new information. When interacting with the function, a new result was presented, but the focus of the screen reader did not shift. This was confusing for the participants, who struggled to navigate and find new information, as they were not sure whether a new departure time had been presented. The only way for them find this information was to navigate upwards or simply press an random element in the screen. I observed the difficulty they had in understanding this, and their issues in navigating the view to find relevant information. As they made mistakes, they became increasingly stressed and frustrated and seemed uncomfortable. They explained how this functionality was not something they would be able to understand by themselves, but would require an explanation. One of them had clearly expected the focus to change, and stated the

following regarding the issue of finding information in this manner:

Ja, det blir litt, da må jeg jo vite hvor jeg er hen, det syns jeg var litt, eh...tungvint.

Regarding the aspect of correcting navigational errors, some issues became very apparent. One of the visually impaired first time users stated that the problem was to know ones location in the application, and whether the navigation has moved the focus to the wrong element. A correlating factor to this aspect is to be aware of the available information and how it is presented, which was perceived as difficult. An example which highlights this, is when one of the participants attempts to navigate to the previous view, but mistook the back-button for a fictive name or station to edit. This was due to the mixture of English words and the Norwegian pronunciation of these words, which results in the read out of "nav-bar back" from the screenreader. As the user expected the same feedback as in other applications, such as the calendar or clock from Apple, this became an issue when navigating backwards in both "Stoppesteder" and "Reiseplanlegger".

In hindsight of these results, there are obvious issues with regard to navigation, despite most participants being satisfied with the overall navigational structure. The core of the matter might be found in a comment made by one of the blind participants, in that the navigation relies on what you as a user know or don't know, which shows that we as designers need to convey the necessary information.

This section have presented the more general issues and concerns which can occur in at any stage of a journey. In the subsequent section, more specific issues are addressed, which primarily relate to the planning phase of a journey.

5.3 | Planning stage

The subsequent section will highlight issues and recurring themes related to the planning stage of the journey, focusing especially on the means used for finding and storing information.

5.3.1 | Finding and storing information

In this section, some of the issues of applying the functions for finding and storing information during the observations and interviews, are addressed. The main features and views that are highlighted, are "Stoppesteder", the option button in Android, the functionality used to find a specific journey, and the display of results.

Information through "Stoppesteder"

The functionality in "Stoppesteder" allow users to find information through search or to use the "i Nærheten" functionality to find nearby stations from their locations.

The feedback from the participants on the search functionality was that this was a good feature. Some of the main advantages highlighted were the real-time information provided, and the fact that results were presented in a list. For the visually impaired users, it was noted that not having to open a new view to find information was great, as it made it easier to get an overview and was more accessible.

Many of the participants mentioned that they preferred to use the search functionality to find information, especially if they knew the whereabouts of the platforms and/or had travelled there before. Their use of the function seemed to be dependent of their knowledge of the area. Another important element to highlight was how the participants attempted to find information relevant to their own situation, for example the participant who wanted to know the last bus home from a nearby location.

On the overall view of "Stoppesteder", the participants noted its simplicity, that there was a good organisation of elements, and the inclusion of the search bar to search for departures from stops. Some thought the option of having "Sist brukte" was great, while other had not used this function extensively. While this was the case for users of the latest version, the user of the previous version were more dissatisfied, describing its appearance as depressive and dark.

With regards to the functionality of "i Nærheten", the participants found this to display good results. For example, having all the bus stops in an area was great, given that it did not clutter the view. One minor issue occurred when the names of the stations were similar. I noted how this caused confusion for a visually impaired participant in terms of understanding the location of the platform.

Despite the overall satisfaction of the search function, I observed how actually using the functionality presented problems, especially with regard to the spelling of the platform name. One participant experienced that spelling the name correctly provided a notification of having no Internet connection, which was not the case. Removing a period however, provided the correct result, which was very strange and annoyed the participant. This concurs with a similar experience encountered by another participant using Android, who had experienced no platforms in the results due to misspellings, and thought the search function should be able to account for misspellings in the user input.

The "hidden" button

Another important element was the option button in the Android application. None of the participants were aware of this function being present, and that it could provide functionality that might be relevant to their use. As mentioned previously, the functionality presented in the menu for this button varies in terms of what view the user is on. For example on "Stoppesteder", there was an option to switch from last used search to most used search, or to choose specific means of transport when using the travel planner. The general consensus was that the participants would have used these functions had they known they were available. As such, there seems to be a need of conveying to users that these options are present.

In terms of using and understanding these features, the participants seemed at first to understand the intention behind them, but showed issues in using them. One participant struggled to locate a certain function, which was connected to a specific screen. Another participant wanted to travel specifically by bus, but struggled to locate the function that would enable this, and eventually had to be aided by the researcher. However, the participant was still not able to find a relevant bus route.

These examples indicate room for improvement in terms of locating, understanding and using these features of the application.

The travel planner

As the term used for finding a specific route varied between the different applications of RuterReise, the term travel planner is used here to describe the overall goal of using this functionality. The travel planner and the results it provided, was appreciated by the participants, and the overall impression was positive. One participant was especially satisfied and noted how it was able to provide additional details, for example the duration of the journey. The participants further highlighted the explanation of the route, having information about the direction of the transport, knowing the transfers and stops along the way and the arrival time for these, and knowing when the transport arrived at their final stop, as positive. One participant described this information as detailed in terms of the time used for the travel, and how far one needed to walk. The participants also thought the travel planner equipped users with a quick way to search for information and receive results. Several participants found the "avvikmelding" regarding delays or other issues on the route, to be a useful feature.

A statement I feel describe the overall view of the participants for when to use of the travel planner, is the following:

> *Når eg ikje vet, eh...alternativene nedover når eg skal komme meg til det stedet.*

However, there were some issues. One participant experienced how the selection of a start position in the travel planner, affected the results of the quick search for platforms in terms of what direction the user were expected to travel. This was noted as an issue by the participant.

Several of the visually impaired participants also stated that though the travel planner was a good feature, and that searching for a route was "okay" and "logical", the use of the function was a learning process, which one has to go through in order to adapt to its use. Thus, it seems that for users with visual impairments, their conceptual model for the behaviour of the travel planner did not initially correspond with the one that had been designed by the designers of the application.

While the functionality of both the search and travel planner were much revered, the results and information displayed was not always beneficiary and understood by participants, The next section will highlight this further.

Displaying and use of results

While the results often provided useful information for participants, there were several problems to address. The first of these related to the older Android version, in which the participant had been told several times by the travel planner to use a different route than what the participant knew was the fastest, and the travel suggestion did not account for or notify about rush-hour traffic. Annoyed by this, the participant explained how this might lead to users not making it to the next transport, or arrive later than originally planned.

Another interesting aspect was the way in which several of the participants using the Android application, found and stored their results. Instead of using the "Favoritter" functionality of the application to store a journey, they would normally to take a picture of the journey they had planned on ruter.no and use that while they were travelling. This was seen as both more practical and time-saving to do on their computer than on a mobile

device. It also enabled them to save battery and money from data transmission on their devices. The concern and reason for many users to do this can be seen in the following quote:

Litt tungvint, men da slipper man å være avhengig av dekning på telefonen

In light of these revelations, I became aware of how the concept of a safe and simple journey was an important factor for the participants, which a future application needed to provide for.

Another issue related to the presentation of results, was the participants understanding of these. Several participants had experienced results where several platforms had the same name, with only minor alterations. From the interviews, it became apparent that this might confuse visually impaired users. During an interview, I observed how a participant expressed issues in terms of understanding the exact location of the platform, given the names presented in the list. The participant thought perhaps the application needed more information, which was not the case. The participant still felt the fault was their own, while other more experienced participants were more inclined to blame the application. Thus, it seems to be a reluctance from first-time users to criticize the application.

A final concern worth noting is the difference in results of the searchbar under "Stoppesteder". In one observation, it was noted that searching for an area for example Majorstuen, provided a route to that area, while searching for a specific platform would display the departures of that platform. The participant did not find this to be logical or intuitive. To further build on this, I later discovered that this does not apply to the iPhone application, but only to the latest Android version and Windows Phone. Thus, there is an inconsistency in the various applications in terms of the results of the search, which seems both strange and unusual.

Having highlighted some of the issues of the different result views, and the methods used by the participants to understand and use the results from the application, the next section will address their use and understanding of "Favoritter".

Using "Favoritter"

Most participants were positive and seemed to understand the practicality of using "Favoritter" to store platforms and routes. However, many of them had not actually used this functionality, and was not aware of what it would achieve. Therefore, they often needed an explanation in order to understand its use. This was especially highlighted in an observation with a user of the old Android version, who were irritated by having to use the search bar to look up the same information several times.

While the icons used in the application had previously been noted as beneficial, one issue was the icon for storing a route in the latest Android version. It displayed a pin rather than a star, which several participants believed was the conventional icon for saving a bookmark on the Internet. I observed how this was particularly an issue in an observation with a participant using the latest Android version. The participant not only struggled to understand the icon but also to find the actual information under "Favoritter" afterwards. The issue is especially highlighted through the comment by the participant on why this functionality had not been used previously:

Figure 5.1: Using the RuterReise application on Windows Phone to plan a journey.

> *Det hadde jo sikkert vært praktisk, hvert fall med favoritter, for eg har jo liksom noen, strekningar som eg reisar mest på."....."Eh..menne, det har liksom ikje vært sånn veldig innlysende måte å legge til favorittar.*

This statement highlights how the actual use of "Favoritter" does not appear to be intuitive to the participants, and that users may at times find it difficult to understand how they can achieve their goal of storing relevant information. Note that this problem occurs despite there being a leading text under "Favoritter" that is meant to explain to users how to accomplish this, and the participants often required an explanation from the researcher to achieve this goal. The problem of not understanding the use of "Favoritter", may in addition to the previously stated reasons; not spending money on data connection and save battery, explain why many of the participants had decided to store their results in images before travelling, rather than using this functionality.

Furthermore, it is important to mention some of the concerns from the visually impaired participants. One participant mentioned how their use of this functionality is limited, using the example that knowing when one train arrives at a station, does not tell you whether other trains will arrive before it. The participant went on to explain how the subway trains might be arriving one at a time, but that buses often arrive simultaneously. In

light of these comments, it appears that the current implementation and functionality of "Favoritter" is not a great aid for these users.

Another important aspect to highlight is the use of "Favoritter" in combination with the VoiceOver functionality from iOS. The observations had not shown any serious difficulties in combining these. However, as the interviewees were asked to store a specific departure, they were not able to achieve this. The star element used in the application to activate this functionality was not accessible and no function was read out. Instead, the screenreader told the participants that there was a button there which they could to interact with. When pressing this button, the participants experienced that the application crashed and had to be restarted. When turning off the screenreader, it was revealed that a user is not able to interact with the element at all, besides activating the star. As this element is not accessible, the button read out by the VoiceOver is not usable. This was seen as an issue by the interviewees, especially one interviewee who had wanted to store several departures as favourites.

This concludes the section on issues related to the planning phase of a journey. It highlights several of the benefits and issues of finding, understanding and storing information when using the functionality of the application to plan a journey. Having addressed these matters, the next section will address aspects related to the travel phase of a journey.

5.4 | The travel phase

The following section will emphasize on the issues related to using the application during travel. Specifically, it examines the problems in using the application to navigate to the right transport and platform, using the map functionality during travels, and the retrieval of information while on the move.

Platform and transport

When highlighting the findings related to the planning phase, I noted the usefulness the participants saw in having the "i Nærheten" function to present nearby stops, when the participants were in unknown locations. However, an issue arises as the result of this function does not state the actual distance to the stop, nor any textual description of how to get there. For visually impaired users, this becomes an issue when moving between locations. One blind participant commented at one point not knowing where the closest platform was, given the locations and results presented by the functionality. The issue this presents is perhaps best described by the comments of one of the blind participants, who stated that:

> *Ja, altså nærmest betyr jo ikke at det er i nærheten.*

Similar issues occurred for visually impaired participants when they attempted to use the results from the search or the travel planner functionality in practice. The participants were able to find the information, but were not always aware of the location of the platform, or where to go between stops. Again, there was no textual description of this, and none of the participants were able to use the map together with their accessibility features.

Many of these participants explained how they often needed to use third-party applications such as BlindSquare to navigate and use as a guide, or ask someone about how to

get to their intended location. One interviewee described the approach for coping with not knowing the platform or location in the following manner:

> *Ja da, akkurat da, da blir jeg veldig sånn, jeg er jo sånn som vil planlegge og vite på forhånd.... Så, jeg...ville snakket, snakket med noen som er kjent og få en..detaljert beskrivelse på forhånd.....Enten det eller til og med få noen til å bli med meg...første gangen.*

Some of the sighted participants were also compensating for the lack of textual descriptions by searching for known stops instead of addresses, or by using third-party applications such as Google Maps to find an address.

The issues highlighted indicates how the information and descriptions provided by the application, are insufficient for enabling users to travel independently, especially the visually impaired users.

Using the map

As mentioned in the previous section earlier, the map and its functionality was not useful for the visually impaired participants. Testing the function with VoiceOver showed that the participants had to press exactly on the icon in the map to receive any useful information, and that navigating the map with the screen reader was not possible. Thus, the directions and locations of the platforms indicated on the map, were only useful to the sighted participants.

However, in many cases the sighted participants were not aware of a map being present. None of the Android users had used the map functionality previously, but were active users of third party applications such as Google Maps. The participant of the previous Android version had looked for a map function, but had not been able to locate this, as it was hidden under the option button of the Android phone which had never been used. The participant was surprised by the placement of this functionality, and when asked why this function had not been located and used previously, a simple explanation was given:

> *Fordi..det står ikke noe om det.*

Again, the lack of information and descriptions for the users are highlighted as an important issue. The participant went on explaining that a button had been expected, which would state that the map functionality was available.

A similar issue of locating this functionality was observed in the participants use of the latest Android version, and the relations the participants had to the map icons. The participants did not seem to understand or relate to the icon that was used to indicate the map functionality, and had not been able to find this functionality. Being familiar with the icon applied in other third party applications, they seemed confused and frustrated as to why not the same icon had been applied in this application. One participant also mentioned how it had not been necessary to use the map, repeating the preferred method of planning and storing a journey by taking a picture of the information beforehand. The participant also described how the need for using a map was limited to situations where the participant was in an unknown area. In these situations, in which ones own intuition and observations were not enough in order to navigate properly, the map functionality became a necessary feature.

As such, the current solution does not seem to be intuitive to users, and does not correspond with their conceptual model and expectation of the map functionality in the application.

Furthermore, I witnessed an important concern and difficulty related to the use of the map functionality when participants attempted to use this functionality to navigate between locations. In one observation, the participant struggled to find the correct bus stop in a large area. The confusion and anxiety of the participant can be seen in the following statement:

> Eg er litt sånn forvirret over hvor er det jeg er og hvor er det...det står liksom ikke noe om hvor jeg er...

This confusion seemed to be in part due to the map itself, and in part due to the lack of instructions from the map and the route about where the stop was located. Besides the issue of not knowing the location of the bus stop, the participant also noted the constant movement of the GPS icon as being a problem. In addition, the participant did not seem to be aware that a icon was present on the map. This icon could be used to indicate the current position of the participant on the map, but this had to be pointed out to the participant.

All of these aspects made the participant appear insecure, and I observed the stress and frustration these issues forced on the participant.

While some participants had severe issues in using and understanding the map, other participants were satisfied. One participant highlighted the benefit of having the icon for your current location appear in the map, and preferred having a visual view instead of having a textual description. The problem for this participant was towards the navigation on the map. The participant thought the markers used to indicate the current user location and the end location were too similar, and that these should be two separate icons. Relating to users with bad eye-sight, the participant noted how these users would not be able to distinguish between the two icons. As the current solution depended on these markers in order for users to use the map, this was a problem, especially if there were many similar roads on the map. If the Ruter map did not provide the necessary information, this participant would use the built-in maps of the mobile device.

Having addressed the findings related to the use of the map functionality, I now turn to an issue many users may encounter while travelling: finding relevant information according to ones own situation and needs.

Finding information on the fly

Through our mobile devices, we can retrieve information in various environments, but this information is not always easy to grasp. An example which highlights this, was when I observed a blind participant that had to navigate through a result page of the application showing the various departures, while being in a noisy area with many platforms. The participant had to remember and count the number of buses that had arrived at the platform, and the departure times and bus routes read out by the application, to find out when the relevant bus would arrive. I observed the struggle the participant went through when trying to listen to the read out from the screenreader. In the workshop, the same participant explained how using the search function and finding information in a noisy

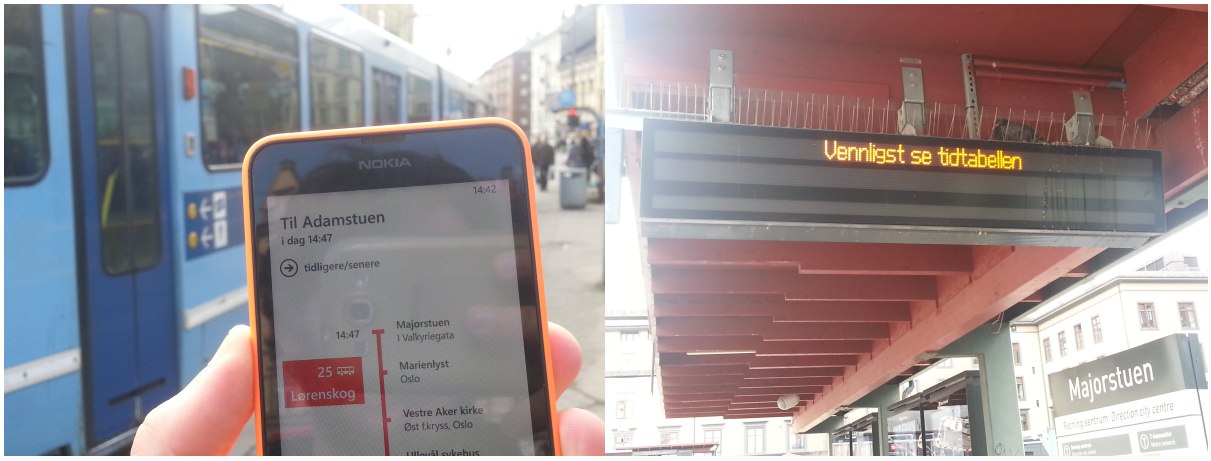


Figure 5.2: Is the use of the application sufficient to provide the necessary information to every user?

environment with many disturbances, is difficult compared to being in a quiet environment at home. Thus, this seems to be a challenge for visually impaired users to cope with when attempting to find relevant information.

Furthermore, another observation show the compromises these users have to make. One blind participant had developed a process of checking whether a tram had left by searching in the application for the next one. If there were other trams in route before that departure, these were not relevant and should not be used. In the case of the subway, the participant had trained in order to remember the order of the various routes used by the participant, and the routes that followed them. This way of deducting and filtering out information provided the participant with relevant results, and was enabling the participant to travel independently with various transport means in a given situation, as the participant had learned the location of these. It was however, acknowledged that this requires training and that the real-time information provided vital information, as illustrated by the statement from the participant about the dependence on this information.

> *Ja, så den er jeg avhengig av. Hvis jeg er, hvis jeg skal til Jernbanetorget f.eks, der nede på t-banen der, så er det ikke alltid det er dekning. Og da...da står jeg der.*

While the information of the application appeared to provide the participant with a new opportunity for travelling independently, relying on the read out of real-time information and deductions to find relevant information is difficult. This process seems to be a cumbersome and error-prone way of finding relevant information during travels. One participant also acknowledged the possibility of navigating to the wrong platform as an issue that the application does not address, while another participant mentioned the problem of boarding the wrong transport. In fact, in the observation, this participant was in the process of boarding the wrong bus, as two buses arrived at the platform at the same time. The application had not notified and made the participant aware of this. In light of these findings, it appears the information from the application can provide both opportunities and issues for visually impaired users.

While finding and using the information was easier for sighted users, this was not without fault either. This was particularly the case when participants attempted to use the travel

planner in combination with the GPS, by searching for a journey where the start location was set to "Min posisjon". In three situations, where the participants were using the latest versions of either the Android or Windows Phone application, all of the participants were instructed to use a different and much more time-consuming route than the one I had found on the website Ruter.no prior to the observation. These results startled both me and the participants at first, and led to much confusion. In one observation, we actually walked for about 10 to 15 minutes to a bus stop, before later discovering that we had the option of taking the tram and transfer to the bus afterwards. In another observation, the instructions for the route at one point altered, telling the participant to walk to a different stop and not use the tram as instructed earlier. In all of these cases, it was later revealed that these issues could have been prevented by selecting the area itself as the starting location, rather than selecting the position of the user with the GPS functionality.

None of the participants seemed to understand why there was a difference in the travel suggestions from the application. However, a reflection from one participant was that this was not so strange, given the participant's previous experiences of using applications with GPS functionality, and how one tend not to think of this as an issue. The responses of the other participants varied from confusion and requesting to see other travel options, to stating that this was a poor feature. One participant expected the application to have the same functionality and behaviour as ruter.no.

This concludes the findings related to the travelling phase. The issues highlighted address the navigation of users during travels, in which using the map and other functionality was important aspects. Other issues was also revealed when the participants tried to retrieve useful and relevant information according to their current travel situation. The next section will present some of the experiences mentioned by the users and their reflections on the issues they encountered.

5.5 | Reflection phase

Having elaborated on the issues participants experienced before and during the journey, the following sections will focus on the participants own reflections and opinions during and after the observations and interview, including my own experience by observing the participants. This goal is to convey to the reader the experience of the participants. In light of these experiences, the section will conclude with the improvements the participants suggested to include in a new version.

5.5.1 | Experience of the participants

Overall, the participants seemed surprisingly pleased with the application. It appeared to provide the necessary information, had a good overview and was simple to use. One sighted participant were particularly pleased with the flow of navigation and the use of the functionality. One of the blind participants highlighted the simplicity in using the functions, felt the application was well presented, and was very comfortable in using it. The option of having VoiceOver and TalkBack feedback was appreciated, including the fact that there were small amounts of text and symbols in the application. The participants were able to relate to and understand the icons that were used, with the exception of the

symbols used to store information in the Android and Windows Phone version.

However, there were some negative experiences as well. First of all, the reader will recall the confusion the participants experienced when presented with the results of using "Min posisjon" as the start location. This element of confusion was also present in the use of the map functionality, as I watched how several of the participants became frustrated and confused. The statement which exemplifies this the most was from the participant who stated that:

> *Eg er litt sånn forvirret over hvor er det jeg er og hvor er det...det står liksom ikke noe om hvor jeg er...*

The same element of uncertainty seemed to occur when participants were presented with parts of the terminology, as they especially struggled to understand the meaning behind a route being planned and how to interpret "Stoppesteder". As such, the findings show an element of insecurity and stress in the users as they try to utilize the application.

Secondly, there appeared to be a strong need for some of the participants to be able to travel safely, and be certain of their arrival to the expected location. This is based on how many participants had stored images of their routes, as mentioned earlier, and is further enhanced by the acknowledgement of one participant that the most important thing is to find a route, and address its usability afterwards, when discussing the result of using "Min posisjon".

The same aspect was true for some of the visually impaired users. One of the blind participants elaborated on the intensive planning that was required to travel safely, either by learning the route beforehand and/or asking someone for a detailed description of it. The same concept applied when not knowing the station itself, as the participant would get a detailed description of the location or ask someone to come along. One example which highlights these aspects occurred in a observation where neither I nor the participant knew the route that we were travelling. Since we could not hear the speakers on the bus due to noise, the participant turned to using "Ariane", an application which uses the GPS, and can read out the name of the streets during travels. This was to make sure we departed the bus at the right location.

A similar example was given by a sighted participant, who had travelled in the outskirts of Oslo, without any sound feedback or text notification on the bus notifying the participant about the stops the bus went by. The solution was to use Google Maps and track the bus through the map to see where the relevant stop was. Another example of this issue was given by another sighted participant, who explained the need to ask friends for directions when travelling to an unknown address or platform, and at times calling them during travels to have them repeat this information.

In sum, these examples and experiences highlights how the application is not able to avoid the participants becoming insecure, and does not provide the necessary safety for the participants, who deemed it necessary to supplement with other services and functions that can provide this.

However, it should be noted that there were participants who were very comfortable with travelling in this manner, especially one blind participant who wanted to be independent and appeared more relaxed towards the travelling situation. This participant explained how a user's relation to these aspects will depend on your own prerequisites

and what you are used to. This highlights not only the difference in experiences, but the personal comfort of travelling on public transport. Despite being seemingly satisfied, the participant also had elements of critique against the application, particularly with the regard to the issue of not being able to find useful information on how to move between transfers and platforms. An adequate statement for describing the negative emotion from not having this feature, is the following:

Nei, det syns jeg er litt humbug.

Figure 5.3: How would you feel after travelling in a large area, and having faced the issue mentioned by the participants?

Other elements of the user experience can be drawn from the stress I saw in the interviews, when the first-time users attempted to navigate and understand the application, and how the level of frustration in the participants increased together with their speed of navigation in the interface. The feedback from these participants highlighted the important concept of the learning process, as they stated several times the need for learning the structure, terminology and use of the menu, or needed to get acquainted with the application through use, particularly the language and the terminology. Compared to the ease I observed from the way one of the experienced and blind participants used the application in a travelling situation, this may be the case. However, this participant also emphasized the aspect of learning and the initial need to receive help from others. This highlights that the application seems to have a steep learning curve, and that negative experiences will be encountered when attempting to use the application during travels. This is further underlined by the statement of a sighted participant, who explained how the application had been more cluttered and difficult to understand before the observation. The participant explained that the functionality was now much clearer, which indicates confusion on its actual use and a need for clarification from the developers.

Another interesting aspect, was the low amount of critique from the participants. In some cases, they expressed how it was easy and simple to use a function, but the problems that I observed, indicated that this was clearly not the case. Though some participants

acknowledged their issues, many focused on the positive aspects of the application. A statement which highlight this is how a blind participant expressed the need of adapting to the larger user groups first, and compromise with the smaller groups afterwards. Thus, there appears to be a large amount of empathy from the visually impaired users for the developers of RuterReise and their work. However, given the issues many sighted participants experienced when using the application, it appears that the application does not provide a suitable user experience for either user group.

As a final note on this issue, it is especially interesting to highlight the difference between the sighted and non-sighted first-time users regarding the learning aspect. The visually impaired participants that were using the application for the first time, did not view the application to have a too steep learning curve, despite the issues and errors noted earlier. One of the younger and sighted first time users however, described the application as not being completely hopeless, but having a high learning curve and a potential for improvement. It seems the participant's expectation for using the application, and their age group, seems to play a part in terms of describing its usability. An fitting note to conclude on is a statement by one of the visually impaired users, who found it difficult to know when the right transport was arriving, and believed the driver should always read this information out loud, regardless of the type of vehicle:

> *Så derfor så syns jeg det er viktig at det ikke... bare tenker at nå, har jo blinde iPhone, nå, nå kan de klare seg... med alt.*

Thus, it seems the current mobile application can only partially address user issues, and that providing for all of their problems can prove difficult. However, an improved application which can address most of the needs and requirements of users can be created. The next section will highlight some of suggestions and ideas proposed by the participants in the interviews and observations.

5.5.2 | Suggested improvements

With the goal of further developing and improving the application, several ideas and alterations were suggested. The visually impaired participants suggested having a warning or notification through an alarm or vibration for when the transport was arriving, to be guided between transfers by using sound and GPS, or to have a textual or audio description of the map, that would give them instructions on how to get to a station or platform. The latter could be done by reading out a description in short terms or sentences, having the application read out nearby platforms, or by having a GPS solution that could guide the user to a stop, giving the user direct instructions on how to get to the locations, as in Google Maps. The use of such a GPS solution was also mentioned by one of the sighted participants. A visually impaired participant stated how the GPS solution would make it easier to travel, making one feel safer and more confident.

Similar issues were addressed by a sighted participant, who saw the possibility of notifying users that had stored a route, when they needed to depart their transport for that route. This would be done with the help of the GPS functionality. That way, the participant would know that the right stop would, for example be, two stops ahead. The participant also suggested having a first time guide, in order to display the various functions and give the user a walktrough of the application.

Furthermore, to provide the users with an improved description of the locations, several participants suggested having the area they were located in appear in text when selecting "Min Posisjon" as the starting location. A bolder idea was to have user profiles, giving the users their own options and alternatives. An offline mode was also suggested to have the possibility to save the image of a route on your phone, or to connect your profile and device to Ruter.no in order to transfer the information to your device, and store it.

In terms of more specific improvements, one participant stated how the travel planner and favourite functionality should be improved, and that a better indication as to whether an icon contained information, was needed. Other minor alterations suggested by the visually impaired participants, was to notify the user to wait until the search was done, so the user would not start navigating in the view, and to have a button that would state next in order to find later departures, rather than using the current solution. The map functionality and its symbol should also be made clearer, particularly for one participant who feared the notion of having to walk around at night time looking for the right transport. This participant also requested a detailed map of the relevant bus stops, and of the most popular travel areas and their exits.

To solve the issue of coverage and not knowing whether the next transport is relevant, a suggested solution was to have the first transport that was arriving according to the application, be the first to arrive at the platform as well. Another suggestion was to include an offline mode that would indicate, for example, where the subway train was last located, which would make it easier to find out when it should have arrived at the station and far away it is.

Finally, one aspect which was especially important for one of the blind participants, was to be presented a list of all the stops on a departure or route, preferably read out, and a notification through sound or vibration when the transport has arrived at the platform. This would make it easy for the participant to know when to get ready and be safe during the journey. One participant also wanted the application to read out the various stops for the route the user was travelling, or to make sure this information was available on the phone. The participant also suggested that adding a departure or route to "Favoritter" would ensure the user always received a notification when using it.

The main findings from the users ideas and suggestions, are the need for more information, especially in terms of planning the journey in your own environment, and receiving the necessary information during the travel phase. In addition, there was an overall consensus from the participants that a future application should remain simple, provide a good search functionality, have an understandable terminology, and a simple overview.

Having noted the important results from the observations and interview, and identified issues and concerns, I was now ready to conduct a future workshop which could further highlight important issues. The next section will address the findings from this workshop.

5.6 | Future Workshop

The reader will recall from the chapter on methodology, and from the section on telling techniques in PD, that the future workshop consists of three phases. To describe the first phase, I have used the term critique phase, as participants bring up issues and complaints about the application with the aim of improving it. The second phase has been called the

fantasy phase, as participants are given the opportunity to list any imaginary solutions to their problems. The final phase is noted as the realization phase, where the participants discuss the different solutions in terms of achieving a common concept and goal, given the present situation and technology. Democracy and the goal of having equal power and influence among participants should be important concepts.

In conducting the workshop, I began the first part by explaining the process, its various phases, and how to conduct these. I highlighted the importance of a democratic process with equal participation and influence. At the start of the future workshop, the participants were given three large pieces of paper, pens, and post-it notes. Each paper was to represent a phase, and the participants could write up issues or suggestions on the post-it notes for that specific phase, when something was mentioned by one of the participants. In the second part of the workshop, the participants were instructed on how the prototyping session would be conducted and I provided them with the necessary tools and equipment. My own role during the entire process was mainly to act as a facilitator, but I provided ideas and comments when deemed necessary. The findings from the workshop have been divided into its corresponding phase, starting with the critique given by the participants.

The critique phase

In the beginning of this phase, the participants seemed quite unsure, and several participants had to pull up the application in order to refresh their memory.

However, after a slow start, they began to provide influential feedback. The blind participant highlighted some of the issues of using the application in a noisy environment when travelling, and wanted to avoid having to swipe the interface of the application if it was cold outside. In addition, while the participant thought having the real-time information was very important, the participant had experienced that information was at times not correct when using the application. The participant had also discovered that finding a nearby subway-departure through the use of the "I nærheten" functionality, was not possible while being in a subway tunnel, and that trying to find the box to validate one's travel pass often proved to be difficult.

With regard to the previous Android version, there were several comments. First of all, some of the participants had experienced that the application had often not set aside enough time for the them to move between platforms, resulting in the participants not making it to the transfer on time.

Furthermore, one participant explained how the map was hidden from the interface, and that there was no button to interact with. When finally discovering the map functionality, the participant described this function as useless. The participant was not being able to see the relevant paths or to be guided to and from locations, for example when using the bus. Another issue in relation to this was the problem of not being able to find street addresses, as the application only provided the closest stop to ones current location.

Moreover, in the earlier Android version, there was no option of saving a route, and one often had to search for the same route several times. One of the participants had also attempted to use the alarm functionality, but was not able to find and deactivate the alarm before it rang. Thus, the participant did not find this functionality useful. The participant further explained how one was often presented with route suggestions which made no sense. This was perceived as bad proposals from the application, for example, having

to transfer to a different transport which would cause the participant to be stuck in rush traffic.

Though the participants had limited experience with the latest Android version, some concerns were raised. They felt that the icon used to indicate the map functionality, was not intuitive. Furthermore, the term stating that "Reisen er planlagt" had no meaning to them, and they did not understand why this was placed under "Favoritter", as the two terms was perceived as two different concepts.

There were also some general issues that was agreed upon by all participants. Firstly, the participants using Android devices explained how they had not been notified about the release of the latest the Android version for the application, which all the participants found strange.

Moreover, the participants felt that using "Favoritter" to set a large area as a favourite was not useful, and that the only viable option was to make a specific stop a favourite. The reason for this was that using the whole area as a favourite, would provide to much information to the user. Participants using the latest version of the applications had also experienced that planned routes had disappeared from "Favoritter" without notice.

Furthermore, the fact that there was different functionality in the Android and iPhone versions, was highlighted as an issue, and the participants wanted the same options to be available for all operating systems. The participants also felt that the application lacked a possibility for the users to provide feedback.

One participant highlighted the need for more information about nearby subway and tram lines for a location. The notion was that for each line, it would be useful to get an overview of its later stops and the estimated arrival times at these. The other participants agreed with this.

A problem related to this issue, was the slowness of the GPS functionality, especially when the user loses coverage. The participants believed the device should be more aware and register when the user last had a viable connection.

Finally, they agreed that there was an issue in using the search functionality, as several of the participants had experienced that searching for stops with the same names as areas or other stops, did not provide the expected results. Also, the application did not address spelling mistakes made by the user. The participants related these problems to users who might not know which stop to use, and expected that the right match would be given to the right input. Having explained their issues in the critique phase, the participants began the fantasy phase of the workshop.

The fantasy phase

To resolve the issues highlighted in the critique phase, several suggestions were made. One suggestion which seemed to resonate the most with all participants, was the possibility of being guided from start to finish and receive notifications, for example for when your bus was arriving at the station, which stop was yours, where to walk between transfers, etc. through the use of GPS, voice feedback and other means of communication and feedback. This became an important goal and concept for the participants. The blind participant expressed several times the need to include audio feedback, while the others were more inclined towards using vibration as the feedback mode. The participants suggested including a view for settings in the application, to give the user an option for changing the

feedback mode. One participant suggested using sound or vibration in the same manner as in calendar notifications. In relation to the feedback mode, vibration was also suggested as a tool which could notify the user while travelling, or could be used as an alarm in order to, for example, catch the last bus home.

To resolve the issue of navigation, a more detailed map was suggested, which had a specific explanation of the location of a stop, and a textual description which could guide the user from start to finish. For the blind participant, this had to be very accurate and be in combination with the GPS. In addition to a written guide, there should also be an indicator that could highlight the direction the user needed to walk towards, as in other GPS applications.

Building on this, the participants suggested that the estimated time to walk between transfers should be included in the map. Another solution to address the issue of transfers, was to include in the algorithm whether a transfer was difficult to complete in the requested time period of a route, or that a user should be able to adjust manually the travel time deemed necessary for a route.

Furthermore, the participants imagined a universal application in the sense that the same options that were available for Android, should be available when using the application on other mobile operating systems. An example that was given was how developers could extend the functions in the latest Android version to the iPhone application.

Moreover, the participants also addressed the possibility of storing routes, for example under the travel planner, and that the application could improve its language and terminology, in order to make this more consistent and concrete. One participant mentioned that "Favoritter", should especially be altered, and wanted a more understandable term, for example "Mine Reiser".

To resolve the issue of rush-hour traffic and being presented with bad route suggestions, the participants suggested to use real-time traffic data to retrieve relevant information, for example by letting the user know that taking this route in a specific time period is not a good idea, or that a route would present delays, given rush-hour traffic or other incidents.

With regard to the issue of validating travel cards, the participants suggested to use iBeacons to send out signals to the mobile units when they arrived at a station. By having the validation machine and mobile phone communicate, these would guide the user to the validation machines.

These suggestions were further validated and examined in the realization phase, which the next section will highlight.

The realization phase

Before conducting the realization phase, I expressed the goal of participants coming to an agreement on a specific concept or idea in terms of what they wanted to realize. The participants had been very interested in the concept of having an application that could be used as a guide from start to finish of a journey. The realization phase extended the discussion on this subject by looking into how one could achieve this functionality by using the suggestions mentioned previously, and whether these suggestions were viable.

With regards to achieving this concept, the use of GPS-navigation in cars were brought up, and the participants believed the developers could use the same technology in Ruter-Reise. Some of the participants mentioned how other GPS-applications provided this

functionality, and that the challenge for a future application was in connecting the GPS functionality in the Ruter vehicles to the system used for RuterReise. Given the automatic announcement on stops and platforms for the arriving vehicle, the mobile phones could then be able to communicate with these systems. One of the participants had experimented with extracting data from the Ruter system, and stated that it is possible to retrieve data from the system, for example when the current train the user is on, arrives at a stop. This information could then be transferred given that the user had an Internet connection to the application.

The blind participant described how the idea is to get a specific direction of where to walk between transfers, and that this could be done in similar fashion to using the GPS navigation in Google Maps, for example "Take a right here" and so forth. The others agreed, but consensus followed that it had to be possible to switch this functionality on and off.

The option of settings and adaptability became increasingly important as the discussion went on. The participants wanted the users to set the notification functionality themselves, in order for users to only receive the information that they want. One participant described how the application should make it possible to get a specific subway-line and not receive everything in the area. After some discussion on to how to achieve this, they agreed on adding functions that would only notify users of the route they had marked. This would be done once the user had pressed the bell or the button that indicated this functionality.

Figure 5.4: The participants discussing possible solutions

In terms of feedback and having various modes available when using the guide mode, it was again referred to the calendar functionality, and how screen readers, such as VoiceOver, can read messages out loud when receiving written notifications. This form of notification could also be used if users were not able to check a route. In line with the idea of using different settings, the notification could also be adapted according to user needs, as some users might want feedback on everything, while others might simply want to get an

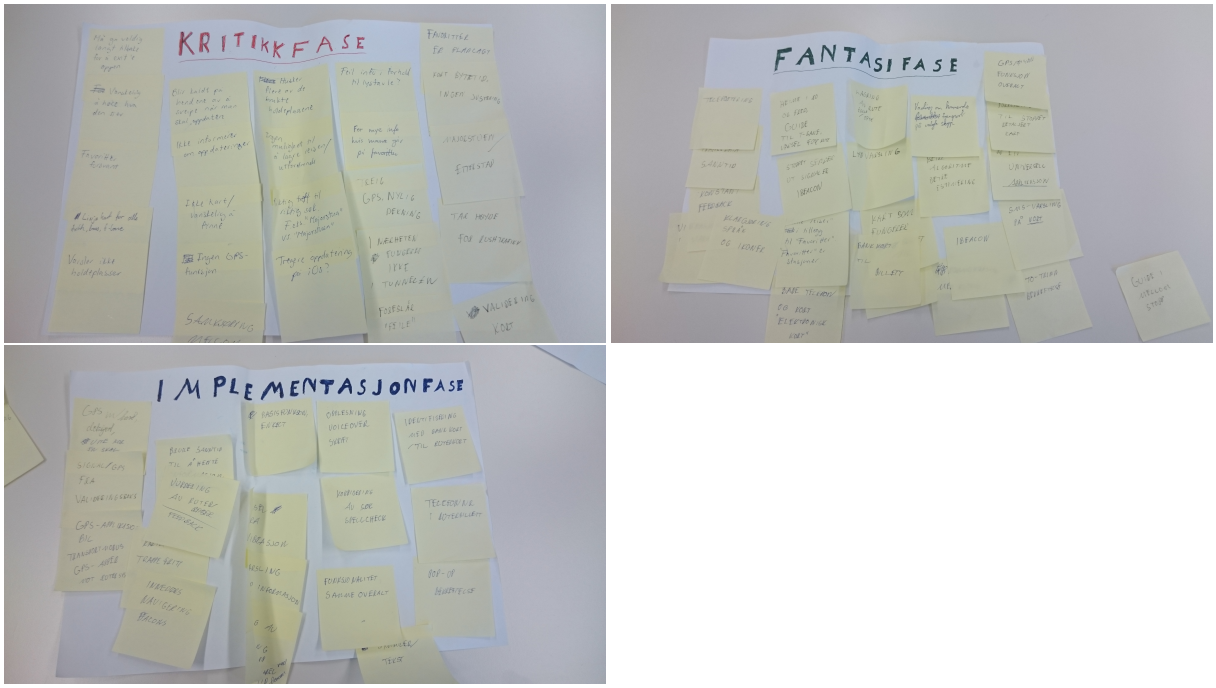


Figure 5.5: The post-it notes from the different phases of the workshop

overview of when a specific transport will arrive at a specific stop, or having the option to check when the transport is leaving. The minimum requirement expected by the blind participant, was to have a notification from the application on the second to last stop, in order to be prepared to depart the vehicle.

The notion of having vibration as a feedback mode, was again seen as a convenient and suitable suggestion. One participant noted that the benefit from this, was that one was not forced to listen to the speaker and worry in terms of the location of your stop, but were instead able to listen to music and relax. With regard to the response time for this functionality, it was noted that the functionality should make it possible for you to decide for yourself how long before the stop you want to be notified, by setting a variable time.

Interestingly, some of the participants did not view the information as the most important aspect, but focused on the following concept; that the Ruter application should be able provide a sensible route from a to b, without guiding the user astray first. They shared some of their experiences of using the application to achieve this, and the problems they had encountered in these situations. A suggestion for addressing this issue was to make sure useful routes were provided, and increase the user feedback by including a "thumb" up or down or "like/dislike" button, which would send a message to Ruter to indicate that a route was not useful. This would provide important feedback when the algorithm was not sufficient. It would also add a possibility for users to give feedback to Ruter, which was not seen as an option in the current applications.

Concerning the ticket and its validation, the participants thought it would be possible to have a ticket connected to an id card from Ruter, which could also be checked against the user's personal id card. This could further be used to ensure an electronic storage of a ticket, by having the two cards connected. If the id card was lost, the user could go to Ruter and receive a new one. Another solution to the validation issue was to connect the

two systems together and indicate the validation machine on the map together with text, in order to notify the user of its location.

To further address the issue of providing an option for those using a physical ticket, the participants suggested sending out an SMS which would notify the user that the physical card had expired. Another participant pointed to the fact that this does not have to be a message, but could be a notification. One suggestion with regard to tickets, was to allow the user to add the credit card and phone number when using the application for the first time, and buy tickets on RuterReise. Some limitations had to be set on these functions, as the participants expected that the mobile device was connected to the Internet and was powered on.

The map was already a part of the functionality in the application, but as mentioned previously, the participants wanted to improve it by adding details. They also wanted the application to provide more suitable names for the larger areas, for example not just use the same name for all the stops in the area, and then add a letter at the end to identify a specific stop. The map should also be instrumental by providing a written explanation that could guide users to their stop, and let them know if there were different stops on both sides.

With regards to the idea of making sure that the same functionality was available on all operating systems, some discussion followed. Some participants saw it as an advantage if certain functions of the application were only available on the specific devices that could provide these options, in order for the application to provide the best functionality possible. Other participants felt that the application should provide the same functionality in all mobile operating systems, and not use technology only suitable for one type of phone, even if it took full use of that specific phone. As the features offered on the Android application were seen as easy to implement into the iPhone application, the participants did not see technology as issue for this application. This was exemplified by one participant stating that it should be possible to save a route on both Android and iPhone devices. The participants therefore agreed that all the functionality from the application should be available for all versions of the application, regardless of operating system.

In terms of storing routes and departures, the participants viewed this to be a viable feature, both in terms of offline and online storing of routes. One participant mentioned that this should be limited to single journeys. This would avoid users having to search multiple times for the same route, and allow them to save the storage of the device.

Other issues, such as clarifying the language and icons were also mentioned, but the exact terms and icons to use in a future application were addressed later in the prototyping session.

The issues and solutions that were addressed in the workshop, is displayed in figure *5.5*. Having completed the three phases of the future workshop, the next step was to express these externally in a prototype session.

5.6.1 | Prototyping

By having established a concept and discussed the realization of the suggested features, it appeared that the group believed most of the suggestions could be included in a future application. The participants were therefore asked to externalize the interface of the future

application on paper sheets. The goal was for them to envision how the application would look and function, in order for me to get an impression of the design they requested, and further develop it.

Having given them the necessary equipment, I told the participants to focus on the elements of simplicity and robustness, and relate to future situations where they were using the new application. Furthermore, the participant who was blind, was asked to play an important role in this process, in trying to ensure that his needs and requirements as a visually impaired user was addressed. My own role was still mainly to be a facilitator, but I provided suggestions and feedback to the participants proposals from a designer perspective.

The participants began the process by drawing on one screen, but since there were limited time and the participants seemed to be slightly confused, I suggested that each participant could draw up one screen while keeping the group informed of the features that they were including.

They quickly decided to keep much of "Stoppesteder" and its functionality. As they drew the various screens, they discussed among themselves the various functions, terms, and elements to include, as well as their placement in the application. As each of the participants drew a separate screen, they asked various questions to the others participants, particularly the blind participant, as to how the suggested solution suited them. The process of the drawing was focused on three screens, how a route would look from start to finish, the screen representing the user profile and its subgroups of travel pass and settings, and the first screen presented to the user. The rest of the session was focused on discussing what features to include and how, in particular the features of notifications and settings for enabling guidance, how to enable notifications and adjusting the amount of information received, the placement of the map, the terms and icons to use in order to provide the necessary clarification, and the inclusion of a guide mode under user settings. Much of the functionality that was discussed, ended up being placed under the screens "Min Profil" or "Mine Varsler", but the participants disagreed on which of the elements to put in the menu.

Furthermore, they discussed the terms frequently, and struggled to find a common terminology. Some of the screens were drawn several times, and the participants seemed to grow tired and frustrated. Instead of the participants creating a clear and simple design proposal, the session therefore became more of an discussion between all of us on the design of the application. The participants seemed to be more focused on how to make each functionality simple to use and make sure the application adhered to each participant's individual expectations and needs, instead of the participants envisioning and coming to a mutual agreement for the interface of the application. Observing that they were tired and out of ideas, I decided to conclude the workshop, and thanked the participants for their help. In Figure 5.6, a few of the screens developed by the participants are displayed. While limited, these screens together with data from the future workshop, observations and interviews, played an important part in creating a new design proposal.

The previous sections have focused on personal and individual matters of different users. The next section will therefore display results from a more technical review of the application, using an heuristic evaluation.

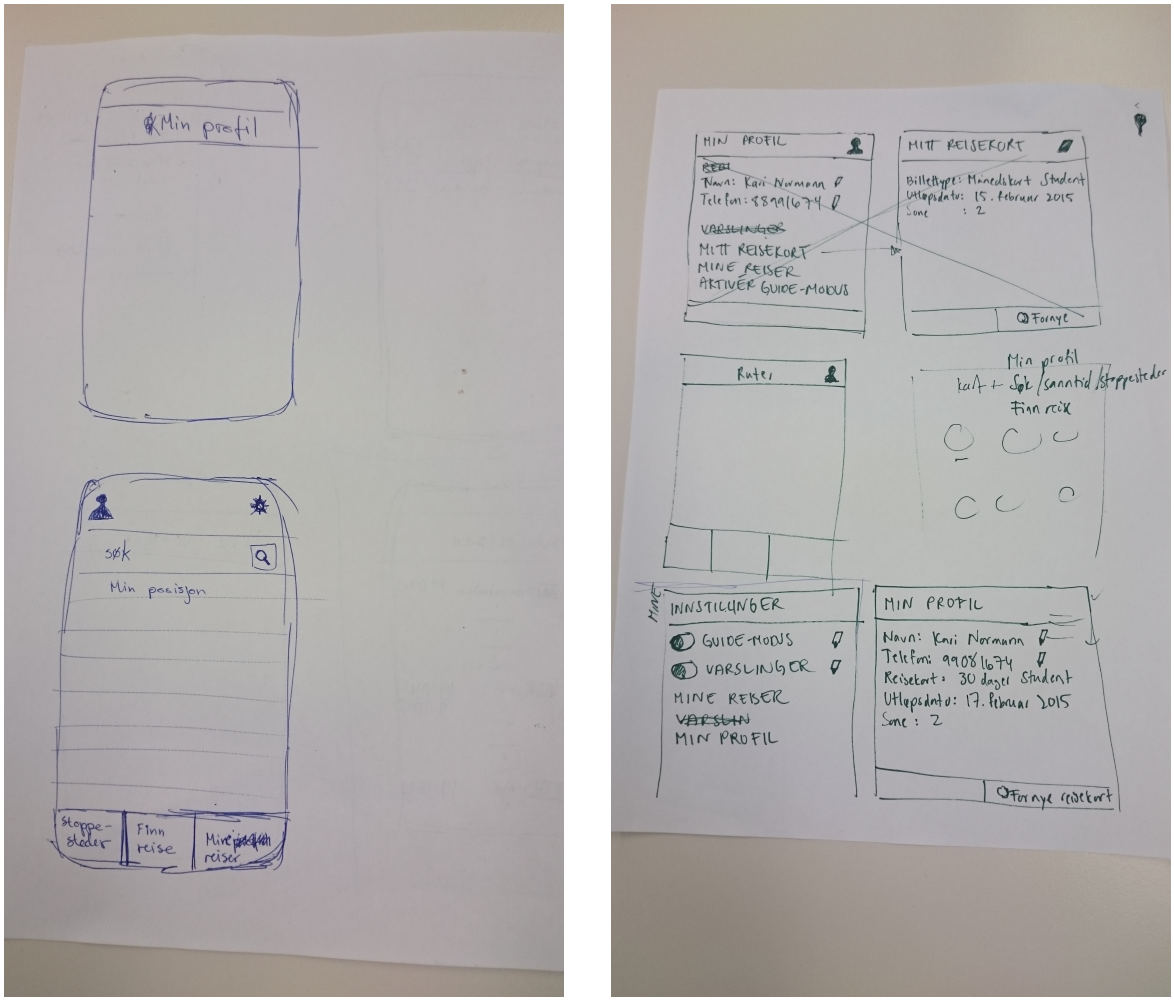


Figure 5.6: Screens for a future mobile application created by the participants

5.7 | Heuristic evaluation

Having focused on the individual experiences of the participants using the existing applications, I wanted to investigate the technical side of the applications, and understand the technical issues that needed to be addressed. I therefore conducted a heuristic evaluation of the application on three separate operating systems; iOS, Android, and Windows Phone. The results presented will focus on a technical review of the usability and accessibility in the application, in an attempt to avoid having many of the same issues from the observations and interviews being repeated. The evaluation has been divided into specific categories, according to the issues that were uncovered. Some of the key aspects are feedback, interaction, icons, specific functionality, terminology, the technical and visual difference of the application on different operating system, and general issues.

Feedback and interaction

As I have mentioned earlier, interacting with "Favoritter" in the iPhone application with VoiceOver proved useless. The function proved to be not accessible and only read out that a button was present, which is not the case. Interacting with this button caused the application to crash. Without the screenreader, there was no text or sound notification,

besides a star icon that changes to a bright colour. This issue of having a non-functional button occurred on all lines and departures of the result view of the iPhone version, and indicates a lack of appropriate feedback.

An issue with "Reiseplanlegger" for iPhone became apparent when trying to find the next departure for a specific route. First, the user has to navigate to an element with no text. The user can double-press this to find the next departure on the next page, but the VoiceOver only reads out the current page number out of the seven available. When interacting with it, the user is told that a new page is presented, but the focus is not changed. Instead, the user has to understand that one has to navigate upwards to the top to get information about the new departure. Furthermore, if the user were to navigate downwards to the menu, realize this mistake and try to navigate upwards again, the page changes back to what was the previous selected element in the page before that, usually the previous page.

Similar issues with feedback and interaction appeared in the Android application. When swiping through the elements of the result page of a search for a station, the elements were not read out in the same way as they were presented visually. For example, the mark-up to a stop starts by reading out the name of the first sub-way line, before the next interaction leads the screen reader to read out the platform which it departs from. More navigation causes it to move to the specific menu for that transport, which has no text or label. Instead, third dots are presented, which causes the screenreader to read out a knocking sound. It is not possible for visually impaired users to understand that this element has useful functionality, such as setting a specific sub-way line as a favourite or showing all the stops for that route, as there is no useful feedback from the element.

Another issue concerns the navigation and focus when using TalkBack. After the menu mentioned previously, the next element of focus is the departure times for the first route. The users might not understand what transport the departure time corresponds to, or may not be aware that the platform number for the departure has changed, as the navigation and build-up of the application when using TalkBack is not hierarchically. This can present the users with the wrong context, and make the application difficult to use. The user also has to navigate the various departures of a route manually, rather than the application reading these out automatically.

Moreover, navigating in the result view of "Stoppesteder" with a screenreader was difficult. It was easy to make mistakes and accidentally focus on the wrong element in the list of stations. No notification was given when a specific departure was entered, and there was no information about the view for each departure being able to display all the stops on that route.

Using the travel planner in Android labelled as "Finn Reise", there were a number of problems. If a user wanted to set a different date, this proved difficult as the date element is not read out before the user changes it. It was difficult to set a specific time, as there is no notification of either hours or minutes being altered. The user has to move the focus on to this element or navigate between them in order to discover this. It is also important to note that pushing the earlier/later button to change the departure time for a route, has no feedback to the user in terms of it being altered, and that a new result is now presented.

Furthermore, when a notification of a route being planned appears in the notification screen, this is not read out by the screen reader, and when accessing the element, no notification or feedback is presented to the user. When swiping through a planned route

under "Favoritter", the screen reader will not read out the transport connected to the line number, or whether the user has to walk between stops.

In the Windows phone application, the navigation was at times difficult, as one has to use the built-in back button of the phone, or the home button in the menu to move backwards. Using the back button too fast makes it easy to exit the application by mistake, which is frustrating for the user.

More importantly, the Windows phone application proved to not be accessible through screenreader functionality, as the built-in screen reader proved not to be functional with the application. It did not read back anything else than a message about the view not having a primary action. No elements are read back, besides the bottom menu that contains information about whether to display view options or find information about Ruter. Regardless of what is chosen, the next screen does not read back any useful information. Hence, it is not usable for visually impaired users, and meets none of the WCAG principles and guidelines, since it is not possible to access the elements on the screen. This means the application is only accessible to sighted users.

In sum, these issues points to problems of accessibility in terms of feedback and interaction for all the operating systems that were evaluated.

Tightly connected to these matters is the issue of icons, which will be discussed in the following section.

Icons

In the Android, there were several occasions in which the symbols were not read out loud by the TalkBack functionality, for example the icon indicating whether the transport for the departure is a tram or a bus, or the icon indicating that a user needs to walk to get to the platform. As there were no direction regarding where to walk or the distance, this could prove very confusing, especially when the area to walk towards and the stop has the same name, as in the case of Storo.

In terms of using the icon to store information in "Favoritter", if this is a station, the icon changes to be active in order to indicate to the user that it has been stored. But the icon is not being described as button to interact with, nor does interacting with it provide an audio notification of what the function did. Instead, the application moves back to the previous view and focus on the two first elements of this view. Visually impaired users will not know if the station has been put in Favourites. If the user tries to set for example a bus route as a favourite, the only new element that appears is "Alle dager", which enables user to enter it and set specific days to have this as a favourite bus route. No notification is given of this element appearing, the term is not intuitive, and the screen reader does not read that this element can be entered. When removing the route, no audio notification is given of it been removed, and since the menu where this is done is not read out by the screen reader, it is very difficult for visually impaired users to access the menu and remove it.

To get this information about the storing of a route, the user has to access it under "Favoritter" to confirm this. If the favourite is a route, the screen reader will not read the platform it is leaving from or tell the user to double-press to see all the stops for the route. To remove any route or journey as a favourite, the user has to access it and pressed the pin again, which seems cumbersome.

Similar issues were present in the iPhone version, where the icons in both results of "Reiseplanlegger" and "Stoppesteder" were not read out, for example the handicap-icon indicating that a low entrance is present on this route.

In Windows phone, the home icon which is the Ruter icon is hard to understand without text in the menu, which is quite small and hard to read. Furthermore, the choice of having a pin to indicate that the departure can be attached to the start menu of the phone, seems a bit strange, especially given the use of a star to indicate that a route can be saved as a favourite. The pin can easily be misunderstood for a favourite, but the two have a quite different functionality.

In addition, some of the icons of the Windows phone version does not have names, which should be provided since many of the icons do are not intuitive and understandable.

Finally, in the latest Android and Windows phone versions, the user can only delete all the favourites from the menu, to delete single favourites, the user has to access them separately and delete them. The Windows phone version also uses the star icon to set both a specific route and a user journey as a favourite, and provides no text notification to the user as to where this has been placed.

Another important aspect to consider is the use of functionality in the applications. The following section will highlight two specific features in that regards, the use of search and map in the application.

Search

In the iPhone version, I discovered that using search causes the focus of the navigation to shift to the last element present, usually the menu tab called "Reiseplanlegger". This was the case for both "Stoppesteder", "Reiseplanlegger", and the map. When navigating in this element, the user is forced to navigate backwards to get the information reads out by the Voiceover.

Furthermore, when using the search field, the screenreader does not notify the user that a keyboard is present, and the focus of the application is not altered. This requires the user to navigate and interact with the element in order to find the search field. Having entering input into it, the user is not notified that a list of suggestions is presented, or notified that that the search for a platform is completed. Instead, the user has to interact with the right element on the screen to get this information.

The read out of a keyboard being presented, was inconsistent in the Android application and if the search button of the keyboard is pressed, it does not close it and start the search for a platform or route. This is also the case with the screen reader, which read out "søk" to user, indicating that an action is done, which is not true.

Another issue occurred when entering a search. A list of results will be presented in an overlay screen, which is not read out by the screen reader. Swiping the screen does not mark the elements in the overlay, but the elements behind it. The only way is to accidentally interact with it through pressing the screen, and have the element read out.

Map

The map proved to not be accessible with screen reader on any of the mobile operating systems, and would only read out information on iPhone and Android if the user clicked

exactly on a icon on the map.

In the map, there is also a function that enables the user to have the map zoom to their position. When using this, no audio notification is given of the position in the map being altered.

The map icon used in the Windows phone and Android version does not seem to be a standard icon when compared to other applications, particularly given the response of the participants.

Given the technical issues found in the functionality of the applications, another interesting aspect were the inconsistency in the terms that were being used.

Terminology

There were several technical issues related to the use of terminology. First of all, in reentering the iPhone after a system crash, an overlay message is presented in English, simply stating that the application had crashed. The term used to describe "Favoritter" is also in English, despite the rest of the application being in Norwegian. Seeing as the Voiceover has Norwegian speech, this is difficult to understand.

When updating the departure times for a route in Windows phone, it is difficult to read the text that appears, and it disappears too quickly. This issue of readability is also an concern for the text in the menu.

Having explained issues related to the terminology, the subsequent section will highlight some of the visual and technical differences of the applications on the various devices.

Technical differences between applications

The visual appearance of the applications differ greatly. The iPhone application is looking quite outdated. The Windows phone version has more the look of a prototype or mockup, while the latest Android version appears to be modern.

The applications also differ in terms of accessibility. In the iPhone version, the functionality of the map and "Favoritter" is not accessible to visually impaired users.

When evaluating the Android application, I became aware of the fact that the built-in TalkBack functionality in Android does not provide a Norwegian language package. I therefore had to buy this from a third-party in order to not distort the language by using English speech. In addition, the application appears to have a different set-up in terms of the TalkBack function. For example, in the search results, no elements are read automatically by the screen reader, in the option under "Favoritter", everything is read automatically. This indicated that the developers have been inconsistent when creating the application.

To navigate away from a route suggestion without storing it and re-entering "Finn Reise", caused the Android application to reset it, and the travel suggestion disappeared. To get it back, the user has to press the built-in back button on the Android device and navigate backwards. Using this button gave no indication from the TalkBack function that could help the users to understand their location in the application.

None of the applications provided many opportunities for the user to have the application adapt to their contextual needs, besides their use of stations or locations in "Sist brukte" or through the use of "Min posisjon". In the Android version, some additional

contextual settings and functions have been placed under the option button, for example which type of transport to use and the option of using "Mest brukte" rather than "Sist brukte", but there is no indication from the application of the functionality being in place there. These functions are also available in the Windows Phone version, but their is no indication of them being present in the menu. The options available in the option button of the Android version will also vary according to what screen the user is on, but the user is not notified of this either.

By having elaborated on some of the technical and visual differences, the chapter will conclude with a section on the general problems and issues in the applications.

General issues

In terms of more general issues, none of the applications provided possibilities for the user to adapt or alter the size of the text without using assistive technology, which increases the difficulty for certain users. There is a possibility to activate zoom as a supportive technology, but navigating with this functionality proved difficult. Furthermore, there is no guide to provide new users with an overview of the functions available and allow them to become acquainted with the application, nor a help system to provide any assistance besides adding a favourite departure, and it does not offer any input through the microphone or other sensory equipment, besides GPS.

Having elaborated on findings which highlights both individual experience of users, the technical issues, and having conducted a workshop with the aim of resolving these issues, I was ready to create a design proposal based on these findings.

6 | Design proposal

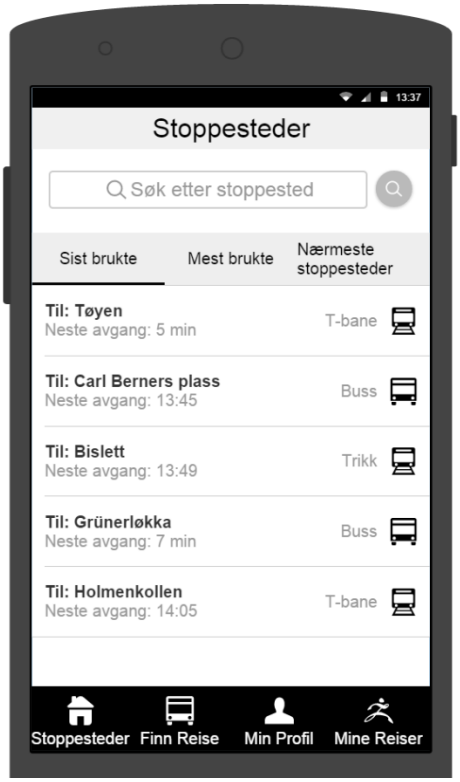
In the following chapter, a design proposal for a future application is presented. When creating this proposal, I had no intention of creating a complete and extensive application with all the functionality included, but wanted to show how the application could be redesigned and improved to accommodate user needs. In conducting this work, I took advantage of Proto.io (2015), a web based prototyping application that allow designers to create a high-fidelity prototype without any actual programming being necessary. The use of this tool made it possible to create a prototype that has interactions on the screen, shows "dummy" functionality and content, and highlights how a future application can be used on a mobile device.

When creating this prototype, I began by consolidating the notes and screens from the workshop and the data from the data gathering, to look for recurring issues and themes. The goal was to see how the participants wanted their issues to be addressed. By examining these matters, I saw the need for a simpler "front-page", without hiding any of the functionality. At the same time, I wanted to guarantee that a future application was easy to use, not cluttered, and ensure that it had the same functions that are present in the current application. The various functions of the proposed application and the intention behind them, are presented in the following sections. The chapter concludes with a summary of the feedback from the participants of the workshop regarding the design proposal for the new application, and their experience of participating in the project.

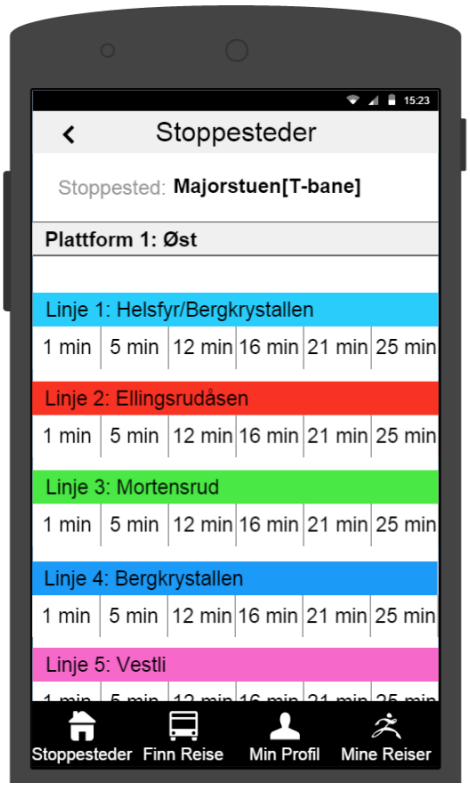
6.1 | Stoppesteder

The first view presented to the user is "Stoppesteder". While the current term for this view was disputed and not easy to understand for all of the participants, there was no common term which the participants agreed upon in the workshop, or a better suggestion from the other participants. Since most participants seemed comfortable with using this term, I therefore decided to keep the term in a future application. "Stoppesteder" has a search bar at the top, enabling the user to search for platforms and areas. Below this element, a tab list is presented, with the elements "Sist brukte", "Mest brukte" og "i nærheten". These contain information and presents platforms, locations and routes according to their headline. This information is displayed in both text and icons. The icons are intended to have a placeholder text that can be read out by a screenreader. A black marker under the tab shows whether a tab is active. In the bottom, a main menu is outlined with the elements "Stoppesteder", "Finn Reise", "Mine Reiser" and "Min Profil", and corresponding icons are used to enhance the understanding of each term. This menu is presented on all of the screens of the application. An example of this screen can be seen in screen 1 in Figure 6.1.

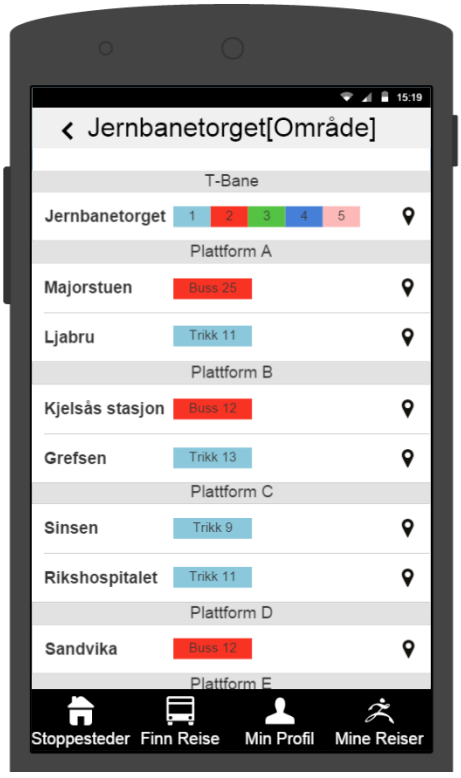
When trying to find a departure, the user may either use the search functionality, choose one of the previously used locations, or try to find one of the locations that are close by. When selecting or searching for a specific station, the user will be presented with a view similar to the second screen of Figure 6.1, in which a list of the different routes and their corresponding departure times from a subway platform, is displayed. The headline in the top, will denote the type of transport that departs from that station, and the routes



(a) Screen 1



(b) Screen 2



(c) Screen 3

Figure 6.1: The example view showing "Stoppesteder" as the application launches, and the results of finding a platform or an area.

are coloured according to their end stations. Note that this view is intended to be scrollable, in order for the user to have the same information on small devices.

When selecting or searching for an area, the user will be presented with a list of platforms for that area, and a list of the transports that departs from each platform, as seen in the third screen of Figure 6.1. This information is displayed through written text and is further indicated by colours showing what type of transport it is. A map icon is displayed, indicating that a map function is available, which the user may use to find the platform. The map function will provide both a visual and textual description of how to get to the platform.

The next section will display another important aspect of the application by focusing on the functionality of "Finn reise".

6.2 | Finn reise

"Finn reise" is intended to provide the user with the necessary functionality to find a suitable journey from start to finish. The user can enter text into search bars to find the start and end location of a journey. The application is intended to be able to interpret, and when combined with a screenreader, read out the input as the user enters the text. The application will then suggest possible locations and platforms as the user provides the input. The user will also have the possibility of selecting the time and date for the departure of the journey before using the search button to locate a suitable route.

One item which is missing from this view, is the button that allows the user to set "Min posisjon" as the location for the starting position. This button could in the future be placed beside or underneath the search field, and present a confirmation message when the user selects it.

The terminology and appearance of this screen is similar to that used in the latest Android application. This appeared to be what most of the participants believed was the most suitable for this view.

Having searched for a route, the user is presented with a new and simplistic view that displays information about the route. The user can add or remove a route from "Mine reiser", and turn off or on whether they want to receive notifications about a route. These functions are elaborated on in later sections.

Furthermore, the user will be presented with a description of the route, its estimated travel time, the delays or rush traffic for the route, and can find earlier and later departures. A map icon is displayed at each station and area, and is to provide both a visual and textual description on how to move between the stops. A clock icon is also presented, giving the user an option of receiving notifications on single stops rather than the entire route. All of the icons are intended to be readable by a screen reader, in order for visually impaired users to be able to understand them and use their functionality.

This result view is also intended to be scrollable, and enable that a large amount of information can be presented on a small screen. An illustration that shows how "Finn Reise" can be used to retrieve information, is displayed in Figure 6.2.

Having explained the features that are used in the dummy application to retrieve information, the next section will present the use of "Min profil".

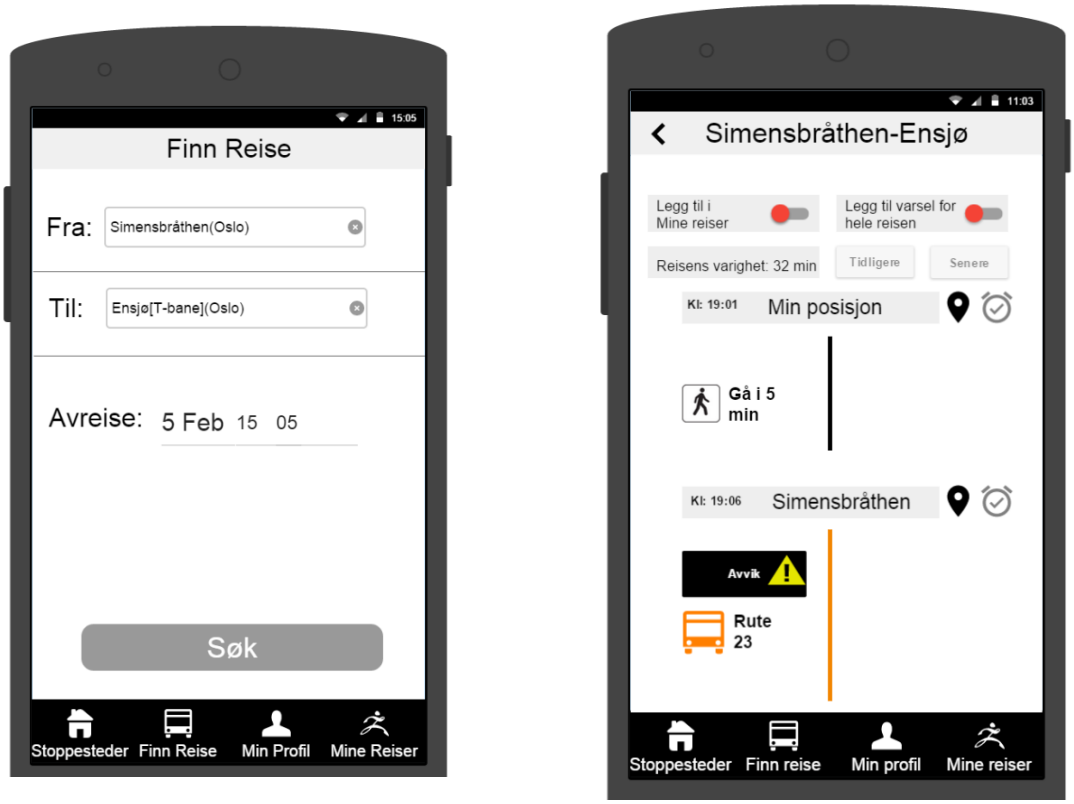


Figure 6.2: "Finn Reise" with example input and the results from the using the function.

6.3 | Min profil

The intention behind "Min profil" is to provide a user profile for each specific user. In this view, they have the option of entering name, phone number and other necessary information in order to connect their physical travel card to the application. The view that shows how this process will work in practice is not finished, as the primary focus has been on other the visual interfaces, and on illustrating the use of the guide mode, notifications system, and the storing of information. The goal is still to provide a way for users to achieve the functionality for the travel pass that was discussed in the workshop. In the screen displayed in Figure 6.3, this information is already entered, but the user can alter this through the button called "Endre informasjon". There will also be a button for purchasing or renewing a travel pass, thereby integrating the functionality from the application RuterBillett. When the user has completed the transaction for a travel pass, the information about the type of travel pass, its expiration date, and its number of valid travel zones will be displayed to the user. Though not shown in the prototype, the intention is to have red/green texts or icons be presented to the user, to indicate whether a ticket is valid or not.

The remaining features relevant to "Min Profil" are in the sub menus of "Mine varsler" and "Mine innstillinger", which will be addressed in the subsequent sections.

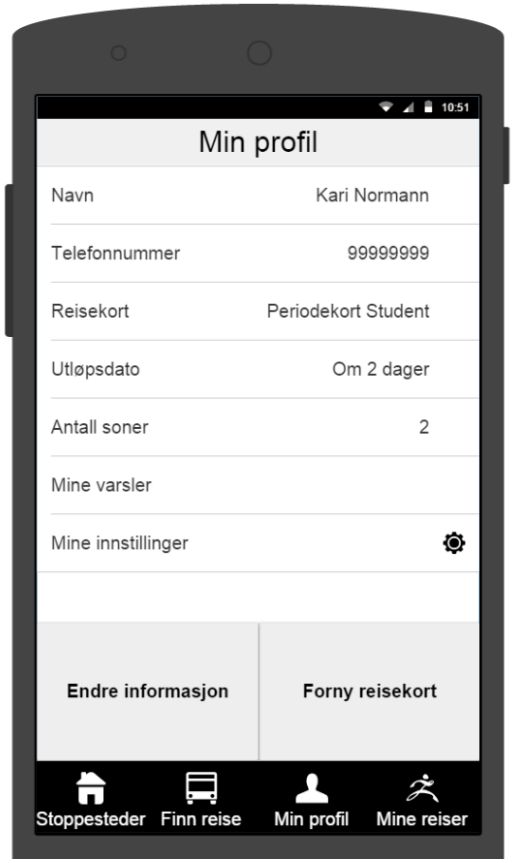


Figure 6.3: A display of how "Min profil will appear to the user.

6.3.1 | Mine varsler

An aspect which became apparent when examining the findings, was the need to provide better feedback and more information from the application. This has been addressed through the inclusion of "Mine varsler". When a user has searched for a route as displayed in Figure 6.2, the user can click on the option "Legg til varsel for hele reisen", in which an overlay box is presented. In this overlay, the user is expected to select from the check-boxes according to what aspects the user wants to receive notification on. For example, to receive a notification on when they need to leave to catch the bus, or to be notified of all the transfers for a journey.

Having done this, a new overlay is presented in which the user has to accept that the GPS function can be used by the application to track the movements of the user. This is an essential part of the functionality in terms of the application being able to provide the right information to the relevant situation and time, and adhering to the goals of contextual awareness. The user will also have the possibility of clicking the clock or alarm icon displayed next to each transfer on the journey, in which the same overlay appears with the same check-boxes and options for enabling notifications. Using this function will only notify the user about that specific departure.

To provide for visually impaired users, this functionality will require compliance with screenreaders to give audio feedback on the information presented in the overlay, and in the icons.

Having added a notification for a route or departure, the user will receive a notification of it being added to "Mine varsler", where the element will appear in a list. The whole process from start to finish can be seen in Figure 6.4.

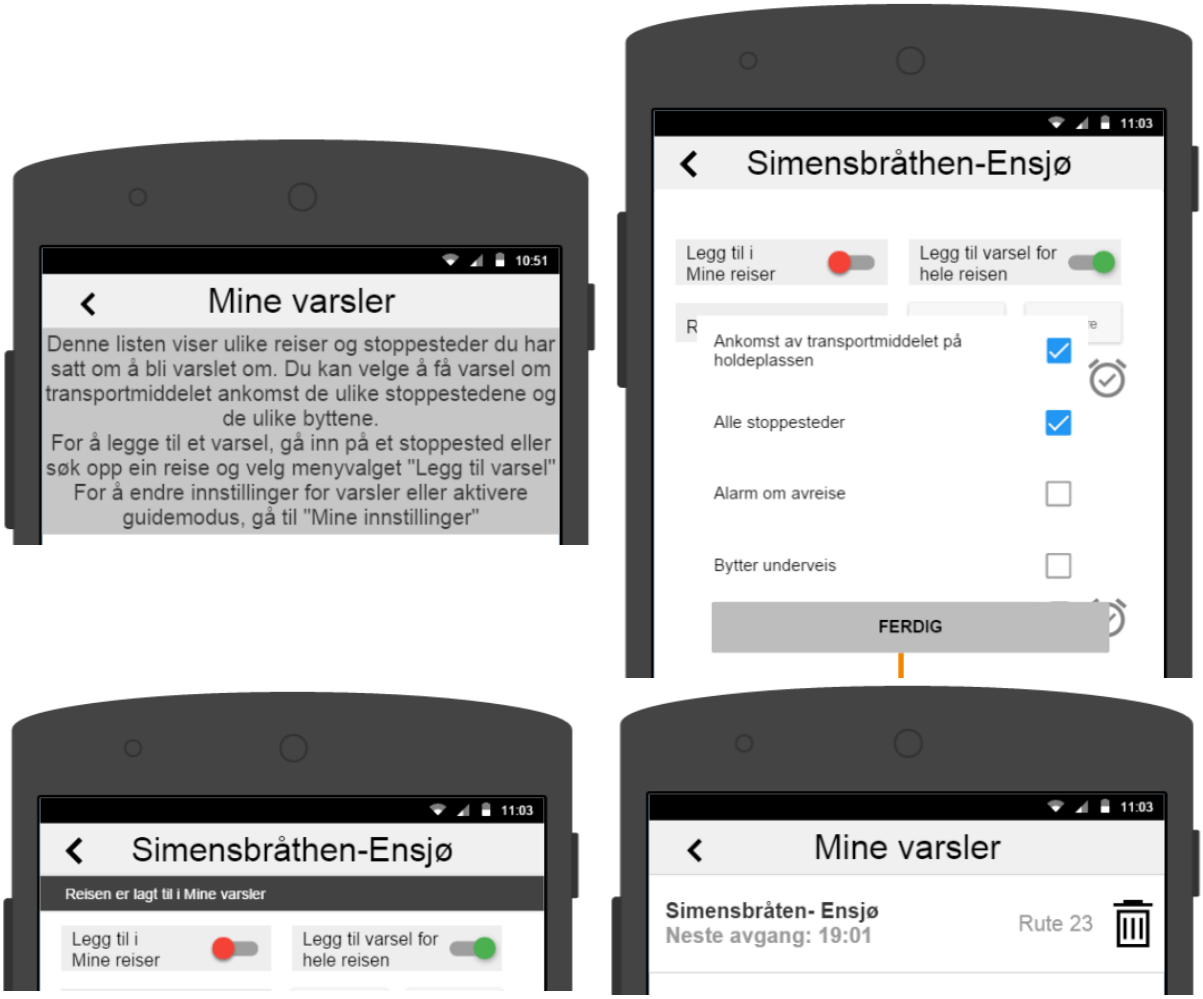


Figure 6.4: The process of adding a journey from start to finish to "Mine varsler"

6.3.2 | Mine innstillinger

Another essential part in the proposed design for the application, particularly with regard to the aspects of notification and feedback, is "Mine innstillinger". It has three important elements; a guide mode, changing the type of feedback for the notification used in the guide mode, and enabling the users to be notified through a text message when their travel pass has expired.

The guide mode is the most influential of these. It is intended to enable visually impaired users or other users in need of audio read out, to have a tailored guide from start to finish. When activated, the intention is that the application can use the GPS functionality to get the location of the user. This can be used to provide instructions to the user on how to move from the user location to the relevant platform, and how to navigate between transfers. When the guide mode is enabled, the route results will have an audio file included, which, when activated, will enable the user to receive this information. This is similar to the audio feedback used in Google Maps and in navigation systems for cars, and

the intention is to provide accurate instructions to the user.

A written description of the function is displayed when trying to activate the guide mode, and user confirmation is necessary to allow the activation of this function. Activating the guide mode will also require that the application is given access to the GPS functionality, and that Internet access is enabled.

After activating this function in "Mine innstillinger", the user will be notified of its activation, and the feedback mode will be altered from its default setting of vibration to sound. The user will also note in the result view that the icon used to indicate that audio feedback is available, has appeared. In future development, one should look into how the user can be notified of the guide mode and other functionality through an example or a first time guide, and make sure the instructions for the navigation are read out automatically as in other applications. The screens showing the process of activating the proposed functionality are displayed in Figure 6.5.

Note that the actual implementation of this functionality has not been addressed, as the focus has been on visual interface. This is also the case for the SMS-service, which is intended to notify the user once their travel pass expires.

Having presented the possibility for users to be notified before and during journeys, and their option of configuring the application to accommodate their personal needs, the storing and retrieval of information is addressed in the next section.

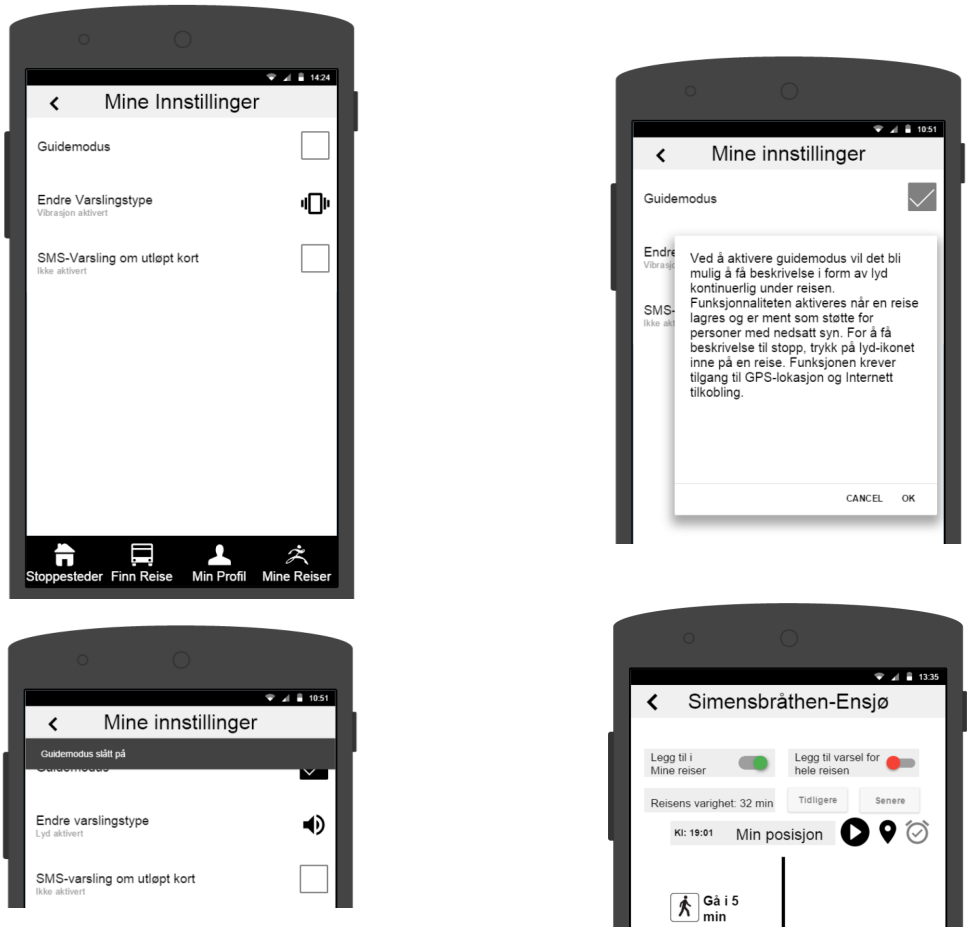


Figure 6.5: The process of activating guide mode through "Mine innstillinger" to add functionality and information to a route

6.4 | Mine reiser

When having searched for a route or a departure, it seemed crucial for the user to store this information, and be able to find previously stored routes. The function of "Mine reiser" is intended to provide this. For example, using "Finn Reise" to find a route from "Simenbråthen" to "Ensjø", the user is presented with a result, similar to that seen in Figure 6.2. He or she may then choose to store this route in "Mine Reiser", by adding it to the list of active journeys. This is intended to be a easy way for users to reuse routes without having to search. The goal is to make it possible to store both routes and single or multiple departure from stations. An illustration which exemplifies this process of storing and retrieval is displayed in Figure 6.6. In the long term view, the intention is to include offline storage of journeys as well, as suggested in the workshop and observations.

Figure 6.6: The process of adding a journey to "Mine Reiser from start to finish

In summary, the proposed design of the application is intended to provide an application which is better suited to user needs and requirements. Note that much of the functionality that is suggested, relies on the application having both an accurate GPS function and a good Internet connection. After developing a design proposal for a new application, user feedback on this proposal was required.

6.5 | User feedback

The following sections describes the feedback provided by those participants who partook in both the workshop and the observation. The feedback present the responses the participants had to the design proposal, and how they described their experience of participating in both the project and the design process.

6.5.1 | Feedback to design proposal

As the prototype was only a design proposal, and presented a "dummy" application without implemented functions or actual data, I viewed to it as to incomplete for a summative or heuristic evaluation. The interactions of the prototype was also predefined, and were so specific and intricate that the risk of the participants not being able to understand its use when testing it by themselves, was too high. Instead, I conducted an explorative feedback session with each participant of the workshop, in which I explained the proposed functions and interfaces, and provided examples on how I intended for the application to work. The participants were then subsequently asked to give feedback.

Overall, the comments from the participants on the design proposal were positive. The participants recognized many of the elements and aspects that had been mentioned in the workshop, and many felt that their requirements had been addressed. An important element that was highlighted was how the simplicity of the current application was retained, while at the same time new functionality had been introduced. The participants pointed to the fact that the new features appeared to be designed with the intention of being integrated with the previous functionality. One of the new functions that were mentioned was the ability to have automatic or semi-automatic notifications, and that this had a seamless integration, making the functions appear as a "hidden feature" if the user did not need them. The inclusion of vibration as a feedback mode for notifications was also seen as a useful element. One participant specifically highlighted the integration of the travel pass, while another participant pointed to the usefulness of the tab menu for "Sist brukte" and so forth in "Stoppesteder", and was quite fond of this functionality. In one interview, the participant mentioned how the proposed design for the application would address the need of having notifications both beforehand and while travelling. The participant saw this as the most important function, as this meant the user was not forced to check or update results to see what the next departure time or transport was. Another participant highlighted "Mine reiser", and that the proposed functionality for finding and storing routes, was a good feature. One participant also pointed to how the new design would make it possible to find a good route which would account for rush traffic.

The navigation for the proposed application received positive feedback and was viewed to be similar to that of the current RuterReise application. This was important for the blind participant, who believed it would be easier to know the expected navigation of a future application, by letting the user keep the same perception and relation that had been developed from using the current application. The participant noted that the layout that was described, meant users were not forced to learn a new navigation, but could use the navigation patterns they had already learned. The proposed order of the elements was seen as beneficial.

The participants thought the terminology used to describe the elements was understandable, relating this to both standards and terms used in other applications. They were also able to understand the icons and symbols of the design proposal, and were familiar with these. One participant mentioned the simplicity of the icons, while the blind participant highlighted the importance of including a good placeholder description of the icons for users that needed to use screenreader functionality.

When asked to compare the design proposal against the existing application, the participants response was that the new design and its proposed functionality was an improvement from the current application. It would provide more features and increase the possibility for configuration without cluttering the interface. Several participants stated that the design proposal covered various users concerns, considered the views of different user groups, had more functionality, and they described the proposed application as more universally designed, especially by offering the functions of the guide mode and the notification system.

The blind participant who was not able to see the proposal, nor interact with it due to its lack of compatibility with screenreaders, explained that given the description of the proposal, it seemed to be a unified system which would comply with standards, and be

similar to other applications. Again, this would also make it easier for the user to adapt to the new application. The participant further noted how this proposal had been developed and built by actually testing and talking with various user groups to uncover their needs and opinions, and pointed to an important fact by stating:

Mange som ikkje veit at synshemma kan bruke smarttelefoner og.

From the statement, it seems the participant believes this aspect is overlooked by designers and developers when they create new applications.

Another feature mentioned in the interviews was the map functionality, and how the participants were now able to see where it was located. They also appreciated how the map was intended to be simplistic yet detailed.

One participant further highlighted how the functionality of both the notifications system and the guide mode could be turned on or off, and believed the ability to do this was a good feature.

With regard to the discussion in the workshop and whether the design proposal had addressed these concerns, it seemed that the participants thought the design proposal addressed these issues, and was developed from the ideas and suggestions mentioned in the workshop.

The proposed application was viewed by the participants as universal and simple in its design. The participants believed that important features that had been mentioned and highlighted by them were included, and that given that these worked in practice, they would be valuable additions for a new application.

One participant stated that had been difficult during the workshop to imagine how the ideas and concepts would be designed and implemented, and that having it visualized on the screen made it much clearer and easier to understand.

With regard to making changes to the design proposal, some suggestions were made. One suggestion was to put the notifications and its functionality under "Mine reiser", as the user would probably only want to receive notifications on journeys that had already been planned and added to "Mine reiser". Another suggestion was to include several route options for a search result when using "Finn reise".

One participant was worried about using the Ruter map from Ruter.no in a future application. This was perceived as poor when the participant had used the map on the website. The new map should also have a better indication of the direction the user needed to move towards, and what the user's present location is. Another participant believed that the map function should display all the platforms, but have an indication of the relevant platform for the route.

Moreover, one participant did state that perhaps too much information was presented to the user, particularly with regard to "Mine innstillinger", and that users who have less technological understanding might feel that there is much to cope with, for example, when trying to remove an alarm or notification. The participant also mentioned that perhaps visually impaired users would like to always have the guidemode enabled, and that this should be its default setting.

Other suggestions addressed minor and primarily aesthetic issues, for example, changing the size of buttons, using other variants of the colours, or using different text fonts. The

participants also pointed out some details which I had forgotten, such as stating the platform number and the direction of the transport. There were also some issues regarding icons, for example, how there should be an arrow to complement the buttons "Tidligere" and "Senere", and a handicap sign to indicate accessible transports. The participants also pointed out that the same icon had been used to indicate both the tram and the subway, an issue which I was aware of, and which was due to a lack of suitable icons in the prototyping tool.

In terms of being able to develop and implement this design proposal into a fully functional application, the overall opinion of the participants was that this was achievable. One participant argued for this by relating to other applications that utilize the same functions, and used the example of an application that provides situation based information to users that need to go grocery shopping, by notifying them when they are close to a store. An issue mentioned by one participant, was that a user will need to have a data connection in order to use much of the functionality. This participant was also a bit insecure in terms of using the functions of the application that provided the context awareness, as this would mean the participant would be under the supervision of a third party. Other participants were very positive, particularly one participant who stated quite boldly:

> *Context awareness er noe av det beste i verden.*

While all the participants believed the new features would be useful, one aspect remains important and was highlighted in one of the interviews; users have to test the application to experience its features, which in turn will help them to trust and rely on it.

In the subsequent section, some of the key points from the participants regarding the overall experience and learning outcome from participating in the project and the design process, are presented.

6.5.2 | Participation in the project

As PD focuses on the values of mutual understanding and learning, co-design, and equal power among participants, I wanted to see if the same values had been present in this project. I therefore asked the participants of the workshop a series of questions about their experiences of participating in this project.

The general feedback from the participants was positive, and they described how participating in an observation had been useful, interesting, and fun, and had given them a possibility to test and explore the application. The workshop was seen as a learning experience, and some of the aspects that were highlighted was the possibility to plan and design a new solution, to be creative, work together, and how one learned to listen to the ideas of other participants and actors. Giving everyone the possibility to participate and contribute to the design was also mentioned as a positive feature.

The participants without disabilities were especially positive in their feedback, and they described how they had gained a deeper understanding of the needs and requirements of visually impaired users, and the knowledge these users have, particularly their insights into using mobile appplications together with assistive technology. One participant mentioned the experience gained from witnessing how the blind participant used the mobile device, and the speed this user had when navigating in the application. The participant went on

explaining that a greater understanding regarding the importance of creating applications that can comply with a screen reader, had been established.

With regard to the approaches and methods used in the workshop, these received mixed feedback. The future workshop was noted as a useful and sensible method, and some participants highlighted how they through using post-it notes had the ability to contribute, discuss, and change the concepts during the workshop. They further commented on the team effort that was gained from collaborating on specific tasks.

Other participants stated how splitting the process into phases, allowed for a better structure, and helped them to see the various parts of the workshop.

In addition to this, the element of not allowing any critic before the final stage was highlighted as beneficial. One participant stated that this made it to possible to view all the opportunities for the design before focusing on limitations, which allowed the participant to account for the various possibilities, and address the views of the other participants. As another participant noted, it is hard to know the needs of others and what they find easy or difficult.

Some of the issues that were mentioned about the future workshop, was that the participants were using different operating systems, and therefore different versions of the application. This meant criticizing the application as a whole was more difficult. However, this also made it possible to generate additional ideas in the fantasy phase. One participant also felt that the process moved back and forth between phases, and noted how the future workshop was not the continuous process it was intended to be, a comment which resonates with my own experience.

Moreover, the participants had several issues with how the prototyping session was conducted. As I expected after reflecting on the use of this method, all of the participants experienced this as a difficult process. Several participants mentioned how the design became very concrete at an early stage, and highlighted this as a negative aspect. Everyone stated that the prototyping session went too fast, and some participants also explained how they felt there was a lack of information in advance on how they should collaborate. The time set aside for the technique was noted as too limited, and some participants stated that this should have been increased, or perhaps a second workshop should have been conducted, focusing solely on the prototyping process. One participant thought this would have provided them with the time to write up the ideas, to think about and evaluate these, bring forth new ideas or changes, and provide the participants with the possibility to do several iterations in the design process.

Another participant stated that there could have been several prototyping iterations and discussions in the first workshop, and evaluations of the suggestions and ideas of others. The different suggestions could then be merged together to reach an agreement of a common solution, rather than the participants being given separate tasks and asked to collaborate over several screens. The participant mentioned how there tends to be a consensus for using the "prettiest" solution, rather than the one that is most functional or useful. The issue of reaching a consensus and giving critic was reinforced by the comment of another participant, who explained the difficulty of criticizing the work of other participants, given the social situation when one is collaborating with others. This participant stated that work and ideas of others were accepted to avoid having a negative atmosphere.

When asked about their experience of collaborating with the other participants, every-

one thought that this went well and that the other actors contributed to the process. The participants felt their individual issues were heard and addressed, and that a specification of the different requirements had been set up. Some participants expressed how collaborating in this group was a new experience, both in terms of understanding the views of others and how this can contribute to ensure that an application is adapted to more users. Again, the fact that all suggestions were allowed was highlighted as a positive aspect.

Regarding the aspect of working with a blind participant, the other participants noted this as a positive experience, and they used the terms "interesting" and "a learning experience" when describing their experience. One participant noted that though it is possible to think about UD and imagine the everyday life of a visually impaired user, it is not the same as actually meeting a visually impaired user and understanding it, as this presents new aspects. Another participant explained that while much of the focus of the prototyping session was on adhering to the needs of one user group, perhaps these are the users who have the biggest advantage of using this application, since they do not know the real-time information displayed on the screens of the platforms and cannot observe the next stop through regular eye-sight.

The blind participant also had a positive experience from the collaboration, explaining how one was able to have an influence on the project, and expressed how the needs of visually impaired users perhaps differ from other user groups. The participant went on explaining how it was necessary and important for other user groups to address these issues as well.

However, though everyone thought the cooperation in the group and the responses from the other members were positive, there were some participants who stated that they had aversions when attempting to provide solutions. One participant expressed this by explaining the need to carefully formulate a matter in order to convey the information and thought process in a way that the other participants could understand. This participant stated that certain suggestions were withheld, as they were not seen as suitable and in compliance with the needs of visually impaired users, and explained how the need to think about ideas before suggesting them, was at times limiting.

During the prototyping session I had tried to emphasize the importance of robustness and simplicity in the design, and asked the participants about the task of focusing on these matters and the issue of making the application universally designed and accessible to all. They noted this as a different and good idea, but one which was difficult to accomplish in the workshop. Some felt that simplicity was a good aspect, since it meant the user could avoid the issue of information cluttering, as the application would only display the necessary information and functions. One participant explained that to achieve these concepts, one is required to look beyond one's own experiences and world view by adapting to that of others, which was difficult. But when agreed upon, the participant felt the result from focusing on these aspects could be quite beneficial. An important note was from one participant, who mentioned how the topics mentioned were not important once the creative "switch" was on, and that perhaps better guidance on this subject was needed.

The blind participant who was an important actor in the prototyping process, explained that this experience was "okay". However, the participant noted the important fact that other user groups with disabilities were not represented, for example, hearing-impaired, or users with some visual impairment but who was not blind. The participant believed

that including these users in the workshop would have probably improved the result. For example, issues such as altering the size of the text was not mentioned.

To summarize, the comments from the participants about the prototyping session indicates that I should have provided more room for discussion, and that I should have allowed the participants to outline and sketch their individual ideas in the prototype session, before asking them to collaborate on several screens. The feedback further indicates that the information, objective and process of the prototyping session should have been more explicitly stated and defined, to avoid the confusion that arose among the participants.

This concludes the sections of the user evaluation, and the accounts of the findings from the research. In the following chapter, a discussion of these findings and their relation to the research questions, will be presented.

7 | Discussion

In the following chapter, the research questions will be discussed and addressed individually in separate sections. Each section will have the attached research question to refresh the reader on the objects of the thesis, starting with examining how UD and PD can be combined.

7.1 | Universal Design combined with Participatory Design

The first research question was the following:

- **RQ1: In what way can characteristics and qualities in Participatory Design be used together with the concepts of Universal Design?**

To address this issue, a critical review of relevant theory is necessary.

7.1.1 | UD: Difference in approaches

In the section on theory and research related to inclusive design and UD, it became clear that no unified practice or definition of the concept has been established, and that various approaches and guidelines are used in parallel. There appears to be no established way for achieving accessibility and usability for all, instead various parties describe the same goal, but attempts to achieve it by using different approaches and means. A critical review of these matters is therefore provided.

Given the widespread promotion of the WCAG 2.0 standard and guidelines, and that these should be used to achieve accessibility in both the Web and the mobile applications, there seems to be a common understanding among these researchers that creating applications and websites that conform to requirements and guidelines is sufficient, particularly with the recent law from Difi (2014*b*) regarding websites. However, while such rules are useful in terms of providing a foundation for developers entering the field of UD, they cannot substitute the actual situation-based user knowledge and address the user's specific needs. Though this has been acknowledged in part by the Funka (2012) guidelines which were developed through user testing, and throughSchulz et al. (2015) recommendation to include the users more actively in the process, much of the focus is still on the designer addressing specific requirements rather than advocating for user involvement.

The same issue is present when examining the approaches applied in UD and their target groups. While the integrated approach suggested by Dong (2007) is both a sensible and tempting notion to adapt to, it does not specify how the actual design process will be conducted and the role of the user in this process. Instead, it appears to present a more abstract concept that describes how to create a universal product without addressing the actual implementation and development of the product.

Similar issues can be noted in the work of Harper (2007) who though he presents good arguments for the personalization and creation of interfaces that can adapt to each user through "design for one", he does not express how such devices and interfaces should be

created. In addition, his notion that universal usability is not practically possible due to the vast variety of users and user situations, is partially flawed. This notion does not address what I note as the importance message from Vanderheiden (2000), which is to acknowledge that all users and situations are important in the creation of a flexible and commercially practical product that can adjust to various user needs. And though Vanderheiden's ideas of prioritization and his principles for acquiring universal usability can be fruitful, their similarity with the WCAG principles raises the question as to whether the goal is simply to have product guidelines which can secure universal usability.

As such, while I acknowledge that valid and important knowledge can be gained from these researchers, they seems to have omitted the *vital importance of the design practice itself and the role users should have in the development of universal product*, particularly when examining how elements of PD when compared to concepts in UD, show many similarities between the two practices, and can be an important contribution.

7.1.2 | How PD and UD compare to each other

In reviewing the principles of PD and UD, it becomes apparent that they have similar goals. The concept in UD of having products and solutions that are usable to all, or to the largest number of users possible, without adaptations and by accounting for physical conditions, has been noted by several researchers (Lid 2013, Norwegian Ministry of Environment 2007, United Nations - Enable 2014, Tollefsen et al. 2013). This is similar to the democratic principles in PD of equal participation and contribution being necessary to address user needs (Bratteteig et al. 2013, Brandt et al. 2013, McIntyre-Mills 2010, Alexander & Robertson 2004). As the focus of PD has shifted from democracy in the workplace to designing for other situations and contexts, the ethical burden of the designer to create a satisfying system for users has become the most important argument (Bjerknes and Bratteteig 1995) (in Fuglerud 2014). The attention is therefore further emphasized towards the participation of the user and the result of the final design (Kyng 2010) (in Fuglerud 2014).

The connection between PD and UD is further supported by the way both practices have focused on the more vulnerable user groups, UD inherently through its definitions and methods that try to achieve usability for all, and PD historically through its earliest projects that attempted to resolve the conflicting issues of the worker-management relation (Robertson & Simonsen 2013), and establishing a premise of having a say and not just a voice (Bratteteig et al. 2013). While the aspect of focusing on democracy in the workplace has diminished as mentioned previously, the concepts of having an equal power structure among participants, having the democratic principles in place during the design process, and allow the participants to have a say, are still vital concepts in the participatory approach. This is further supported by the comments from Aslaksen et al. (1997) about UD being a technique which affect the shaping of the product, and the PD approach can provide the users with the influence to do this.

Finally, I have previously mentioned how Fuglerud (2014) has noted several parallels between UD and PD, particularly with regard to the role of ethics and moral obligations. There is potential for UD to use lessons from PD to resolve conflicting views and interests among the various groups, for example, when involving user groups with disabilities in the process.

The aspects that have been highlighted, further builds on the image of PD as practice which can applied to help ensure the development of universally designed products.

7.1.3 | PD as the design practice for UD

The main issue for UD is to ensure universal accessibility and usability, and there are several arguments which suggest that PD can play a vital role in achieving this.

First of all, as a design practice, PD tries to include all relevant users into the project and put them on *equal* terms, removing the inherent power structures. For UD, this would mean that the needs and opinions of a blind user are just as important as those of a person with dyslexia or a person with no disabilities. This approach would lead to a democratic practice for the stakeholders, in which the similarities with UD already have been mentioned. Having these grounded principles in place throughout the process will ensure that the final product addresses the needs and values of all participants. As such, it speaks to the heart of UD as it attempts to address the weaker user groups in our society while remaining concerned for other user groups as well. Through including different stakeholders, the different levels of influence mentioned by Lid (2013) can be included to make their mark on the product. The individual experience of users and the software created by developers and managers are the most important parts of the design practice, but there is no reason to not involve members with legislative and political power if they have a stake in the product. Inviting these members to the table and making them an equal partner to those users that face the challenges of a disability on a daily basis, could in turn broaden their own view and understanding of the product, the user environment, and make them emphasize changes on a higher level of the society. This is also noted in the argument from Fuglerud (2014) that all levels of influence are needed to provide for individual experiences.

Secondly, PD is a situation-based practice and examines the issues in the user context itself. The research from Kensing and Blomberg (1998) as well as Orr (1986, 1996) and Linde (2001) (in Brandt et al. 2013) highlights how an ethnographic approach can be used to initiate dialogue, and transfer important knowledge between designer and participant. By applying ethnographic methods (Bratteteig et al. 2013, Brandt et al. 2013, Blomberg & Karasti 2013), the designer can gather detailed knowledge about the users, an important aspect of inclusive design (Fuglerud 2014). Other techniques, such as discussing issues in future workshops or acting out scenarios, will also provide marginalized user groups with the possibility to express their issues about the current product, and envision what a future product will look like. By using the techniques for making, these users will also be able to produce prototypes and content which inhabits their own specified desires and dreams for the product (Brandt et al. 2013), which can help the final product address their disability and usability issues. The use of these techniques further opens up for the possibility of mutual learning between the actors of the UD process (Bratteteig et al. 2013), which both parties will benefit from. The designer will learn about the user context and needs of others, and the participant may gain an understanding of how the product is developed. This can in turn change both parties view on the product, the development process, and the different user situations, which the final product will profit from. By expressing and incorporating their values and needs into the product, users will be able to influence both

the artefact created, the process itself, and their relationship with the designers (Halloran et al. 2009). This will build a deeper understanding for everyone involved in the co-design process.

The deeper the understanding of the user needs, the more likely it is that the designers can bridge the disability gap of the gap model and address the environment of the users (Fuglerud 2014), given that the designer becomes more conscious and aware of the problem users face. Thus, the holistic approach highlighted by Fuglerud (2014) and Blomberg & Karasti (2013) becomes relevant. This is supported by Schön's(1983) (in Bratteteig et al. 2013) notion that the context and solution to a problem will be intertwined, and must be seen in relation, which indicates that active user involvement and explorative methods are necessary. When using these methods to interact directly with the more vulnerable groups of our society, our empathy and respect for humans who encounter accessibility and usability challenges will be reinforced or altered, and affect our role as researchers. This is an aspect Fuglerud (2014) noted as an important personal experience, and a effect which I myself have experienced by conducting this research.

Considering these concepts, it becomes apparent that PD will allow the researcher to get first hand accounts of user needs rather than imagining and adhering to perceived notions of these as the W3C guidelines and tools (W3C 2008, WAI 2005*a*, W3C 2010), and the guidelines and recommendations provided by Apple.Inc (2012) and Google.Inc (2015*a*,*d*,*b*), do. This will further help designers and developers in becoming more emotionally involved, and therefore more motivated to improve the situation of the users. In hindsight of the findings by Power et al. (2012), this could prove very useful for the development of accessible websites and applications.

Thirdly, the explorative and shifting nature in PD makes it possible to continuously alter the goals and objectives as needs and desires are clarified, and the values of participants are altered (Halloran et al. 2009). As such, the description of the design process of PD (Bratteteig et al. 2013, Brandt et al. 2013), bears resemblance to the process described by Löwgren & Stolterman (2004) and Sanders & Stappers (2008) of changes and reiterations in the visions of the design, and how the user is actively engaged in the process. This will become important when addressing the different issues in UD, where several different user groups are involved. The designers can react to their different and changing situations, visions, and values, by applying different techniques and tools (Brandt et al. 2013).

This brings us to the last and perhaps the most important contribution that PD has to offer: user participation. While other practices primarily observe the user (Sanders & Stappers 2008), PD seeks to engage the user in the design process, and the whole process relies on active participants. Without this fundamental aspect, the process will fall apart and none of the stated benefits from the approach will be achieved. Through participation, one can create the community of practice described by Brandt et al. (2013), in which participants both with and without disabilities can come together to discuss issues and standpoints in a democratic manner, and envision their future. The vulnerable groups of our society will have the possibility to actively and explicitly shape the usability of the future product and ensure its accessibility, changing their own role as well as that of designers and researchers (Sanders & Stappers 2008). The designers and researchers will move from being extractors and interpretors of what they *believe* the users need, to facilitators where they *know* the product will address user needs, by having the users become

an active part of the process. By focusing on participation and the concepts of making, telling, enacting, (Brandt et al. 2013) and co-realisation (Sanders & Stappers 2008), and by changing the user role through the employment of techniques such as user prototyping or scenarios (Bratteteig et al. 2013, Rogers et al. 2011), all actors become involved in the process. When using these elements in a space of collaboration, we will be able to reach a consensus between various user groups, designers and other stakeholders by enabling and facilitating for an environment of common language and influence. Thus, there are many benefits that can be achieved by creating this community of practice for the design process. Having all the needs addressed and acknowledged, also makes it less likely for the final product to have issues and problems. The description given by McIntyre-Mills (2010) underlines the increased influence and awareness among those inflicted by the product, who through the provided information become aware of the implications of the choices that are made, and can inform designers.

Participation should not solely be seen as tool which facilitates this practice and makes its tools and techniques viable, it should be a moral right for users to have a say on the issues that affect them, not only in the development and accessibility of products and systems in ICT (Theofanos & Redish 2003), but in our society as a whole. By not enabling users to have a say, we are reducing them to bystanders, and the usability and accessibility of the product will become a reflection of how we as designers expect the products to behave, not from a user perspective.

Some may state that this is as an idealistic approach, without practical use in the real business world of ICT development, or that other design practices may prove equally beneficial. Other arguments could be to question which user groups to include when the design is for everyone, or how to gain access to all the stakeholders. I am aware of these issues, and that certain compromises may be required. In addition, by not having used a different design practice in this research, the expected results of not involving users in the same manner as in PD, are primarily based on theoretical reasoning and arguments. However, I agree with Fuglerud (2014) that the involvement of users highlights other purposes, such as social, cultural and political aspects. As Fuglerud notes, whereas evaluations, tools and user models have a function, they do not address these issues. As such, in order to create universal products and ensure that these abide to the principles of design (Norman 2002, Rogers et al. 2011), the designer can use a combination of a PD practice and its techniques together with the evaluation tools to address issues, and adhere to the conceptual model of users. These elements can then be used to ensure the usability and accessibility for the largest number of possible users, as suggested in the disability model and usability pyramid (Fuglerud 2014, Darzentas & Miesenberger 2005)

Having explained the theoretical aspects of PD and UD, and the advantages and benefits that can be gained from their combined use, I now turn to discuss the themes and results of the study on the travel application RuterReise.

7.2 | Universal design issues in RuterReise

Before elaborating on these matters, it is worth repeating the research question at hand:

- **RQ2: What will an in-situ investigation, focusing on universal usability and accessibility for a mobile travelling application, reveal in terms of issues and problems for users?**

Having given an extensive account of the findings in the study, this section will be a discussion which examines how the breach of design principles leads to issues for the universal usability and accessibility of RuterReise, and point to specific themes which needs to be addressed in order to ensure that RuterReise can be universally designed. When conducting the analysis, I focused on addressing three specific aspects; terminology, feedback and functionality. I have looked at how faults in these aspects creates issues when using the application in situation-based and real-life contexts. This has allowed me to focus on actual user issues, and to examine how these are addressed by the application. As such, the principles for design (Norman 2002, Rogers et al. 2011) as well as the aspect of usability (Nielsen 1995*b*, ISO 1998, Bevan 1995) and its goals (Rogers et al. 2011), are important factors when assessing the user experience (Law et al. 2009, ISO 2010, Nielsen & Norman 2015) of the participants. The concept of accessibility (Rogers et al. 2011, ISO 2014) also becomes important to investigate how the application can provide for users with disabilities.

The relations the findings have to the three concepts mentioned will be discussed in detail, starting with the importance of terminology. Note that the issues addressed are interconnected aspects, and will in many cases affect each other.

7.2.1 | Terminology

The findings show several cases where users did not understand the terms being used in the application. Two major examples were the terms "Stoppesteder" and "planlagt". The latter showed up when planning a journey, and highlights the issue participants had in terms of understanding and using "Favoritter". The findings further highlights that not knowing the term, meant the participants became confused, and lost overview of the application. At other times, the lack of a term to explain the functionality became an issue. The question is how these issues affect the overall user experience, and align with the established principles of usability and design.

First of all, the issues points to how the *conceptual model* the designers and developers have created for the terms in the application, does not correspond to that of the actual users. This is turn seems to have limited the user's interaction with certain functions in the application, for example, how several participants had not taken advantage of the "Favoritter" functionality.

Furthermore, it highlights an issue in affordance and visibility. When users are presented with unknown features or situations, they will as humans tend to look for what is known and familiar to them, and the same pattern is being used here. For example, most of the participants were used to having a search bar at the top and knew how to use this, presumably having experience from using this on the Web. The participants were

also able to understand its actions. information. One may ask why the same concepts has not been put in place with regard to terms. Given the issues several participants had with the terminology, it is understandable that some struggled to perceive and understand the meaning of certain functions. Is "Stoppesteder" a list of all the relevant stops for a route or list of all the stops that are available and nearby? Is "Favoritter" used for storing specific elements or any element that can be relevant for a journey? On the iPhone, why does not the application provide a term for the function that enables the user to locate a later departure time for the same route?

When users do not understand the terminology, they are not likely to use the function, which explains the lack of experience many participants had with certain functions, such as "Favoritter". Hence, the unintuitive term seems to have lowered the use of the function itself. In other cases, the lack of suitable terms breaches with the principle of perception, as I noted in one interview where the participant had recurring misconceptions and misunderstandings of the term "Stoppesteder", and who later stated:

Ja, det er stoppestedene jeg blir forvirra av da, menne....

This problem is further highlighted by another participant who stated:

Ja , ehm, eg ble kanskje meir forvirret av at den heter stoppesteder, bare...siden det virker mer som bare hovedmenyen, på en måte, eller...

Noting the uncertainty in both statements, its seems clear that the term is difficult to interpret, and that the participants were not able to explain why this was the case.

Furthermore, in other cases where blind participants had to struggle to locate a later departure for their route, several of them acknowledged that they would not be able to achieve this by themselves. As such, not being able to perceive and understand the function since no explanation or term was given, was an issue to both the usability of the function and the accessibility of the information. The issue is perhaps best highlighted through the words of a visually impaired participant who explained the experience of locating this information in the following manner:

Ja, det blir litt, da må jeg jo vite hvor jeg er hen, det syns jeg var litt, eh...tungvint.

Another example which highlights the issue of terminology has already been mentioned in the findings with the words from one participant, who stated the following when presented with the term "planlagt" after using "Favoritter":

Det siar meg ingenting.

This was a problem for several participants using the Android application, who were all sighted users, but still struggled to understand and apprehend what was being accomplished, simply due to the ambiguity of the term being presented. I observed how several participants were unable to find the stored information when using "Favoritter", and eventually had to be guided to locate this information.

The examples highlights how the best intentions of a function will be useless if users are not able to perceive, observe, understand, and use the functionality, simply because its term is not in coherence with the user model and important design principles.

Some may argue as one blind participant did, that these are aspects which users will learn and adapt to. Regardless, terms should be intuitive and easy to understand for users with their first glance on it. Given the amount of words in our language and the different ways users perceive and associate meaning to terms, this may appear to be an impossible task. I believe the aim for designers should be to provide terms that are not to broad and contain ambiguity, but nor too narrow, as this would mean that only certain user groups will be able to relate to it. Learnability and memorability of concepts such as terminology cannot be the responsibility of the users themselves. As a designer or developer we must ask ourselves the following question; at what point does the work of becoming acquainted with a term outweigh the advantage you gain from using the functionality it contains, particularly if you as a user have a disability, which means your choices of feedback modes are limited?

The examples and findings show issues in the terminology which directly affect the usability and accessibility of the application. Similar issues were present in several of the features of the application, and as such, a more elaborate account of the functions should be provided.

7.2.2 | Functionality

The means designers equip the user with, is what makes it possible for them to reach their goals when using the system. In RuterReise, much of the implemented functionality enables this. However, the findings also show how problems in the functions and their properties affects the user experience. A few examples will highlight this.

First of all, in the Android application, the map functionality has been stored either in a icon or under an option button which the participants rarely explored. This may be one of the reasons for why none of the participants using the Android application were familiar with the use of this functionality. When a function is not visible to users, it loses its inherent purpose. Though that in itself does not affect its usability, it points to faults in the design which should be addressed. Recalling that every sighted participant were active users of services such as Google Maps or other third-party applications that are used to find a certain location, the desire for a map function is clearly present and should be utilized. The lack of understanding the "Favoritter" icon and how to use this function to store favourites, is another example of a function which suffers from the problem of visibility.

As such, it seems the lack of affordance and perception to the function's corresponding icon, or the lack of visibility of its location, is what is causing this issue. As one participant explained when asked why the map functionality had not been found:

> *Fordi..det står ikke noe om det.*

The need for visibility becomes even more apparent in a later statement from the same participant:

> *Ja, da skulle det gjerne, da hadde det vært veldig greit hvis de hadde hatt en knapp,....Hvor det sto kart! Når de faktisk har et kart!*

As such, storing functionality in unknown places or within icons that users are not familiar with, should be avoided. The actual use of "Favoritter" further highlighted usability

problems, as an efficient use of it proved diffcult for many participants. As one participant expressed when asked why this functionality was not being utilized:

> *Eh..menne, det har liksom ikkje vært sånn veldig innlysende måte å legge til favorittar.*

The usability issue and the uncertainty regarding the use of the functionality, was also highlighted in another statement from the participant:

> *Og så har eg bare...på en måte...gitt an litt opp, på en måte, for siden eg....Den ene gangen eg prøvde så klarte eg det ikje...så...*

From the formulation of the statements, one senses the uncertainty and cautiousness when discussing this function. There may be an error on the user side, but the participant is not able to convey why. While several of the participants tended to focus on blaming themselves when conducting errors, my reasoning is that the provided features are not intuitive to use, making it difficult to utilize the functions efficiently, and to learn and memorize the steps needed to achieve the desired result. Other usability issues were highlighted by how some participants struggled to use the map function efficiently, and how other participants were confused of the difference in the search results when searching for a area and not a platform.

The incidents that highlighted the difference in route result when using the GPS and "Min posisjon" to find a journey rather than typing in an actual location, is perhaps what underlines the lack of effectiveness the most. When a participant used "Min Posisjon" and was faced with a result which required a 13 minutes walk to get to the first stop, the participant stated what I believe is a common user reaction:

> *Det hakkje eg lyst til.*

The difference between the results is remarkable and show that the present functionality of "Min Posisjon" is neither effective in its result, nor efficient enough for the user.

The findings in these examples emphasize how the functions of the application are not in accordance with the usability and user experience goals, which in turn affects the usability and user experience of the application.

Secondly, the observations and interviews have uncovered that specific features were not accessible to all, in particular the visual map and "Favoritter", where the latter had an issue which was highlighted when combining the function with the screenreader of the iPhone. The lack of accessibility was further indicated by the results of the heuristic evaluation where several accessibility problems were uncovered, among which were the issue of navigating with a screenreader, and the difficulty of locating and utilizing functionality in combination with a screen reader. Given these findings, it appears that the features and information that are provided by the application, are not accessible and usable to all, and that changes and further developments should be made in order to address the situation.

The third and final aspect with regard to functionality is the concept of consistency. Through the example mentioned earlier, it has already been pointed to the lack of consistency by highlighting the difference in the results when using "Min posisjon" and not typing in an actual location. However, the findings also show an element of inconsistency across platforms as they provide different functionality. While one might think this is not an issue which users consider, a statement from one participant highlights an important fact:

Bør jo vera likt...samme funksjonalitet samma ka du bruka.

The only limitations that could hinder developers from achieving the same functionality in the application across devices, are funding and proprietary technology designed for specific devices. But this is not the case of the current situation. As the same participant later noted:

Sånn så de e no, så trur eg da atte, da e funksjonalitet...f.eks på Android som godt kunne ha vore på iPhone...

In light of the request from the participants for one universal application, it seems evident that consistency is an element which is important for users as well. Thus, this should be addressed to provide for several user groups, and to make the application usable for all users, and for all devices.

However, when using features, users require a form of confirmation and acknowledgement to help them understand the actions and behaviour of the application. This brings us to the third and final topic of feedback.

7.2.3 | Feedback

In the findings, several incidents points to the application having problems in providing vital feedback. One example which indicated both a usability problem and a issue with feedback, was when the blind participants were not able to perceive the actions from the page switcher, an issue which is related to the problem of the application not having a term to describe this function. Other examples were how the search button reads out "søk" but does not provide any information as whether an action is done on the screen, the participants misunderstanding of terms that were read out, and the lack of audio feedback from icons. The common issue for these examples is that they are not conforming to design principles, WCAG guidelines, and usability goals, thereby affecting the usability and accessibility of the application.

First of all, not being able to comprehend the result when performing an action with a function, means the feedback provided is simply not adequate. This in turn leads to poor visibility for the users regarding their current location in application, and means the perceived affordance users relate to the function, is not confirmed. These issues can explain some of the confusion I noted when observing certain participants and their use of the application.

Secondly, the lack of feedback combined with the previous issues of terminology means users are not able to do their task efficiently and fully utilize the functions of the application. By not understanding terms such as "planlagt" and by not having another feedback mode, certain actions and functions seemed to be not used or understood by the participants. This may further be caused by the lack of visibility.

Moreover, not having the necessary feedback can impact the users navigation skills, how efficiently they can use the application, as well as the effectiveness of the system. This was the case for several of the participants with visual impairments, particularly with two participants who in their eagerness to navigate either missed out on important information, were not able to find the location of a function, or did not know when an action had

been completed. As such, the audio feedback presented was too slow and not suitable to their user interaction.

Furthermore, as several icons and visual elements displayed in both the results and functions provided information and actions which were not read out by the screenreader, this underlines the lack of accessibility and feedback in the application. This has been exemplified earlier by highlighting the issue of using VoiceOver when trying to set a favourite in the iPhone application. Part of the reason for this issue is the audio feedback stating that the route is an accessible button, which is not the case. As such, no constraints or audio feedback has been implemented to alert the user of this, or to provide the user with an additional way of adding a favourite. Instead, the application has completely different behaviour than expected. Another example is how the icons in combination with visual maps was the only way for participants to find out how they should navigate to a platform or between two transfers, as no textual description was provided. An accurate statement which sums up the overall opinion of this issue is provided by a blind participant:

Nei, det syns jeg er litt humbug.

In summary, an analysis of the findings show how the application with regards to the concepts of terminology, functionality, and feedback in many cases do not conform to the goals of usability (Nielsen 2012, ISO 1998, Bevan 1995), and the overall design principles for ID outlined by Rogers et al. (2011). This created issues and affected the user experience for several of the participants, as the findings highlight. In addition, the application cannot be classified as accessible and universally designed given both its lack of adhering to WCAG 2.0 criteria and principles (W3C 2008), and the fact that it is not able to provide accessible features that can ensure the universal usability that is needed (Vanderheiden 2000, Shneiderman 2000). This is further supported by the results of the heuristic evaluation which showed several accessibility and usability issues, among those the lack of a logical structure and the navigation issue when using the Android application together with a screenreader, the complete lack of compatibility between the Windows Phone application and the device's own built-in screen reader, and the issue of not finding the necessary information in the iPhone application. As such, there were accessibility issues in all platforms, which in certain cases made the application completely useless for impaired users. This highlights how the application is not able to adhere to the important principles of UD (Connell et al. 1997) and its definitions (Lid 2013, United Nations - Enable 2014, Tollefsen et al. 2013), and is not able to bridge the disability gap illustrated in the gap model (Fuglerud 2014).

However, before moving on, it is necessary to highlight an underlying theme and user aspect which is not addressed by the application.

7.2.4 | A guaranteed and independent journey

Through analysing the findings and examining the issues mentioned earlier, an underlying user need and theme became evident; A guaranteed journey from start to finish and how this can ensure that users can be independent on their travels.

In my research, I have been fortunate enough to have access to visually impaired users. The insights and knowledge I gained from hearing about their experiences in the field and observing their behaviour, has given me new understanding of the importance for

them to have a secure way of getting from A to B. As I learned about the fear visually impaired users have of getting lost while travelling, and their need to plan intensively, use third party software such as Blindsquare or ask others for help, it became evident that this was an issue that needed to be addressed by the application. More so after hearing from the experiences of one participant who had entered the wrong subway train, and from my own observation of how easy it is for these users to enter wrong transport, which one blind participant nearly did during an observation. However, the need for a safe travel is not specified to a specific user group. Recall the incident of the sighted participant who struggled to find the right bus stop, and became both irritated and confused. I observed the participant's anxiety and need for being assured by the application, as the participant relied on the instructions and information from the application. The need for many of the participants to plan their travels, consult friends, take pictures of a planned journeys, or use map services when navigating large areas, further supports the claim that a secure journey is important to the users. Several participants expressed themselves as being a person who worries, and who needs confirmation. One example was in the workshop where one participant expressed the following opinion about the possibility of having vibration as feedback mode:

> *Altså, vibrasjon er veldig greit da...jeg skulle gjerne hatt vibrasjon, også fordi, liksom jeg....ofte så kan man finne info om sånn..det er, det er nå jeg skal av, tror jeg, men jeg vil gjerne ha en bekreftelse på at jeg skal av, for jeg er sånn super bekymra, person..*

From my own standpoint, this indicates how we as humans require a "security plan" and a confirmation from a third party, a way of making sure that we are able to reach our expected goal. The means and methods of storing information as mentioned previously, can be seen as ways of assuring that this is possible while travelling.

Having uncovered the accessibility and usability issues mentioned earlier, it became more and more clear that the current application does not provide this safety net, even more so after examining the suggestions from the participants about what functionality they wanted to include in a future application. The recurring theme mentioned was to include more information, particularly in text and audio format, and provide extra features that could help the users with their biggest issue; to get from start to finish without facing major problems and issues. The importance of this became especially apparent in the workshop, by the way the participants mentioned similar experiences and issues the, and their agreement to focus on a guide mode as their primary goal for the prototyping session. A statement which sums up the overall resulting goal from this session and perhaps the goal for many users of RuterReise, is seen in the following statement:

> *Første prioritet er at jeg vil være sikker på at jeg kommer meg til det stedet jeg skal.. med hjelp av Ruter appen. Og helst ikke uten at jeg havner først helt i gokk og så..må tilbake igjen, og at det, og at det er en fornuftig rute.*

To achieve this functionality would require the application to provide the safety net mentioned earlier at all stages of the journey and be consistent throughout the process. A statement which exemplifies this, and highlights some of the stress, uncertainty and irritation I observed in users during observations, can be seen in one of the comments from the workshop:

> *For det, marerittet er når du har funnet reisen hvor med Ruter, men så er det sånn, plutselig så finner du ikke stoppet der, fordi du trodde at du skulle til det som het Jernbanetorget i, også, et eller annet..vei, og så, nei, dette er en helt annen vei, og så må du gå..å prøve å finne et annet, og så misser du den bussen, og så setter du deg på en eller annen buss og så er den, bussen skal jo bare et stopp mer, finner du ut, og det tok to minutter, og du kunne gått...*

From the findings, it seems evident that these concerns are not addressed by the current application, especially given its issues with usability and accessibility.

Tightly connected to the aspect of a safety net is the concept of independence. By ensuring a safe journey, one may inductively give users more independence. Having to rely on a combination of friends, pictures, several external services or just ones personal memory, together with the mobile application, makes the situation complex and difficult. The complexity and effort put into the process is perhaps best illustrated by the answer that a blind participant gave when asked about travelling to unknown locations:

> *Ja da, akkurat da, da blir jeg veldig sånn, jeg er jo sånn som vil planlegge og vite på forhånd...Så, jeg...ville snakket, snakket med noen som er kjent og få en..detaljert beskrivelse på forhånd...Enten det eller til og med få noen til å bli med meg...første gangen.*

By creating a process where several components interact, there will also be a greater risk of one of these components causing an error. While reducing these down to one component and solely relying on a mobile application is not a complete independence from all devices, it removes a number of factors which may cause issues during the journey. It will also remove the stress factor from the concerned users if they know they can trust the application to be the instrument which will help them reach their goal. Not only will this insert confidence into some users and allow for them to travel more independently, for others this will allow them to do other activities during their travels, for example, listen to music, which also would make for a more comfortable journey. Thus, a universally designed application can provide both safety and independence for the travellers, and give them comfortable and positive experiences.

The issues and themes uncovered in RuterReise must be considered as specific and solely related to that specific application. While it is tempting to generalize and state that the problems and underlying issues are present in all travel applications, this would be a mistake. The findings does however, point to concerns developers of such applications should address and investigate, both before and during the development of their applications.

Having established the theme and problems to account for, the remaining matter is to address the design proposal, which have tried to address these issues and concerns by using a participatory approach.

7.3 | Context-awareness + PD = UD solutions?

Having established and discussed the underlying issues of RuterReise, the previous discussions and findings have proven the lack of accessibility in the application and highlighted the usability problems users face. An earlier discussion have also argued for the role PD

might play in the creation of inclusive and universal mobile applications. For that reason, a look at how a practical endeavour of PD and contextual-awareness can be used to solve these contentions, and how this can provide a more universally designed application, can provide new insight. Thus, the remaining concern is on the combination of these elements. Specifically, it aims to address the following matter:

- **RQ3: How would a new design proposal that addresses the results in RQ2 through the combination of a Participatory Design practice and context-awareness, contribute to the design of a universally designed travelling application?**

Firstly, by using an ethnographic approach, I have been able to get up-close to the participants, experience their behaviour in real-life settings, and record their problems in this context. Including them as co-designers in the workshop and creating a space for collaboration among different user groups (Sanders & Stappers 2008, Brandt et al. 2013), has opened up for the participants to share values and experiences, and for an examination of relevant theory through practical use. As a result of this, a proposal for a new application has been developed which represents the views of several user groups, including their ideas and visions for a future application. The feedback from the participants supports this notion by their approval of the proposed solution. Moreover, their statements of being able to share opinions and be heard, illustrates how democratic values were in place and that equal influence was given to each member. Through the use of techniques such as future workshop (Junck and Müllert (1987), and explorative prototyping (Floyd 1984) (in Brandt et al. 2013, Rogers et al. 2011), the various user values were incorporated into the solution, which is emphasized by how the participants felt their needs and requirements from the workshop had been addressed. This gave the participants the opportunity to express how they wanted a future application to behave and work (Brandt et al. 2013). Several participants further underlined their newfound consideration and insight into the everyday life and situation of other participants, which advocates that mutual learning has taken place in this process.

These findings show that PD as a practice will make the design process a fair and equal process where the various contributions and the shared understanding among participants will ensure that the final product can address the various needs. It also highlight how including users with disabilities, will help to make the product more accessible and universal by addressing their issues.

Secondly, the idea of using contextual-awareness will be essential for a new application in several ways. Through the intention of connecting the GPS of the device to the Ruter system, relevant real-time information can be presented to the user at appropriate times. By using this functionality together with specific user input and various feedback modes such as audio and vibration, the information provided by the application will be able to address the travel needs of each individual journey, ensuring a secure and comfortable journey for all users. The opportunity for leisure is further broadened as the fear aspect of getting lost is removed, and the necessary resources are provided for in one simple application. This allows the user to use the travel time for other activities such as listening to music, reading, work, and so forth. This simplification of the travel process, together with the addition of accessible features, can provide the new application with the necessary means to insert confidence in the users, and increase their trust in the application. In

turn, this will allow them to be more independent and self-reliant, and make it easier for the users to navigate by providing a guide throughout the travel process. By creating a tool that is able to utilize the location, nearby information, and context, as proposed by Schilit et al. (1994) and Schmidt et al. (1999), and has the appropriate scope (Brown et al. 1997, Winograd 2001), these issues can be addressed. The solution can also be extended and further developed if necessary to ensure that other and more general situations are provided for (Dey 2000, Razzaque et al. 2006). The intention of using these functions to give the users more flexibility, without increasing the complexity and difficulty of using the application, is inline with principles of UD (Connell et al. 1997) and the notions of Fuglerud (2014). To include these aspects into the solution may make it a especially useful tool for impaired users, who several times underlined the importance of safety and assurance, but also wanted to be self-reliant and not depend on others. The need for this technology and concept is indicated by how it was requested by the participants, and the positive reception that the proposed solution received, especially from one participant who stated that:

> *Context awareness er noe av det beste i verden!*

In hindsight of these aspects and findings, I will argue that the addition of contextual awareness may present information that is more useful and relevant, and that when used with several feedback modes, contextual awareness will help the usability and accessibility of an application.

Thirdly, in creating the proposal I have attempted to learn from the experiences and results of the study, and tried to address the accessibility and usability problems uncovered. A replacement for the map has been provided for by adding a textual description, telling the user how to navigate to platforms or between transfers. This means the users will have more information at their disposal. By adding a tab under "Stoppesteder" for the functions most used and so on, these features are easier to locate. Having understood that users utilize different means and senses to gather information, various feedback modes are provided, and labels and neutral colours have been given priority. In addition, given the ambiguity of previous icons, which created issues in terms of finding and understanding the functionality that were incorporated into an icon, more universal icons have been proposed which are to be more understandable. There have also been changes made to address the issues of terminology, as the removal of the terms "Favoritter" and "Reiseplanlegger highlights.

The design proposal has been composed with the intention of developing an application where all its aspects are compatible with assistive technology, and where the same functions and results are presented on all versions. The application is also intended to be easy to understand and use, and to ensure user satisfaction. The feedback to this proposal was very positive, and though some minor issues were highlighted, the overall reception from the participants show that the intended solution can address their needs and requirements.

Providing a design proposal for the application which adhered to the principles of UD (Connell et al. 1997) as well as the WCAG standards and guidelines (W3C 2008, 2014*a*), and which considers the importance of both accessibility (ISO 2014, Theofanos & Redish 2003) and UD, (United Nations - Enable 2014, Tollefsen et al. 2013, Lid 2013, Dong 2007) has been an important goal, and the research in this field has been a crucial foundation

for conducting this work. Given the positive feedback from participants on both the proposal and the process itself, my own experience and results from using PD in practice, the findings from other research projects (Azenkot & Fortuna 2010, Neris de Almeida & Baranauskas 2009, Sahib et al. 2013), and how the underlying themes have been addressed by the concept of contextual awareness, I believe that the following claim is accurate; that the use of PD and contextual awareness can have a crucial role and contribute greatly to the creation of mobile applications that are universally usable and accessible to all.

7.3.1 | Reflective thoughts

Having presented these arguments, some reflective thoughts should be considered, first of all with regard to the design practice that has been used in this research. While PD can be viewed as a suitable practice for developing a universal application due to its focus on user participation and democratic values, this is not to say that other design practices are not user-centered and may be influential as well. Tracing how the concept of design have shifted from ergonomics to usability and later UCD, user studies have become the focal point for designers, not usability testing and lab experiments (Baecker et al. 2000, Karat & Karat 2003, Rosson & Carroll 2002). One may also recall Gould & Lewis (1985) early focus on users and tasks, indicating a "know thy user" approach, which have become an important part of the ID practice (Rogers et al. 2011). Hence, there are valid arguments to claim that similar results could have been achieved by using a different design approach within ID.

However, I believe the most suitable option for designers attempting to achieve accessibility and usability, is through the PD practice, especially given the recent development and shift in focus of design as a practice. As Sanders & Stappers (2008) points to, the focus of design is shifting from designing products for the user, to designing for the purpose and future experience of the user. The change in the practice will require an alteration in the scope and approach of the design process, and its centre of attention will be on the personal and social needs of users. This is highly relevant for designers seeking to create universal products, as it allows us to understand the challenges of users and create solutions together in a cooperative manner. Given the widespread difference of stakeholders and participants, a PD practice would allow for a platform of equal opportunity, and create an understanding of the different contexts and needs. The research from Azenkot & Fortuna (2010), Mi et al. (2014), Gkatzidou et al. (2011), and Sahib et al. (2013) have highlighted some of the advantages of this with regard to the mobile context, and the importance of having active user involvement to solve important user issues and challenges related to inclusive design. Their findings show that direct involvement of users is favourable for creating more suitable tools and guidelines, and for establishing an understanding of the future design. The latter is especially emphasized by the results of Gkatzidou et al. (2011) on the need for personalization in applications. This is similar to the findings that Giuseppe et al. (2009) had regarding a museum guide for blind users, and is further emphasized through the findings of Kane et al. (2011) about the need to provide for different user gestures. In hindsight of this, the participatory approach presented by Neris de Almeida & Baranauskas (2009) to address all users, becomes viable and can be used as an example of the change in the design approach, as proposed by Sanders & Stappers (2008). In my

opinion, these aspects will only become increasingly important as the use of smartphones increases, the technology of mobile applications expand, and these applications engulfs into other aspects of our society. Given the previous history and development of mobile devices and technology (Agar 2003, GSMA 2015, Sager 2012), and the recent implementation and success of smartphones (Ahson & Ilyas 2008, IDC 2015, Apple.Inc 2014), it seems likely that the progress of such devices and technologies will only continue its development.

Furthermore, some of the vulnerabilities in design proposal needs to be mentioned. It should be emphasized that the developed proposal is not a complete and final suggestion, but is a work in progress. Some of the issues relating to terminology and icons have not been completely resolved and should be explored further, as noted by some of the participants. Finding a more unifying term that can replace "Stoppesteder", is one of several issues that should be addressed. In addition, the reader will notice that much of the proposed functionality relies on the GPS functioning properly, and its cooperation with the Ruter system. While this should be technically possible and was perceived as achievable by the participants, further investigation and development is needed to see not only whether this is possible, but the actual usability of this function. In light of this, I recall an observation where the participant was presented a route suggestion that involved a 13 min walk, having used "Min posisjon" and the GPS function to find the starting location of the route. The participant was not surprised by this result, as noted in the following statement:

Ehm...ikkje...ikkje sånn veldig overraskende, men det e kanskje ikkje noe man tenker på.

The statement about this not being an problem one considers, highlights the issue of using GPS and localization functions, and underlines the importance of user testing in the field to ensure that the expected results and functions are presented, and can give users the trust and safety they need to travel by themselves. This is especially important since disabilities often occur in the user environment and in specific user situations (Fuglerud 2014, Lid 2013). To test and make sure that the functions are not causing additional issues, and are able to address existing concerns and disability issues, is important.

The privacy concern of using the GPS function should also be mentioned. While I have tried to include mechanisms in the proposal to ensure that users are aware of their data being collected, a high level of security and privacy needs to be in place to avoid the application being misused. Some users may have also the same opinion as one participant, who was very sceptical towards certain applications and their data gathering. The application needs to address this in order to be useful and interesting for these users as well.

Moreover, some aspects related to the design practice and process should be acknowledged. While an explorative feedback session was conducted with each participant from the workshop, the lack of a implemented application meant the participants were not able to interact with the proposal themselves. This was especially an issue for the visually impaired participant who depend on the interface being compatible with a screenreader or other assistive technology. As such, a formative or summative evaluation of the proposal has not been conducted (Rogers et al. 2011), which partially reduces the validity of the proposed solution.

Furthermore, adhering to a complete and ideal PD process with user evaluation and

reiterations was impossible given the limited scope of time and resources. The feedback from participants show that while the intentions of techniques used were understood and appreciated, the critique and request from the participants for an additional workshop, and/or a more iterative approach in the prototyping session, points to an issue in how this technique was conducted. The statement from one participant regarding the need to formulate and withhold ideas, also highlights that I as a designer should have addressed this issue by applying the measures of further discussion and individual sketching, as summarized in the feedback section. Thus, the emphasis of this process should have been on creating a unified space for sketching and collaboration at a later stage.

However, I view this as a fault on my part, not as a problem of the PD practice. The problems mentioned further highlights the difficulty of creating a space for collaboration and negotiation, and combining one's own world view to that of other participants, as mentioned in the feedback from one participant.

In addition, techniques and tools such as probes, scenarios and theatre (Brandt et al. 2013, Gaver et al. 1999), should have been included and explored to better facilitate for the concepts of making and enacting, and to provide a more wholesome process. This could have helped the process to better adhere to the tentative and explorative practice described by Brandt et al. (2013), and could have contributed to the promotion of different ideas and visions for the future. Applying such techniques would also have given the participants new ways to express themselves, provide for further dialogue, and help the participants to learn more about the different opportunities and constraints for the design.

However, I believe the users were given the opportunity to affect both the organisation and outcome of the project, and that they were given power. The process in this research have adapted to methods outlined by Bratteteig et al. (2013) by finding an application area in RuterReise, focusing on the world view of the participatory approach, and by applying principles, guidelines and techniques that would promote participation. Given my own experience of having to respond to changes in the design situation (Schön 1987) (in Löwgren & Stolterman 2004), and address both the future development and the process itself (Bratteteig et al. 2013), I experienced the effect user involvement has on a project, as I had to reflect and react to both my own actions, as well as the actions of the participants, and the changes that were made during the research project. In my view, this has strengthen the process. It has enabled me to learn from my previous actions, to consider the requests and needs of the participants as they were revealed, and learn to adapt and adjust these, and myself, to the situation at hand.

Finally, the choice of participants should be addressed. There are valid arguments for stating that other user groups should have been given the opportunity to influence the design, and that these may have presented other requirements, for example, users with hearing or motoric impairments. In addition, no stakeholder or developer was present from Ruter to offer insight into their decisions for the design of the current application, and to provide new knowledge concerning the possibility of achieving the proposed ideas. Hence, one may argue that one of the core stakeholders expressed by Löwgren & Stolterman (2004) is missing. Moreover, while the primary users were involved, the outer sphere of occasional and tertiary users have not been involved in the project (Eason 1987) (in Rogers et al. 2011). The issue mentioned by Alexander & Robertson (2004) regarding the problem for developers to involve the right stakeholders, and Fuglerud's description on

the difficulty of recruiting participants, support the notion that deciding on user groups is a common problem in research and development processes.

The narrow focus on a specific group of users with disabilities, was necessary due to the range of disabilities in our society, and the scope of the project. Though I acknowledge that other requirements could have been promoted by including other participants, the issues uncovered by the study appear to me as universal issues that can be applied to many users, and the design proposal has been developed to address different user situations, as suggested by Vanderheiden (2000).

Despite certain shortcomings, the findings show how a design process that is conducted by using a PD approach and by applying the method from Bratteteig et al. (2013) to construct the project, can be reflected in both the user experience of the process, and the product that is designed. Thus, I believe a PD approach with a focus on the core principles of the design practice, has been conducted. My own experiences and results from the research also have similarities with the design processes of Sanders & Stappers (2008) and Löwgren & Stolterman (2004) and their explorative nature, particularly with the diffuse requirements, different visions, and the shifting possibilities and ideas that I and the participants had during the design process. However, my design process lack the iterative elements of prototyping and evaluation which is seen in the process from Rogers et al. (2011). By including these elements into the process, they could have contributed by further stabilizing the requirements and specifications, especially if the participants were given the opportunity to further implement their ideas and give additional feedback. I believe that by adding extra prototyping and feedback sessions, the design proposal could have been developed and implemented into an accessible and useful application, thereby addressing the need for a more universal application. Further development may also fulfil the desire for safe travel requested by one of the blind participants:

> *For da kunne man ha sett på det, på forhånd og planlagt litt lissom,sånn.. på en måte roa seg litt ned..jeg blir stressa når jeg skal ut å reise, særlig på ukjente steder og sånn, da blir jeg kjempestressa....så jeg planlegger noe voldsomt....og da, hvis jeg lissom hadde den faktisk på telefonen ,og kunne sitte hjemme og planlegge litt og tenke litt over det....ville jeg følt meg litt tryggere.*

Whether this aspect will be addressed in a future travel planner from Ruter, will depend on their interest and ability to improve and continue the development of their current applications.

8 | Conclusion

In this thesis, an investigation into the mobile application RuterReise has been conducted in order to understand how we as designers may create applications that are accessible and usable to the largest number of possible users. In doing so, three research questions have been addressed.

- **RQ1: In what way can characteristics and qualities in Participatory Design be used together with the concepts of Universal Design?**
- **RQ2: What will an in-situ investigation, focusing on universal usability and accessibility for a mobile travelling application, reveal in terms of issues and problems for users?**
- **RQ3: How would a new design proposal that addresses the results in RQ2 through the combination of a Participatory Design practice and context-awareness, contribute to the design of a universally designed travelling application?**

In examining the relation between UD and PD, relevant research and theories regarding the two approaches were established. This enabled for a comparison and evaluation to find similar qualities and concepts between the two approaches, and indicate how PD as a design approach can contribute to achieve the goals of UD. The results show that PD and UD have similar goals with regard to democracy and equality for all, and that PD can play an influential part in ensuring a democratic process in which different parties are discussing on equal terms, and through a third space of collaboration, create an understanding and learning of the needs of others. The element of participation is vital, and is necessary as it allow weaker parties to influence and have a say in the design process as they become co-designers. This supports the notion by Fuglerud (2014) that users have to be involved in the design process, and illustrates how PD is a design practice which can be used to further enhance the creation of universally designed applications.

Furthermore, through an in-situ investigation of RuterReise using ethnography, several severe accessibility and usability issues were revealed, most predominantly with regard to the aspects of feedback, terminology and functionality. By further examination of the results and additional data gathering from a workshop, a theme was established. This showed a lack in the application to ensure a guaranteed, safe and independent journey from start to finish.

In the workshop, requirements were defined by the members through the practical use of the participatory techniques and the democratic mindset suggested by Brandt et al. (2013). I observed how the participants was able to work together as co-designers, and influenced the design process by expressing needs and concerns in the manner Bratteteig et al. (2013) and Sanders & Stappers (2008) suggest, an impression which was strengthen by the feedback from the participants in post-workshop interviews.

Using the suggestions, requirements and data gathered from the study, and the initial proposal from the workshop, a design solution was created. This solution focus specifically on the concepts of GPS functionality and contextual awareness, and addresses the underlying themes and issues from the data gathering. Though only a prototype, the proposal

received positive feedback and participants felt their needs and requirements were incorporated, which highlights how universal usability and user demands can be addressed through design.

As the proposal is a work in progress and has not been tested sufficiently, further work should focus on involving a larger variation of user groups, having several iterations, and ensure the development of a high-fidelity prototype. The main findings is that PD as a practice is highly relevant for design of universal products, and exemplifies how contextual awareness can be used to address problems in travel applications regarding usability and accessibility. The combination of UD and PD can be used as an approach for creating accessible and usable mobile applications. Whether those responsible for RuterReise will be able to achieve this, remains to be seen.

8.1 | Further Work

In future research and development, there are several improvements and alterations which can be made. I have already briefly mentioned ways for improving the design proposal, specifically through highlighting the need for implementing a high-fidelity prototype which can be evaluated, and further developed with user feedback and participation. This will help improve the terminology and perception of the application, and make it possible to observe the proposed functionality of contextual awareness and feedback in practice. Given that the systems at hand are under the control of Ruter, their involvement is crucial for any further development.

At the end of the project, I became aware that Ruter is in a process of testing out how the use of Bluetooth functionality from the mobile device, can be used to notify the users of incoming transports. This is an interesting aspect which, when combined with the functionality from this design proposal can be a solution to the cases of inaccurate GPS location, and be an extra element in assuring user security.

Moreover, the new guidelines from W3C on how WCAG 2.0 rules can be applied to the mobile context, is another step being made towards ensuring increased accessibility (W3C 2010). While the user aspect still remains overlooked, the technical standards appear to be altered to a more relevant situation.

Furthermore, given the rapid development of wearables such as smart watches, and the recent launch of the Apple Watch (Apple.Inc 2015*a*), it is interesting to see how this will affect apps for travelling. NSB recently prepared for this with by building support for the Apple Watch in their mobile application, before the smartwatch has reached Norwegian stores. The argument for this action is that it will help provide useful real-time information before and during travels (NSB Labs 2015). To expand the existing Ruter application and allow for similar support, can further simplify the travelling process of public transport. This could turn the smartwatch application into an extension of the mobile application by offering the necessary contextual information at a glance, and with different feedback modes to ensure accessibility. The design of such applications will further require a design which enables usability for all.

In summary, these are all opportunities to work on to achieve the most important aspect; the creation of an application which addresses usability and accessibility problems, and which ensures a universal application that can be used by as many users as possible.

Bibliography

Agar, J. (2003), *Constant touch : A global history of the mobile phone(Revolution in science)*, Cambridge, Icon Books,.

Ahson, S. & Ilyas, M. (2008), Smartphones, *in* B. Furht, ed., 'Encyclopedia of Wireless and Mobile communications', Auerbach Publications, pp. 1065–1085.

Alexander, I. & Robertson, S. (2004), 'Understanding project sociology by modeling stakeholders', *Software, IEEE* **21**(1), 23–27.

Apple.Inc (2012), 'Making your ios app accessible'. https://developer.apple.com/library/ios/documentation/UserExperience/Conceptual/iPhoneAccessibility/Making_Application_Accessible/Making_Application_Accessible.html#//apple_ref/doc/uid/TP40008785-CH102-SW5 visited 08.04.2015.

Apple.Inc (2014), 'First weekend iphone sales top 10 million, set new record'. https://www.apple.com/pr/library/2014/09/22First-Weekend-iPhone-Sales-Top-10-Million-Set-New-Record.html, visited 13.05.2015.

Apple.Inc (2015*a*), 'Apple watch'. http://www.apple.com/no/watch/ visited 25.05.2015.

Apple.Inc (2015*b*), 'ios. en rekke funksjoner for en rekke ulike behov'. https://www.apple.com/no/accessibility/ios/ visited 08.04.2015.

Aslaksen, F., Bergh, S., Bringa, O. & Heggem, E. (1997), 'Universell utforming- planlegging og design for alle'. http://home.online.no/~bringa/universell.htm, visited 19.05.2015.

Azenkot, S. & Fortuna, E. (2010), Improving public transit usability for blind and deaf-blind people by connecting a braille display to a smartphone, *in* 'Proceedings of the 12th International ACM SIGACCESS Conference on Computers and Accessibility', ASSETS '10, ACM, pp. 317–318.

Baecker, R., Grudin, J., Buxton, J. A. & Greenberg, S. (2000), Morgan Kaufmann, San Francisco.

Bevan, N. (1995), Usability is quality of use, *in* Anzai & Ogawa, eds, 'Proc. 6th International Conference on Human Computer Interaction', Elsevier. http://nigelbevan.com/papers/usabis95.pdf, visited 30.04.2015.

Blomberg, J. & Karasti, H. (2013), Ethnography: positioning ethnography within participatory design, *in* T. Robertson & J. Simonsen, eds, 'Routledge International Handbook of Participatory Design.', Routledge International Handbooks, Routledge, chapter 5, pp. 86–116.

Brandt, E., Binder, T. & Sanders, E. (2013), Tools and techniques: ways to engage telling, making and enacting, *in* T. Robertson & J. Simonsen, eds, 'Routledge International Handbook of Participatory Design.', Routledge International Handbooks, Routledge, chapter 7, pp. 145–181.

Bratteteig, T., Bødker, K., Dittrich, Y., Holst Mogensen, P. & Simonsen, J. (2013), Methods: Organising principles and general guidelines for participatory design, *in* T. Robertson & J. Simonsen, eds, 'Routledge International Handbook of Participatory Design.', Routledge International Handbooks, Routledge, chapter 6, pp. 117–144.

Brewer, J. (2000), *Ethnography*, Open University Press, Buckingham.

Brown, P., Bovey, J. & C., X. (1997), 'Context-aware applications: from the laboratory to the marketplace', *Personal Communications, IEEE* **4**(5), 58–64.

Center for Universal Design (2008), 'About the center: Ronald l. mace'. `http://www.ncsu.edu/ncsu/design/cud/about_us/usronmace.htm`, visited 2015-06-04.

Connell, R. B., Jones, M., Mace, R., Mueller, J., Mullick, A., Ostroff, E., Sanford, J., Steinfeld, E., Story, M. & Vanderheiden, G. (1997), 'The 7 principles of universal design'. `http://www.ncsu.edu/ncsu/design/cud/pubs_p/docs/poster.pdf`, visited 2014-11-03.

Darzentas, J. & Miesenberger, K. (2005), Design for all in information technology: A universal concern, *in* K. Andersen, J. Debenham & R. Wagner, eds, 'Database and Expert Systems Applications', Vol. 3588 of *Lecture Notes in Computer Science*, Springer Berlin Heidelberg, pp. 406–420.

Dey, A. (2000), Providing Architectural Support for Building Context-aware Applications, PhD thesis, Atlanta, GA, USA.

Dey, A. K., Abowd, G. D. & Salber, D. (2001), 'A conceptual framework and a toolkit for supporting the rapid prototyping of context-aware applications', *Hum.-Comput. Interact.* **16**(2), 97–166.

Dickinson, J., Ghali, K., Cherrett, T., Speed, C., Davies, N. & Norgate, S. (2014), 'Tourism and the smartphone app: capabilities, emerging practice and scope in the travel domain', *Current Issues in Tourism* **17**(1), 84–101.

Difi (2014*a*), 'Krav til nettløsninger'. `http://uu.difi.no/veiledning/nettsider/krav-til-nettlosninger/krav-wcag`, visited 2014-11-03.

Difi (2014*b*), 'Universell utforming av ikt'. `http://www.difi.no/digital-forvaltning/universell-utforming`, visited 2014-11-03.

Dong, H. (2007), *Universal Access in HCI, Part I*, Springer-Verlag Berlin Heidelberg.

EDeAN (2007), 'eaccessibility and design for all'. `http://www.edean.org/central.aspx?sId=64I160I771I323I264414&neID=341&neTa=61&tbid=0&lrID=2&oldUIID=aI50I0I1&acID=1&lanID=1&resID=1&assID=99&inpID=3&disID=1&famID=3&skinID=3`,visited 2015-04-28.

eMarketer (2014), '2 billion consumers worldwide to get smart(phones) by 2016'. `http://www.emarketer.com/Article/2-Billion-Consumers-Worldwide-Smartphones-by-2016/1011694` visited 08.04.2015.

Fuglerud, K. (2014), Inclusive design of ICT: The challenge of diversity., PhD thesis, University of Oslo, Faculty of Humanitites.

Funka (2012), *Guidelines for the development of accessible mobile interfaces*, Funka.NU AB. http://www.funka.com/contentassets/9131835638b640cf96baf2ef62a2fba4/guidelines_for_the_development_of_accessible_mobile_interfaces.pdf,visited 12.09.2014.

Funka (2014*a*), 'About funka'. http://www.funka.com/en/about-funka/,visited 12.09.2014.

Funka (2014*b*), 'Mobile accessibility guidelines'. http://www.funka.com/en/our-assignments/forskningsuppdrag-under-arbete/archive---research-projects/mobile-accessibility-guidelines/?_t_id=1B2M2Y8AsgTpgAmY7PhCfg%3d%3d&_t_q=guidelines&_t_tags=language%3aen%2csiteid%3a1ba9e28b-b400-47e0-a85a-1a211f659cf4&_t_ip=193.157.202.170&_t_hit.id=Furb_Models_Pages_StandardPage/_95a25472-31cc-494c-b8e5-d0ca50cebbc0_en&_t_hit.pos=1, visited 13.05.2015,.

Gaver, B., Dunne, T. & Pacenti, E. (1999), 'Design: Cultural probes', *interactions* **6**(1), 21–29.

Giuseppe, G., Leporini, B. & Paternò, F. (2009), 'Vibrotactile feedback to aid blind users of mobile guides', *Journal of Visual Languages & Computing* **20**(5), 305 – 317.

Gkatzidou, V., Pearson, E., Green, S. & Perrin, F. (2011), Widgets to support disabled learners: A challenge to participatory inclusive design, *in* 'Proceedings of the 23rd Australian Computer-Human Interaction Conference', OzCHI '11, ACM, pp. 130–139.

Google.Inc (2015*a*), 'Accessibility - guidelines'. https://developer.android.com/design/patterns/accessibility.html visited 08.04.2015.

Google.Inc (2015*b*), 'Accessibility developer checklist'. https://developer.android.com/guide/topics/ui/accessibility/checklist.html visited 13.05.2015.

Google.Inc (2015*c*), 'Android-tilgjengelighetsfunksjoner'. https://support.google.com/accessibility/android/answer/6006564?hl=no&ref_topic=6007234 visited 08.04.2015.

Google.Inc (2015*d*), 'Making applications accessible'. https://developer.android.com/guide/topics/ui/accessibility/apps.html visited 08.04.2015.

Gould, J. D. & Lewis, C. (1985), 'Designing for usability: Key principles and what designers think', *Commun. ACM* **28**(3), 300–311.
URL: *http://doi.acm.org/10.1145/3166.3170*

GSMA (2015), 'Brief history of gsm & the gsma'. http://www.gsma.com/aboutus/history, visited 25.03.2015.

Halloran, J., Hornecker, E., Stringer, M., Harris, E. & Fitzpatrick, G. (2009), 'The value of values: Resourcing co-design of ubiquitous computing', *CoDesign* **5**(4), 245–273.

Harper, S. (2007), 'Is there design-for-all?', *Universal Access in the Information Society* **6**(1), 111–113.

Honan, M. (2007), 'Apple unveils iphone'. http://www.macworld.com/article/1054769/iphone.html visited 13.05.2015.

IDC (2015), 'Android and ios squeeze the competition, swelling to 96.3both 4q14 and cy14, according to idc'. http://www.idc.com/getdoc.jsp?containerId=prUS25450615 visited 08.04.2015.

Institute of Transport Economics (2015), 'Forskningsprosjekt: Mobile applikasjoner underveis'. https://www.toi.no/mobil-teknologi-underveis/category1453.html, visited 2015-06-04.

ISO (1998), *ISO 9241-11:1998*, 1 edn, ISO. https://www.iso.org/obp/ui/#iso:std:iso:9241:-11:ed-1:v1:en, visited 30.04.2015.

ISO (2010), *ISO 9241-210:2010*, 1 edn, ISO. https://www.iso.org/obp/ui/#iso:std:52075:en, visited 07.05.2015.

ISO (2014), *ISO/IEC Guide 71:2014*, 2 edn, ISO. http://www.iec.ch/webstore/freepubs/isoiecguide71%7Bed2.0%7Den.pdf, visited 12.05.2015.

Joyce, G. & Lilley, M. (2014), Towards the development of usability heuristics for native smartphone mobile applications, *in* A. Marcus, ed., 'Design, User Experience, and Usability. Theories, Methods, and Tools for Designing the User Experience', Vol. 8517 of *Lecture Notes in Computer Science*, Springer International Publishing, pp. 465–474.

Julsrud, T., Denstadli, J. & Herstad, J. (2014), New mobile communication tools on everyday travels. what happens to the travel experience?, Technical Report 1330, Institute of Transport Economics. https://www.toi.no/getfile.php?mmfileid=37217,visited 2015-04-30.

Kane, S. K., Wobbrock, J. O. & Ladner, R. E. (2011), Usable gestures for blind people: Understanding preference and performance, *in* 'Proceedings of the SIGCHI Conference on Human Factors in Computing Systems', CHI '11, ACM, pp. 413–422.

Karat, J. & Karat, C.-M. (2003), 'The evolution of user-centered focus in the human-computer interaction field', *IBM Systems Journal* **42**(4), 532–541.

Kensing, F. & Greenbaum, J. (2013), Heritage: Having a say, *in* T. Robertson & J. Simonsen, eds, 'Routledge International Handbook of Participatory Design.', Routledge International Handbooks, Routledge, chapter 2, pp. 21–36.

Law, E. L.-C., Roto, V., Hassenzahl, M., Vermeeren, A. P. & Kort, J. (2009), Understanding, scoping and defining user experience: A survey approach, *in* 'Proceedings of the SIGCHI Conference on Human Factors in Computing Systems', CHI '09, ACM, New York, NY, USA, pp. 719–728.

Lid, I. (2013), 'Developing the theoretical content in universal design', *Scandinavian Journal of Disability Research* **15**(3), 203–215.

Löwgren, J. & Stolterman, E. (2004), *Thoughtful interaction design: a design perspective on information technology.*, MIT Press, Cambridge, Mass.

Madden, R. (2010), *Being Ethnographic*, SAGE Publications Ltd.

McIntyre-Mills, J. (2010), 'Participatory design for democracy and wellbeing: Narrowing the gap between service outcomes and perceived needs', *Systemic Practice and Action Research* **23**(1), 21–45.

Mi, N., Cavuoto, L. A., Benson, K., Smith-Jackson, T. & Nussbaum, A. M. (2014), 'A heuristic checklist for an accessible smartphone interface design', *Universal Access in the Information Society* **13**(4), 351–365.

Ministry of Labour and Social Affairs (2003), 'Dismantling of disabling barriers strategies, objectives and political measures aimed at persons with a reduced functional ability'. https://www.regjeringen.no/globalassets/upload/kilde/sos/rap/2004/0001/ddd/pdfv/220598-sle-engelsk-stmeld40-2002-2003.pdf.

Myers, M. D. (1997), 'Qualitative research in information systems', **21**(2), 241–242. `http://www.qual.auckland.ac.nz/#Introduction`,visited 2014-09-15.

Neris de Almeida, V. & Baranauskas, M. (2009), Interfaces for all: A tailoring-based approach, *in* J. Filipe & J. Cordeiro, eds, 'Enterprise Information Systems', Vol. 24 of *Lecture Notes in Business Information Processing*, Springer Berlin Heidelberg, pp. 928–939.

Newell, A., Gregor, P., Morgan, M., Pullin, G. & Macaulay, C. (2011), 'User-sensitive inclusive design', *Universal Access in the Information Society* **10**(3), 235–243.

Nielsen, J. (1995*a*), '10 usability heuristics for user interface design'. `http://www.nngroup.com/articles/ten-usability-heuristics/`, visited 08.04.2015.

Nielsen, J. (1995*b*), 'How to conduct a heuristic evaluation'. `http://www.nngroup.com/articles/how-to-conduct-a-heuristic-evaluation/`, visited 08.04.2015.

Nielsen, J. (2012), 'Usability 101: Introduction to usability'. `http://www.nngroup.com/articles/usability-101-introduction-to-usability/`, visited 30.04.2015.

Nielsen, J. & Norman, D. (2015), 'The definition of user experience'. `http://www.nngroup.com/articles/definition-user-experience/`, visited 07.05.2015.

Nordby, K. (2004), 'eaccessibility for all: The role of standardisation in shaping the end-users' tel-eeurope', *Telektronikk* **100**(1), 4–13. `http://www.telenor.com/wp-content/uploads/2012/05/T04_1.pdf`,visited 2015-04-28.

Norman, D. (2002), *The design of everyday things*, Basic Books, New York.

Norwegian Ministery of Government Administration and Reform (2006), Report no. 17 (2006–2007) to the storting: An information society for all, Technical report, The Norwegian Storting. `https://www.regjeringen.no/globalassets/upload/fad/vedlegg/ikt-politikk/stm17_2006-2007_eng.pdf`, visited 30.04.2015.

Norwegian Ministry of Environment (2007), 'Universal design - clarification of the concept'. `http://omega.regjeringen.no/Upload/MD/Vedlegg/Rapporter/T-1468.pdf`,visited 2015-01-15.

NSB Labs (2015), 'Reiseinformasjon – en armlengde unna'. `http://nsblabs.no/reiseinformasjon-en-armlengde-unna/`, visited 25.03.2015.

NSD (2012), 'Data protection official for research'. `http://www.nsd.uib.no/personvern/om/english.html`, visited 08.04.2015.

Orlikowski, J. & Baroudi, J. (1991), 'Studying information technology in organizations: Research approaches and assumptions', *Information Systems Research* **2**(1), 1–28.

Power, C., Freire, A., Petrie, H. & Swallow, D. (2012), Guidelines are only half of the story: Accessibility problems encountered by blind users on the web, *in* 'Proceedings of the SIGCHI Conference on Human Factors in Computing Systems', CHI '12, ACM, New York, NY, USA, pp. 433–442.

Razzaque, M., Dobson, S. & Nixon, P. (2006), Categorization and modeling of quality in context information, *in* 'Proceedings of the IJCAI 2005 Workshop on AI and Autonomic Communications, 2005. © PLANET, FZI, ICCS, TUM, EPFL, CIM, INTRAINTL, LIPSZ, TRT, TXT Page 47 of'.

Robertson, T. & Simonsen, J. (2013), Participatory design: an introduction, *in* T. Robertson & J. Simonsen, eds, 'Routledge International Handbook of Participatory Design.', Routledge International Handbooks, Routledge, chapter 1, pp. 1–17.

Rogers, Y., Sharp, H. & Preece, J. (2011), *Interaction Design- beyond human-computer interaction*, John Wiley and Sons Ltd.

Rosson, M. B. & Carroll, J. M. (2002), *Usability engineering: scenario-based development of human-computer interaction*, Morgan Kaufmann, San Francisco.

Ruter (2011), 'Trafikantens historie'. `https://ruter.no/om-ruter/om_trafikanten/historie/`, visited 25.03.2015.

Ruter (2012*a*), 'Appene ruterbillett og ruterreise'. `https://ruter.no/verdt-a-vite/app/`, visited 25.03.2015.

Ruter (2012*b*), 'Ruter - kollektivtrafikken i oslo og akershus'. `https://ruter.no/om-ruter/`, visited 25.03.2015.

Sager, I. (2012), 'Before iphone and android came simon, the first smartphone'. `http://www.bloomberg.com/bw/articles/2012-06-29/before-iphone-and-android-came-simon-the-first-smartphone`,visited 25.03.2015.

Sahib, N. G., Stockman, T., Tombros, A. & Metatla, O. (2013), Participatory design with blind users: A scenario-based approach, *in* P. Kotzé, G. Marsden, G. Lindgaard, J. Wesson & M. Winckler, eds, 'Human-Computer Interaction – INTERACT 2013', Vol. 8117 of *Lecture Notes in Computer Science*, Springer Berlin Heidelberg, pp. 685–701.

Sanders, E. B.-N. & Stappers, P. J. (2008), 'Co-creation and the new landscapes of design', *CoDesign* **4**(1), 5–18.

Satyanarayanan, M. (2005), 'Swiss army knife or wallet?', *IEEE Pervasive Computing* **4**(2), 2–3.

Schilit, B., Adams, N. & Want, R. (1994), Context-aware computing applications, *in* 'Mobile Computing Systems and Applications, 1994. Proceedings., Workshop on', pp. 85–90.

Schmidt, A., Aidoo, K., Takaluoma, A., Tuomela, U. & Van Laerhoven, K.and Van de Velde, W. (1999), Advanced interaction in context, *in* H. Gellersen, ed., 'Handheld and Ubiquitous Computing', Vol. 1707 of *Lecture Notes in Computer Science*, Springer Berlin Heidelberg, pp. 89–101.

Schulz, T., Gladhorn, F. & Sæther, J. A. (2015), Best practices for creating accessible mobile applications., Technical report, The Norwegian Computing Center. http://www.nr.no/en/nrpublication?query=/file/1421328805/NR1031-BestPractices-Accessible-MobileApps.pdf, visited 12.05.2015.

Shneiderman, B. (2000), 'Universal usability', *Commun. ACM* **43**(5), 84–91.

The Norwegian Storting (2013), 'Forskrift om universell utforming av informasjons og kommunikasjonsteknologiske(ikt)-løsninger'. Fastsatt ved kgl.res. 21. juni 2013 med hjemmel i lov 20. juni 2008 nr. 42 om forbud mot diskriminering på grunn av nedsatt funksjonsevne (diskriminerings- og tilgjengelighetsloven) § 2, § 11 og § 16. Fremmet av Fornyings-, administrasjons- og kirkedepartementet (nå Kommunal- og moderniseringsdepartementet)., https://lovdata.no/dokument/SF/forskrift/2013-06-21-732, visited 2015-01-15.

Theofanos, M. F. & Redish, J. (2003), 'Bridging the gap: Between accessibility and usability', *interactions* **10**(6), 36–51.

Tollefsen, M., Ausland, T., Brynn, R., Herstad, J., Holone, H., Lunde, M. & E., S. F. (2013), *Web og Universell Utforming*, Universitetsforlaget, Oslo.

United Nations - Enable (2014), 'Article 2 - definitions'. http://www.un.org/disabilities/default.asp?id=262, visited 2015-01-15.

Vanderheiden, G. (2000), Fundamental principles and priority setting for universal usability, *in* 'Proceedings on the 2000 Conference on Universal Usability', ACM, New York, NY, USA, pp. 32–37.

W3C (2005), 'User agent accessibility guidelines (uaag) overview'. http://www.w3.org/WAI/intro/uaag.php,visited 11.09.2014.

W3C (2008), *Web Content Accessibility Guidelines (WCAG) 2.0*, World Wide Web Consortium. http://www.w3.org/TR/2008/REC-WCAG20-20081211/#contents, visited 2015-01-15.

W3C (2010), *Mobile Web Application Best Practices*, The World Wide Web Consortium. http://www.w3.org/TR/2010/REC-mwabp-20101214/, visited 11.09.2014.

W3C (2014*a*), 'Introduction to understanding wcag 2.0'. http://www.w3.org/TR/UNDERSTANDING-WCAG20/intro.html, visited 11.09.2014.

W3C (2014*b*), 'Web accessibility initiative (wai)'. http://www.w3.org/WAI/, visited 12.05.2015.

W3C (2015*a*), 'About w3c'. http://www.w3.org/Consortium/, visited 12.05.2014.

W3C (2015*b*), *Mobile Accessibility: How WCAG 2.0 and Other W3C/WAI Guidelines Apply to Mobile*, World Wide Web Consortium. http://www.w3.org/TR/mobile-accessibility-mapping/, visited 2015-06-01.

W3C (2015*c*), 'Understanding conformance'. http://www.w3.org/TR/UNDERSTANDING-WCAG20/conformance.html, visited 2015-01-15.

W3C (2015*d*), 'W3c mission'. http://www.w3.org/Consortium/mission, visited 12.05.2015.

WAI (2005*a*), 'Authoring tool accessibility guidelines (atag) overview'. http://www.w3.org/WAI/intro/atag.php, visited 11.09.2014.

WAI (2005*b*), 'Essential components of web accessibility'. http://www.w3.org/WAI/intro/components.php, visited 2014-09-28.

WAI (2005*c*), 'Web content accessibility guidelines overview'. http://www.w3.org/WAI/intro/wcag.php, visited 11.09.2014.

WAI (2009), 'How wcag 2.0 differs from wcag 1.0'. http://www.w3.org/WAI/WCAG20/from10/diff.php, visited 11.09.2014.

WAI EOWG (2008), 'Mobile accessibility'. http://www.w3.org/WAI/mobile/, visited 12.05.2014.

WAI et al. (2008), *Web Content Accessibility and Mobile Web: Making a Website Accessible Both for People with Disabilities and for Mobile Devices*, W3C. http://www.w3.org/TR/mobile-bp/, visited 2014-09-28.

Winograd, T. (2001), 'Architectures for context', *Hum.-Comput. Interact.* **16**(2), 401–419.

9 | Appendix

This section provide an overview of items which are not presented explicitly in the thesis, but have been used in the research and are referred to. The first section presents the questions that were used during the observation and in the in-depth interviews.

The second section displays the questions used for the feedback interviews with participants.

The third section presents the heuristic guidelines from Joyce & Lilley (2014) and W3C (2015*a*), which were used when conducting the heuristic evaluation of the applications.

The final section highlights the consent form the participants were given prior to their participation in the research.

9.1 | Appendix A: Questions used in the observations and interviews

Spørsmål til Observasjon/Intervju:

Navn: Skal anonymiseres/brukes med koblingsnøkkel

Alder: Ble notert for å vise spekter til brukergruppen

Teknologi: Ble notert for å sjekke operativsystem ulike brukere har.

1: Hvordan opplever du at framsiden er? Hvorfor finner du (ikke) det du trenger?

2: Hvordan er det å finne relevant informasjon i applikasjonen?

3: Hvordan oppleves navigasjonen og flyten/bevegelsen i mellom menyelementene?

4: Hvordan tolker du navnene i menyen? Forstår du intuitivt hva de leder til? Hvorfor/Hvorfor ikke?

5: Hvordan er det å søke etter sted? Får du informasjonen du ønskjer og slik du ønskjer den presentert? Hvorfor er det bra/dårlig?

6: Når du trykker på ein stasjon, hvordan finner du riktig avgang og/eller plattform?

7: Hvordan syns du prosessen med å finne en aktuell rute er?

8: Hvordan er det å finne overganger videre eller ruter som går seinere?

9: Om du gjør feil i applikasjonen, hvordan er det å rette opp dette?

10: Oppfører applikasjonen slik du forventer i forhold til valgene du gjør?

11: Hva syns du om visningen av resultatene?

12: Vet du om dei ulike visningsvalgene gir deg mulighet til å bestemme tidsinnstillinger,transportmidler avstand å gå, etc?? Hva synes du om disse?

13: Er dette noe du vil bruke og tilpasse til dine behov, hvorfor/hvorfor ikke?

14: Hvordan er det å finne informasjon for steder eller ruter du bruker ofte?

15: Hvordan oppleves det å bruke favoritt funksjonen og lagre en rute?

16: Hvordan opplever du å bruke Finn reise?

17: Når du er ute og venter på et transportmiddel, hvordan veit når det transportmiddelet kommer og at det er det riktige?

18: Hvilken funksjonalitet bruker du mest og hvorfor?

19: Hva syns du om tilbakemeldingen du får i frå applikasjonen?

20: Er det noe teknologi i applikasjonen som hjelper deg i bruken av applikasjonen/ er veldig bra eller som motvirker bruk av applikasjonen/er dårlig?

21: Er det noe du savner i applikasjonen?

22: Har du noen siste ord eller kommentarer? Er det noe jeg ikke har nevnt?

9.2 | Appendix B: Questions used in the post-workshop interviews

1: Hvordan var det å delta på observasjonen? Hvorfor?

2: Hvordan opplevde du det å delta på workshop? Hvorfor?

3: Hva syns du om framgangsmåten som ble brukt i workshopen? Hvorfor?

4: Hvordan var det å samarbeide tett med andre og komme fram til et konsept i fellesskap? Hvorfor?

5: Hvordan opplevde du det å formidle ønskene dine til de andre i gruppa? Hvorfor?

6: Hvordan var det å utarbeide eit forslag til en prototype sammen med andre? Hvorfor?

7: Hvordan opplevde du det å jobbe med svaksynte og ta hensyn til deres behov?

8: Hvordan var det å tenke universelt i form av robusthet og enkelthet, og prøve å designe for noe som kan brukes av alle? Hvorfor?

Designforslaget:

9: Hva syns du generelt om designforslaget?

10: Hvordan relaterer du til ikoner og farger? Hvorfor?

11: Hva syns du om navigeringen i menyen og i mellom elementer? Hvorfor?

12: Hva syns du om navnene er blitt gitt til menyer og andre elementer? Hvorfor?

13: Hva syns du om plasseringen av de ulike elementene og funksjonene?

14: Opplever du at designforslaget tar hensyn til dine ønsker i fra workshopen, eller er det andre elementer og funksjoner som har tatt plass?

15: Hva tenker du om funksjonaliteten som blir foreslått og måten den blir gjennomført?

16: Hvordan opplever du dette designforslaget og den foreslåtte funksjonaliteten i forhold til Ruterapplikasjoner du har brukt tidligere?

17: Har du forslag eller kommentarer til designforslaget?

18: Har du noko siste kommentarer eller innspill til prosjektet? Hvordan var det å være en del av en slik prosess?

9.3 | Appendix C: Guidelines used in the evaluation

Guidelines for native mobile applications

- **SMART 1: Provide immediate notification of application status** – Ensure the mobile application user is informed of the application status immediately and as long as is necessary. Where appropriate do this non-intrusively, such as displaying notifications within the status bar

- **SMART 2: Use a theme and consistent terms, as well as conventions and standards familiar to the user –** Use a theme for the mobile application to ensure different screens look alike. Also create a style guide from which words, phrases and concepts familiar to the user will be applied consistently throughout the interface, using a natural and logical order. Use platform conventions and standards that users have come to expect in a mobile application such as the same effects when gestures are used.
- **SMART 3: Prevent errors where possible; Assist users should an error occur –** Ensure the mobile application is error-proofed as much as is possible. Should an error occur, let the user know what the error is in a way they will understand, and offer advice in how they might fix the error or otherwise proceed.
- **SMART 4: Display an overlay pointing out the main features when appropriate or requested –** An overlay pointing out the main features and how to interact with the application allows first-time users to get up-and-running quickly, after which they can explore the mobile application at their leisure. This overlay or a form of help system should also be displayed when requested.
- **SMART 5: Each interface should focus on one task –** Being focusing on one task ensures that mobile interfaces are less cluttered and simple to the point of only having the absolute necessary elements onscreen to complete that task. This also allows the interface to be glanceable to users that are interrupted frequently.
- **SMART 6: Design a visually pleasing interface –** Mobile interfaces that are attractive are far more memorable and are therefore used more often. Users are also more forgiving of attractive interfaces.
- **SMART 7: Intuitive interfaces make for easier user journeys –** Mobile interfaces should be easy-to-learn whereby next steps are obvious. This allows users to more easily complete their tasks.
- **SMART 8: Design a clear navigable path to task completion –** Users should be able to see right away how they can interact with the application and navigate their way to task completion.
- **SMART 9: Allow configuration options and shortcuts –** Depending on the target user, the mobile application might allow configuration options and shortcuts to the most important information and frequent tasks, including the ability to configure according to contextual needs.
- **SMART 10: Cater for diverse mobile environments –** Diverse environments consist of different types of context of use such as poor lighting conditions and high ambient noise are common ailments mobile users have to face every day. While the operating system should allow the user to change the interface brightness and sound settings, developers can assist users even more for example by allowing them to display larger buttons and allowing multimodal input and output options.
- **SMART 11: Facilitate easier input –** Mobile devices are difficult to use from a content input perspective. Ensure users can input content more easily and accurately by, for

instance displaying keyboard buttons that are as large as possible, as well as allowing multimodal input and by keeping form fields to a minimum.

- **SMART 12: Use the camera, microphone and sensors when appropriate to lessen the user's workload –** Consider the use of the camera, microphone and sensors to lessen the users' workload. For instance, by using GPS so the user knows where they are and how to get there they need to go, or by using OCR and the camera to digitally capture the information the user needs to input, by allowing use of the microphone to input content which would save the user from having to type on the small keyboard.
- **SMART 13: Create an aesthetic and identifiable icon –** An icon for a mobile application should be aesthetic and identifiable as this is what a user sees when searching the device interface for the application they wish to launch and when scanning through app stores it will be the first item they see before the application title, description and screenshots.

WCAG guidelines

- Principle 1: Perceivable - Information and user interface components must be presentable to users in ways they can perceive.
  - Guideline 1.1 Text Alternatives: Provide text alternatives for any non-text content so that it can be changed into other forms people need, such as large print, braille, speech, symbols or simpler language.
    - 1.1.1 Non-text Content: All non-text content that is presented to the user has a text alternative that serves the equivalent purpose, except for the situations listed below.(referring to controls, time-based media, test, sensory, CAPCTCHA and formatting or decoration)(Level A)
  - Guideline 1.3 Adaptable: Create content that can be presented in different ways(for example simpler layout) without losing information or structure.
    - 1.3.2 Meaningful Sequence: When the sequence in which content is presented affects its meaning, a correct reading sequence can be programmatically determined. (Level A)
  - Guideline 1.4 Distinguishable: Make it easier for users to see and hear content including separating foreground from background.
    - 1.4.1 Use of Color: Color is not used as the only visual means of conveying information, indicating an action, prompting a response, or distinguishing a visual element.(Level A)
    - 1.4.4 Resize text: Except for captions and images of text, text can be resized without assistive technology up to 200 percent without loss of content or functionality.(Level AA)
- Principle 2: Operable - User interface components and navigation must be operable.
  - Guideline 2.4 Navigable: Provide ways to help users navigate, find content, and determine where they are.

    * 2.4.3 Focus Order: If a Web page can be navigated sequentially and the navigation sequences affect meaning or operation, focusable components receive focus in an order that preserves meaning and operability.(Level A)
    * 2.4.4 Link Purpose (In Context): The purpose of each link can be determined from the link text alone or from the link text together with its programmatically determined link context, except where the purpose of the link would be ambiguous to users in general. (Level A)
    * 2.4.6 Headings and Labels: Headings and labels describe topic or purpose.(Level AA)

- Principle 3: Understandable: Information and the operation of user interface must be understandable.
  - Guideline 3.1 Readable: Make text content readable and understandable.
  - Guideline 3.2 Predictable: Make Web pages appear and operate in predictable ways.
    * 3.2.1 On Focus: When any component receives focus, it does not initiate a change of context. (Level A)
    * 3.2.2 On Input:Changing the setting of any user interface component does not automatically cause a change of context unless the user has been advised of the behavior before using the component. (Level A)
  - Guideline 3.3 Input Assistance: Help users avoid and correct mistakes.
    * 3.3.1 Error Identification: If an input error is automatically detected, the item that is in error is identified and the error is described to the user in text. (Level A)
    * 3.3.2 Labels or Instructions: Labels or instructions are provided when content requires user input.(Level A)

- Principle 4: Robust: Content must be robust enough that it can be interpreted reliably by a wide variety of user agents, including assistive technologies.
  - Guideline 4.1 Compatible: Maximize compatibility with current and future user agents, including assistive technologies.

9.4 | Appendix D: Consent form

Forespørsel om deltakelse i forskningsprosjektet: Universell utforming av RuterReise

Bakgrunn og formål:

Dette prosjektet er en masteroppgave ved Institutt for Informatikk ved Universitetet i Oslo. Masterstudenten ønsker å undersøke Ruter sin applikasjon RuterReise og hvorvidt denne er designet i henhold til universell utforming. Dette gjøres gjennom deltakende observasjoner med brukere for å samle inn kunnskap og erfaringer rundt applikasjonene.

Gjennom bruk av participatory design skal masterstudenten så samarbeide med brukere i å designe en Ruter applikasjon som er universelt utformet og er tilpasset ulike brukere sin krav og behov. Dette designet vil så evalueres av brukerne med det mål om finne ut om en slik designdisiplin er godt egnet til å designe applikasjoner og gjøre de universelt utformet. Masteroppgaven gjøres i prosjektet «Underveis» som er et samarbeidsprosjekt mellom TØI(Transportøkonomisk Institutt), NSB og Ruter med det mål om se hvilke applikasjoner og tjenester som kan gjøre reiseopplevelsen bedre. Deltakeren er valgt ut som en del av et utvalg hvor målet er å få en mest mulig heterogent samling av deltakere for å gjenspeile ideen og tankegangen bak universell utforming.

Hva innebærer deltakelse i studien?

Første steg i denne prosessen er en deltakende observasjon under reise hvor masterstudenten observerer og deltar i samtale med deltakeren. Det vil deretter bli gjennomført en eller flere workshops, hvor masterstudenten i samarbeid med ulike brukere skal utvikle en applikasjon rundt Ruter som skal være universelt utformet. Dette initielle designet vil så bli videreutviklet av masterstudenten og evaluert av brukere mot slutten av prosjektet gjennom et intervju. Deltakeren bestemmer selv om han/hun kun ønsker å delta på deler av studien og datainnsamlingen. Informasjonen som samles inn skal i hovedsak dreie om deltakeren sin meininger og kunnskap rundt Ruter applikasjonen og universell utforming.

Personopplysninger som alder, navn og kjønn vil bli registert, men vil anonymiseres i publikasjonen av masteroppgaven og fjernes etter prosjektet sin slutt. Andre personopplysninger som religiøs overbevisning, seksualitet, helsetilstand, o.l som på noe måte kan være diskriminerende eller skade deltakeren i fremtiden vil ikke bli samlet inn. Under datainnsamlingen vil det bli tatt i bruk lydopptak og notater i deltakende observasjonene. I workshopene vil det bli samlet inn notater, lydopptak og bilder.

Hva skjer med informasjonen om deg?

Alle personopplysninger vil bli behandlet konfidensielt. Kun masterstudent og veileder skal ha tilgang til personopplysningene under prosjektet. Navn, alder og kjønn vil bli oppbevart separat og med ulike koblingsnøkler i fra resten av dataene. Deltakere skal ikke kunne identifiseres i publikasjonen av masteroppgaven.

Prosjektet skal etter planen avsluttes 01.05.2015. Alle data og personlig informasjon om deltakeren vil da bli anonymisert og fjernet slik at informasjonen ikke kan spores tilbake.

Frivillig deltakelse

Det er frivillig å delta i studien, og du kan når som helst trekke ditt samtykke uten å oppgi noen grunn. Dersom du trekker deg, vil alle opplysninger om deg bli anonymisert.

Dersom du ønsker å delta eller har spørsmål til studien, ta kontakt med Bjørnar Fjeldstad på telefonnummer: 98857906 eller gjennom epost: bfjeldstad@outlook.com.

En kan også rette henvendelser til veileder Jo Herstad gjennom epost-adresse: johe@ifi.uio.no. Studien er meldt til Personvernombudet for forskning, Norsk samfunnsvitenskapelig datatjeneste AS.

Samtykke til deltakelse i studien

Jeg har mottatt informasjon om studien, og er villig til å delta:

_____

(Signert av prosjektdeltaker, dato)