

Suvi Rossi

Developing Accessible Banking Services

For visually impaired customers

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Author	Suvi Rossi
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<p>The objective of the Thesis was to analyse and propose changes needed for developing an accessible online banking. The case company is one of the biggest Nordic banks. At the moment, the case company can – to some extent – serve the visually impaired for online banking (via the use of screen reader etc), but these services need improvement. According to Finnish Federation of the Visually Impaired FFVI 2020), in Finland there are currently 50-60 000 of the population who is considered as visually impaired. Fully blind are less than 10 000 people in Finland.</p> <p>In the Thesis, first, theoretical background was investigated for developing accessible online banking and web-designing from accessibility perspective. Based on suggestions from literature and available guidelines and best practice, the retrofitting model was selected as a basis for developing accessible online banking in this study.</p> <p>Second, the analysis of customer needs was done for the visually impaired customers in online banking of the case company, guided by the conceptual framework developed in the previous step. The current state analysis used interviews as well as accessibility test where the current beta version of online bank was used. The Accessibility test was done based on the standards provided by World Wide Web Consortium 2018 (W3C) international web standards. The current state analysis revealed the needs for improvements in accounts, payments and contacting the bank.</p> <p>The outcome of this study is a development plan for accessible online banking for the case company. The proposal is built based on the results from the current state analysis and the retrofitting model for developing accessibility and usability for visually impaired customers. The outcome of the thesis was validated in the case company and became part of the ongoing project to develop online banking for the visually impaired. The Thesis proposed what can and need to be improved before publishing the online banking to wider markets.</p>	
Keywords	Accessibility, online banking, visually impaired users, banking services, web-development, usability

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1 Introduction

Digitalisation is the trend for all industries, and it changes them a lot. Financial industry is hit by the digitalisation in many ways; banking services are directed to digital, augmented reality (AR) and robotics process automation (RPA) that are changing the need for human assistance work and legislation requires more attention for example data privacy and investment advice. All this is supported by digitalisation. With appearance of modern technology and digitalisation, accessibility is extended to computer accessibility. (Sierra, 2012), also for various types of customer segments, where previously it was not widely used.

Is there a difference when defining and developing web interfaces for non-disabled and visually disabled person? I answered that there must be. This was the starting point for these. I decided to investigate how design and development differ, what are the accessibility tools and assistive technology that visually impaired people use and mainly, how they see current situation and what are the pain points that should be taken into consideration when designing web pages for visually impaired people.

Digitalisation is part of everyday life and financial industry and bank sector are no exception of this. Digitalise banking services is essential for any company. Services are needed to access anytime and anywhere. Customers trend is also to have daily banking services 24/7 instead of traditional Monday to Friday.

Internet access is roughly available to all people in Nordic countries. Internet can be accessed using smart devices or computers. Offering daily banking services to customers is an effort of service design and development. These elements are essential also when understanding how accessibility is handled and implemented. One of the target group is visually impaired people. Visual impairment is a decreased ability to see to a degree that causes problems that are not fixable by glasses.

1.1 Case Industry and Case Company

Banking sector in the financial industry is part of every person's life; everyone needs banking services. Banking is also rapidly changing from human assisted service towards digital world. In Finland, according to European Banking Federation (EBF), three biggest credit institutions are OP Financial Group, Nordea Bank Finland and Danske Bank Finland. These are supervised by ECB. Smaller groups, like Savings Bank Group and POP Bank Group are under supervision of the Finnish Supervisory Authority. (The European Banking Federation EBF))

The case company in this thesis is a Nordic bank offering banking services to both private and corporate customers. The company's main market is Nordic countries; Denmark, Finland, Sweden and Norway. The company provides banking services in different channels; including web and mobile application as well call centres and branches. This study focuses on online banking; i.e. banking services that are accessible and available using web. Mobile banking and especially application, is scoped out.

The case company is one of the biggest banks in Finland. Its strategy has changed from physical branch strategy over to online customer service. Customer service will continue as human assisted although virtual assistants like chatbots will support the customer journey and customer experience. This strategy needs focus for designing online services also for customer groups with different kind of limitations.

1.2 Business Challenge

This study explores accessibility of banking services; how accessibility is implemented and how it could be improved. Key drivers behind this thesis are customer feedback and changing legislation which has minor impact in this thesis. Based on my experience, it is also known that that the user experience is not seamless between different devices, channels and platforms in banking services. Web and app based financial platforms differs between banks and between solutions within one bank. Legislation for

accessibility, security and privacy are having more focus both in national as well as on European level.

Business challenge for this study is to meet accessibility requirements in online banking services for the visually impaired in the case company. For directing customers anytime, anywhere online banking, usability and accessibility issues has come to prominence. Usability, design and web development differs depending, especially if the final user is a short-sighted or visually impaired user in your services in the case company.

Usability design differs depending if the user is sighted or visually impaired. Accessibility is more than visual impairment. Limiting the study for this target group is based on personal interest and the fact that how it has been challenging in real life.

1.3 Objective and Scope

The objective of this study is to propose a development plan for accessible online banking services for the case company.

The purpose of the study is to find out how visually impaired people experience their possibilities to conduct banking services. Scope of this study is to explore user experience based on the needs and challenges that visually impaired customers are experiencing in banking services in the case company, how the case bank is responding to this, and what are the future requirements that need to be taken into consideration. The scope is limited to the banking services in the case company that are strongly supervised by different authorities. Developing online banking focuses on retrofitting as the standard platform is already in place.

Exploring digitalization can be done from different angles; user experience, technology and legislation. The scope of this thesis is to explore accessibility of banking services in Finland and then improve online banking user experience in the case company based on the findings. Accessibility is followed by laws and regulation and it is also competitive advantage for companies. Focus here is to explore the accessibility of banking and finance systems for use by visually impaired users.

The outcome of this study is a development plan for accessible online banking for the case company.

Next section describes the research methods and data used to reach the objective in this study.

2 Method and Material

This section introduces method and material that is used for the study to meet the objective, as well as the research approach and data collection methods.

2.1 Research Approach

Research approach used in this study is the case study. Case study research is an inquiry that focuses on describing and understanding the case unit, i.e. a person or group or a problem (Woodside A. 2010). This group has to have its unique character, as Saldana et al. describes it (Saldana et al. 2011). Woodside's definition by his own words is intentionally broader than the definition that Yin (1994, p13) proposes: "A case study is an empirical inquiry that investigates a contemporary phenomenon within its real life context, especially when the boundaries between phenomenon and context are not clearly evident".

This study relies on qualitative research. Qualitative data can be described as non-numerical data or data that have not been quantified (Saunders et al. 2009). Saldana et al. (2011) defines qualitative research as information or data collected and analysed, and primarily non-quantitative in character consisting of textual material such as interview transcripts, field-notes and documents (Saldana et al. 2011).

One of the popular data collection methods in qualitative approach is interviews. The purpose of the interviewing is to find out what is in the interviewee's mind; perspectives, feelings, opinions, values, attitudes and beliefs about their personal experience (Saldana et al. 2011). It is important that the interviewer does not make assumptions or influence the interviewee in any way. According to Patton (1990), the purpose of open-ended interviewing is not to put things in someone's mind but to access the perspective of the person being interviewed (Patton, 1990).

Patton introduces three different approaches for qualitative interviewing; informal conversational interview, general interview guide approach and standardised open-ended

interview (Patton, 1990). Patton introduces that the interview guide provides topics or subject areas within which the interviewer is free to explore, probe, and ask questions that will elucidate and illuminate that subject (Patton, 283). This gives interviewer a possibility to build conversation logically and create trust during the interview. Using interview guide enables systematic and comprehensive approach that also supports time management the way that needed topics are covered during the interview. (Patton 1990, 283) Qualitative data source can be divided into two groups; primary and secondary data sources. Primary data is collected specifically for the research whereas secondary data has originally collected for some other purpose. (Saunders et al. 2011).

In this Thesis, a case study is used as it focuses on single unit for analysis. Specific one group in this case study was chosen deliberately and is limited for visually impaired users. This study is based on conducting interviews guided by an interview guide approach that involves outlining a set of issues that are to be explored with each respondent.

2.2 Research Design

The research design for this study is shown in Figure 1 below.

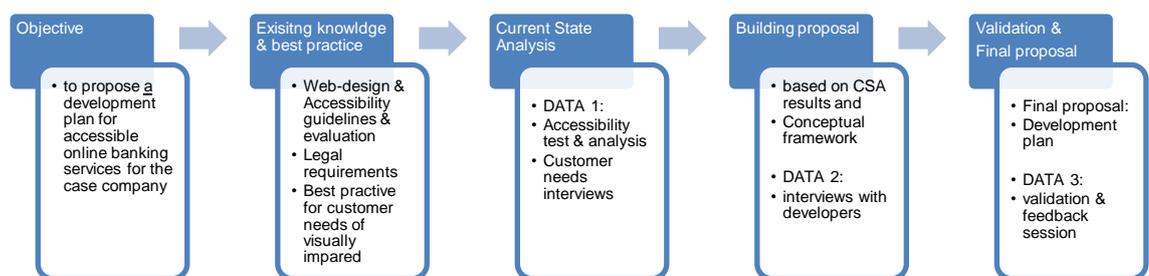


Figure 1. Research design of this study.

As seen from Figure 1, after defining the thesis objective, the study proceeds to the current state analysis (CSA) of user experience by conducting interviews with visually impaired users in the chosen bank.

Following UK English definition, a visually impaired person can be partially sighted, totally blind and everything between those. Comparison to US English where visually

impaired had partial sight and blind person is blind. According to the Finish Federation of the Visually Impaired (FFVI), there is no recent data how many of the population are visually impaired or blind. FFVI refers to the latest research by National Institute for Health and Welfare from 2011. According to that, approximately 50-60 000 people are visually impaired and less than 10 000 are blind. As seen, this is very limited group of people and because of that, suitable for qualitative case study.

In the course of this study, the business challenge is researched by interviewing visually impaired users and then analysing current accessibility requirements towards different solutions that currently are implemented in the case company. The challenge is addressed based on the existing accessibility guidelines. There is currently little publicly available research on this topic. To identify the current and future requirements for accessible banking service, this thesis utilizes an exploratory research to investigate accessibility issues.

Approach of the study is to explore the current requirements. In the second phase, visually impaired users are interviewed. The third part of the thesis maps the interview outcome towards exploring existing knowledge. The current state analysis is based on the fieldwork that includes interviews with relevant stakeholders as well as customers. Interviews are done to find out the current state of the online banking services in case company. Results of the interviews are used as primary data for thesis. Current state analysis establishes how banking services are accessible based on the interviews and what kind of user experience those are creating.

Literature review contains sources on web accessibility and usability. The results from CSA and existing knowledge from literature review leads to a proposal for retrofitting where the results are from accessibility test that is done for online bank beta version.

2.3 Data Collection and Analysis

Current State Analysis (CSA) is based on the interviews regarding needs and challenges for banking services. Primary data collection method for the current state analysis was

interviewing that contributed to this case study. The researcher conducted CSA by interviewing two groups of stakeholders. External interviews were held for visually impaired customers and the content of the interview was not limited to any specific bank. In the internal interviews, the interview guide was sent to designers in the case company. Structure of the interviews is illustrated in Appendix 1. Data collection is presented in Table 1 below.

Table 1 Details of data collection 1-3 and analysis.

Data Round	Data Type	Data Source	Date & Approach	Recording	Purpose / Focus
Data 1 Current State Analysis	Interview, external	Users 1-6	Phone interviews 30 minutes each 10/2018	Field notes	Find out customer's needs, expectations and challenges
Accessibility test results	Test results	based on the test with 8 users	Test	Observations & notes	Find out customer's needs and challenges via testing the beta version
Data 2 Proposal	the same data used for Data 1				
	Customer ombudsman in the company	Customer ombudsman	Written feedback from ombudsman & her collected customer feedbacks	Company internal data	Find out how to improve the current online banking
Data 3 Validation	Internal interview with a key stakeholder (lead expert)		Interview 40 minutes	Field notes	To validate & get feedback to the Proposal

External interviews with the blind customers contained questions related to the customer banking behaviour, needs and challenges of the visually impaired people. Depending if customer is more web or mobile users, the interview followed this route as assistive technology differs between these two platforms. External interviews gave the current situation the picture of what kind of needs and expectations a visually impaired customer has. The target group for these external interviewees were visually impaired customers. Interviewees were gathered using Finnish Federation of the Visually impaired bulletin board via internet. Interviewees were called for and invited for research related to banking services accessibility; their needs, hopes, use cases and challenges. Interviews took place by phone and followed the interview template in Appendix 1.

Data 2 is a limited to the use of the same Data 1 as in the current state analysis coupled with the data collected from the Customer ombudsman in the case company and a number of customer feedbacks. As feedback given was mainly negative, it was important to utilize it in the Proposal, as it discussed the issues affecting one user group and proposed improvements to the current online banking.

Finally, validation used Data 3 in the form of an interview with the key stakeholder, the lead expert, who is involved in the development of online banking.

3 Existing Knowledge and Best Practice on Accessibility for the Visually Impaired in Web Services

This section discusses the definitions of web accessibility and discuss the key legislation that is important to consider when improving web service for visually impaired users. Web Content Accessibility Guidelines (WCAG 2018) covers recommendations for making web content more accessible. Following the guidelines will make web content accessible to people with disabilities including blindness and low vision. Following the guidelines makes web content more usable to any users in general. (WCAG 2018)

3.1 Legislation and Guidelines Related to Accessibility

Web accessibility is essential and important social issue for equal opportunities that are legislated. Web and accessibility have become almost mandatory daily help in everyday life. Many governmental services are already digitalised for web, banks are reducing branch network and moving banking online as well as rapid news and information flow cannot be met by print anymore. Web enables people with disabilities to participate more actively in society and making the web accessible can improve lives' and benefit society as whole (Thatcher et al. 2006 p.53).

Growing recognition that disability rights demand equal access to information and online services, such as banking, has contributed to the development of accessible web design standards (Thatcher et al. 2006 p.56).

Access to information is a human right that article 9 of the United Nations Convention describes appropriate measures to ensure to persons with disabilities access, on an equal basis with others, to the physical environment, to transportation, to information and communications, including information and communications technologies and systems, and to other facilities and services open or provided to the public, both in urban and in rural areas (un.org).

Legislation differs between Europe and US. Section 508 Standards, that is part of the U.S federal Acquisition Regulation (FAR), specifies the requirements for accessible electronic and information technology. The statute requires that individuals with disabilities have access to use of information and data that is comparable to those who are not disabled. This statute contains all disabilities, not only visual impairment or blindness (United States Access Board)

As US, also EU has similar directive. Directive 2016/2102 requires websites and mobile applications of public sector bodies to conform with WCAG2.1 level AA. (EUR Lex)

Directives in USA and EU are targeted for public sectors but can be used for private sector services. EU is encouraging its member states to extend the application to private entities where banking sector is an example. (EUR Lex)

3.2 Web Accessibility and Usability

Web accessibility and usability have different meaning when related to digital products. Usability can be described as the extent to which a software can be used by users of a specific group to achieve their goals effectively, efficiently and with satisfaction. Accessibility is the enabler to have product usable for everyone including disabled users. (Polidea 2016) Usability creates value for accessibility so that disabled people can accomplish the required task. Aim for web accessibility is to minimize or remove barriers that may stop visually impaired users to technology and digital services.

Range of hardware technology exists to assist users with any degree of visual impairment. This includes Braille displays that translates on-screen text to more tactile output or keyboards with enlarged keys.

Visually impaired users also need assistive software to access computers. One form of assistive software known as screen readers, interacts with device's operating system to describe relevant information through audible outputs (curve.carleton.ca 12.2.2020 page 5). Visually impaired users use keyboard shortcuts so that screen readers enable user to process through interface based on the information they can hear. Popular screen readers

include Job Access With Speech (JAWS), NonVisual Desktop Access (NVDA) and VoiceOver on Apple Devices (curve.carleton.ca 12.2.2020 page 5). Screen magnifier is another assistive software that enlarges page size so that user can see visual cues easier.

Finnish Federation of the Visually Impaired organisation has created check list for web development that states that accessible web page serves all users, not only the ones with disabilities. This check list is based on The World Wide Web Consortium (W3C) published Web content and mobile accessibility guidelines under Web Accessibility Initiative (WAI). W3C is an international consortium that has mission to publish standard guidelines for web and mobile standards.

User-Centered Design (UCD) is a user interface design process that focuses on usability goals, user characteristics, environment, tasks, and workflow in the design of an interface, such as website (Thatcher et al 2006 71/26). UCD follows a series of well-defined methods and techniques for analysis, design, and evaluation (Thatcher et al. 2006 71/26). The UCD process is an iterative process, where design and evaluation steps are built in from the first stage of the project and throughout the implementation (Thatcher et al. 2006 71/26). Accessible design techniques fit well into UCD processes; with a few additions and adaptations, design teams can use UCD practises to focus design on accessibility (Thatcher et al. 2006 71/26).

Usability is defined by The International Organisation for Standardisation (ISO) “extent to which product can be used by specified users to achieve specified goals effectively, efficiently and with satisfaction in a specified context of use” (Thatcher et al. 2006 26). Following this definition, “specified users” are people with visual disability and “specified context of use” is a wide range of situations, including assistive technology. (Thatcher et al. 2006 26)

Thatcher et al. encapsulates these as follows: “usability means designing the website to be effective, efficient, and satisfying whereas accessibility makes sure it is effective, efficient, and satisfying for more people” (Thatcher et al. 2006 27).

One fundamental distinction is following; usability problems impact all users equally while accessibility problems decrease access to a website by people with disabilities. (Thatcher et al) Distinction is not clear and often overlapping. Using UCD and WCAG as the basis for addressing accessibility ensures that the broad range of issues are covered well, at both the technical level and the user interaction level (Thatcher et al. 2006 28).

3.3 Best Practises and Standards (WCAG / W3C Guidelines)

World Wide Web Consortium (W3C) is the main international standards organisation for the world wide web. Purpose of the W3C is to develop protocols and guidelines that ensure long term growth for the web (W3.org).

One of the standards is World Wide Web Consortium's Web Content Accessibility Guidelines (W3C WCAG) and is used for guiding principles in accessible web development mainly for users with disabilities. First version WCAG 1.0 was published in 1999. Latest guideline, WCAG 2.1, became a recommendation in 2018. According to W3C, it was "initiated with the goal to improve accessibility guidance for three major groups: users with cognitive or learning disabilities, users with low vision, and users with disabilities on mobile devices (WCAG)

World Wide Web Consortium's Web Content Accessibility Guidelines (W3C WCAG) and is used for guiding principles in accessible web development mainly for users with disabilities. According to WCAG principles, focus areas are related to perceivability, operability, understandability and robustness. The term 'mobile' used in guidelines is a generic term for a broad range of wireless devices and applications.

Devices can vary from smaller smart watches to tablet devices. The choice of technology is guided by these required featured. Compared and separate from a desktop / laptop device, that usually has different standards, touch screens become more common in these devices and accessibility as well as usability is a set of issues. Web pages designed responsive can be used with mobile devices instead of native application.

WCAG has four principles: content must be perceivable, interface elements in the content must be operable, content and controls must be understandable, and content must be robust enough to work with current and future technologies. (WCAG, Thatcher et al 2006) Each principle contains guidelines what to do instead of how to do it.

Following subtopics deepens understanding of each of the principles. According to Thatcher et al (2006 462), these are not for the most part technology specific.

3.3.1 Perceivable

According to WCAG perceivability is mandatory for visually impaired users so that application is easy to perceive. Information and user interface components must be presentable to users in ways they can perceive. This is dependent of screen size, zooming possibilities and contrast. Zoom or magnification are built in native tools in all operating systems, but various third-party applications are available on the market.

First guideline is divided into four subcategories; text alternatives, time-based media, adaptability and distinguishability where text alternatives are relevant for online banking services.

Text alternatives are provided for any non-text content so that it can be changed into other forms people need such as large print, braille, speech symbols and simpler language. All non-text content that is presented to the user has a text alternative that serves the equivalent purpose. If non-text content is a control or accepts user input, then it has a name that describes its purpose. Text alternatives are important for visually impaired users that screen saver can read the action that is needed. (WCAG Guidelines)

According to Thatcher et al (2006 462-463), providing text alternatives for nontextual content makes it possible for users with different abilities and devices to perceive the content. When multimedia is presented, alternatives such as synchronized captioning with audio and video presentations should be presented (Thatcher et al 2006 463).

3.3.2 Operable

The second principle for web accessibility, according to WCAG, is operability. Interface elements in the web content must be operable. Focus areas are keyboard control, touch target size and spacing, touchscreen gestures, device manipulation gestures and placing buttons where they are easy to access. User interface components and navigation must be operable (WCAG Guidelines).

Operability is succeeded with four guidelines by WCAG. First one is that all functionalities are available from a keyboard. Second one guarantees that user has enough time to read and use content in web page. Third success criteria are that content is not designed the way that is known to cause seizures. Fourth principle is to help users to navigate, find content and determine where they are. (WCAG Guidelines) Thatcher et al (2006 463) has added fifth principle. The fifth success criteria is to help user to avoid mistakes and make it easy to correct when doing so. (Thatcher et al 2006 463)

Visually impaired user needs to detect location on web page, main page or subpage, with ease. Visually impaired user also needs to know, in which part of the navigation user is. There are different ways to present the page location; main page title, page name, navigation and bread crumb.

Main page title tells user the current location. Page name, also used title, tells which subpage user is. Navigation links, tree view, shows visually current page location. Bread crumb is “a hierarchical series of hyperlinks displayed at the top of a web page, indicating the page's position in the overall structure of the website” (Lexico).

3.3.3 Understandable

Third principle is that all content and controls must be readable by all users, whether or not they are sighted (Thatcher et al 2006 464). Understandability focuses on screen orientation, consistent layout, element positioning, page scrolling, grouping elements that perform same actions, providing clear indicators that elements are actionable and

providing instructions for custom touchscreens and device manipulation gestures (WCAG Guidelines).

Purpose of the third guideline is to make text content readable and understandable, make web pages appear and operate in predictable ways and help users to avoid and correct mistakes. (WCAG Guidelines) Thatcher et al refers here for guideline where the placement and functionality of the content are predictable. (Thatcher et al 2006 464).

3.3.4 Robust

Robustness is the fourth principle stating that all content should be designed so that it will not break in the future. Its focus is on setting virtual keyboard to the type of data entry required, providing easy methods and data entry and supporting characteristic properties of the platform.

For example, there is a difference also when using mouse or not. Design and development for accessibility, should take many points into consideration. Keyboard users who have for example used to skip irrelevant navigation links do not benefit this with screen reader as it may not be supported. (WCAG Guidelines) Thatcher et al (2006 464) states two guidelines: content supports compatibility with current and future user agents, and it is ensured that the content is accessible or provides alternative. (Thatcher et al (2006 464)

3.4 Assistive Technology, Code Languages & Web Standards

Currently, there are a lot of inventions proposed in relation to accessibility for the disabled people in banking. There are multiple examples of technology innovations (such as Mobile Banking Payment Interactive Interconnected System Supporting Information Accessibility patent, for instance) to help various disabilities to get access to banking services, especially online banking.

According to WCAG, assistive technology is hardware and / or software that acts as a user agent to provide functionality to meet the requirements of users with disabilities that go beyond those offered by mainstream user agent (WCAG Guidelines).

Visually impaired customers can use different assistive technology with online banking. Use and selection of the tool is dependent on the degree of the impairment. Users that are partly visually impaired can use different tools than users that are blind. Two most common tools to use are screen readers and magnifiers.

3.4.1 Screen reader

Screen readers are the primary method used by visually impaired and blind users to access web sites and applications. Screen reader works the way that it has speech synthesiser that reads the web page aloud.

A screen reader is a software application that enables people with visual disabilities to consume web content, in this case Netbank. Screen readers are commonly seen assistive technology for blind people, but user with visual impairments can also benefit of it. There are several free of charge screen readers available on the market and most of the operating systems contains this.

Screen reader read the source; text is read out in source-order rather than in the order that the CSS positions it. Website need to be built with focus order in mind. If the website is not coded following the guidelines, then the user may not find the content expecting to find.

3.4.2 Screen magnifier

Magnifier works same way as zooming page for sighted people. Difference in the user experience is that magnifier can be moved around the page which makes reading and finding correct content easier.

CSS - Cascading Style Sheets, typographic possibilities

Description of the look of the content is in a style sheet, which tells the browser where on the page headings, images, copy-right section should go. As well as colours and fonts to use. This means that if there will be changes needed in throughout entire site, it can be done by editing one style sheet instead the information on every page. (Thatcher et al 39)

XHTML - Extended Hypertext Markup Language

Markup language can used to describe the structure of the web page. This means that using markup language describes what something is and not what it looks like. Usage of different markup language, either HTML or XHTML, is selected based on the need. Rules published by the W3C and the most beneficial outcome is to follow those. (Thatcher et al)

Semantic code is alluded in three WCAG 1.0 checkpoints: usage of header elements to convey document structure and use them according to specification, mark up lists and list items properly and mark up quotations.

Summing up, each technology has its strengths and weaknesses and these need to be prioritised to see which technologies reaches as many customers as possible. As stated earlier, usually decisions based on accessibility, are valid also for users without any disabilities.

3.5 Web Content Accessibility Evaluation and Guidelines

The primary accessibility guidelines for Web pages and applications are developed by the World Wide Web Consortium (W3C) and are known as the Web Content Accessibility Guidelines, or WCAG. The current version of WCAG is WCAG 2.0 and specifies 12 standards that fall under categories of Web content being perceivable, operable, understandable and robust (WCAG Guidelines).

Perceivable content means that information and user interface components must be presentable to users in ways they can perceive. This means that users must be able to perceive the information being presented given that it can't be invisible to all their senses. User interface components and navigation must be operable. This means that users must be able to operate the interface given that the interface cannot require interaction that a user cannot perform. Information and the operation of user interface must be understandable. This means that users must be able to understand the information as well as the operation of the user interface given that the content or operation cannot be beyond their understanding. Web content must be robust enough that it can be interpreted reliably by a wide variety of user agents, including assistive technologies. (WCAG Guidelines)

This means that users must be able to access the content as technologies advance give that as technologies and user agents evolve, the content should remain accessible. If any of these are not true, users with disabilities will not be able to use the Web pages. (W3.org) The evaluation goal is to define accessibility barriers. The focus will be on high level instead pointing every single page. This is due to that for example, navigation need to be evaluated only once as well as other elements that are repeated in every page. Evaluation target is to find out templates, style sheets and elements that impact many pages. Those pages should be the ones that are mainly needed for daily banking but also corner cases if any.

Thatcher et al. (2006) proposes to have higher priority in following pages; log in page that is the entry point to the Netbank as well as homepage after log in. Daily banking includes accounts, payments, cards, loans and self-service contact channels. It is needed to understand navigation, path to get to daily banking services from the common entry points and the path to complete transactions such as payment. (Thatcher et al. 2006)

WCAG checkpoint (W3.org) identifies accessibility barriers by priority that helps determine the impact of a particular accessibility barrier. Thatcher's approach to retrofitting is to fix all Priority 1 barriers first and the lower priority barriers later. This though may have disadvantages such as going back over templates, style sheets and pages. According to Thatcher et al. (2006), a more effective approach in most cases is to do all of the high impact and easy repairs while working on a page, template and style sheet

(Thatcher et al, 2006). Addressing harder problems later has several advantages; usually shorter turnaround towards accessibility.

Checkpoints by WCAG are:

Priority	Explanation
Priority 1	A Web content developer must satisfy this checkpoint. Otherwise, one or more groups will find it impossible to access information in the document. Satisfying this checkpoint is a basic requirement for some groups to be able to use Web documents.
Priority 2	A Web content developer should satisfy this checkpoint. Otherwise, one or more groups will find it difficult to access information in the document. Satisfying this checkpoint will remove significant barriers to accessing Web documents.
Priority 3	A Web content developer may address this checkpoint. Otherwise, one or more groups will find it somewhat difficult to access information in the document. Satisfying this checkpoint will improve access to Web documents.

Table 2. Checkpoints for web content accessibility guidelines. (WCAG Guidelines)

For each barrier, Thatcher et al. (2006 31) approaches two parameters to be considered; impact on people with disabilities and effort required to repair (Thatcher et al. 2006 31). Input related to barriers will be added to quality assurance (QA) processes as well increasing awareness by educating developers.

3.6 Customer Needs of Visually Impaired

This chapter explains customer needs of visually impaired person for using web-based banking services. Banking services that are covered in this section are account balance information, write message to bank and card details. Customer need to have relevant

device and software to support web usage. Web pages can be used with desktop and mobile devices. To work in all devices, web page needs to be progressive and responsive. Responsive web design means that code is developed to automatically resize, hide, shrink and enlarge website that it works well in all devices. Progressive web application works for every user regardless of browser of choice.

Blind and visually impaired persons can have different needs. Depending on the degree of disadvantage, several assistive technologies is available. Customer needs device to access online bank. This device can be desktop or mobile device. Device need to have browser that is supported.

Opening browser in device, customer can use assistive braille technology or voice recognition. Braille technology is assistive technology which allows blind or visually impaired person to browse internet. Braille technology is divided for hardware and software. Blind person can use braille display and braille keyboard to access browser and type command. Browser can be opened using speech recognition.

When internet browser is open, blind or visually impaired person can use braille keyboard or speech recognition to access online bank. Visually impaired people can use screen magnifier that zoom web view and web address can be typed using normal keyboard.

When web page is loaded, blind customer can read the content with help of screen reader. According to screen reader survey by WebIAM, most commonly used screen readers are NonVisual Desktop Access (NVDA) and Job Access With Speech (JAWS). Both screen readers are made for Windows operating systems and can be used in all browsers. Blind or visually impaired person can control operating system with keyboard shortcuts and spoken feedback.

Blind and visually impaired user need to have web content that is easy to use with assistive technology. Blind and visually impaired user has a need that web content is fulfilling. Web content need to be easy to navigate. It also needs to have clear commands if there are any pictures or call to action buttons. Blind user does not see any colours or

forms of different layout. Visually impaired user can see colours. Contrast and colour controls are important to find needed action or information.

After blind or visually impaired customer access online bank URL, web page needs to direct correct authentication for customer to log in. Log in case company is done using screen reader. Authentication is done using code app on mobile device or talking code calculator. Customer need to know if log in has been successful or not.

After successful log in, customer need to have easy access to defined services; account information, payments and contacting bank. These topics must be found easily using screen reader and need to be marked with clear headings.

Customer navigate to account overview and information. The outcome of the navigation is to get account balance. Information provided by screen reader. Navigating to payments and own transfer is one basic need for banking. These need to be easy to find and understand. After payment or own transfer, it is important that customer receive information if the transaction is completed successfully.

Blind or visually impaired customer can have questions to daily banking issues. When customer want to write secure message to bank, starting message thread need to be found easily after logging in and during navigation around online bank. Screen reader need to be able to provide information what topics are available, how long the message body can be if there is limitation and is it possible to add one or multiple attachment. Screen reader need to have clear commands if message is saved as draft, if it is sent successfully or is there any errors.

When blind or visually impaired customer has performed needed services, screen reader needs to understand where log out can be found so that customer can safely log out.

3.7 Conceptual Framework

Table 3 below shows the conceptual framework of this study.

The conceptual framework describes three levels of priorities based on W3C WCAG. Additionally, based in literature review, the customer needs related to accessibility were distributed into groups according to their priority levels. Each group of customer needs (i.e. checkpoints) was assigned a priority level that describes their impact on accessibility. For each checkpoint, it should be clearly stated if the checkpoint is satisfied, not satisfied or not applicable. The checkpoint list (i.e. customer needs) are identified from W3C WCAG and, the grouping of customer needs (i.e. checkpoints) and their prioritization levels when developing accessibility make the basis for the conceptual framework and later development work.

As seen from the conceptual framework, W3C WCAG has three priority levels, and the checkpoints are listed and grouped according to their priority when developing websites, from the accessibility perspective. There are 65 checkpoints in all: 16 of them are Priority 1, 30 are Priority 2 and 19 are Priority 3.

The conceptual framework of this study is summarized in Table3 below.

Table 3. Conceptual framework for developing the web content accessibility based on customer needs.

Priority	Checkpoints for web content accessibility guidelines	Customer needs
Priority 1	<p>A Web content developer must satisfy this checkpoint. Otherwise, one or more groups will find it impossible to access information in the document. Satisfying this checkpoint is a basic requirement for some groups to be able to use Web documents. (WCAG 2.1 2018)</p>	<ul style="list-style-type: none"> • All non-text elements are provided text equivalent. • All information conveyed with colour is also available without colour. • Changes in natural language are clearly identified (e.g. captions). • Documents can be read without style sheets. • Equivalent for dynamic content are updated when dynamic content changes. • Until user agents allow users to control flickering, causing the screen to flicker is avoided. • Clearest and simplest language is used. (WCAG 2.1 2018)
Priority 2	<p>A Web content developer should satisfy this checkpoint. Otherwise, one or more groups will find it difficult to access information in the document. Satisfying this checkpoint will remove significant barriers to accessing Web documents. WCAG 2.1 2018)</p>	<ul style="list-style-type: none"> • Foreground and background colour combinations provides sufficient contrast • Dynamic content needs to be accessible • Refreshing page is done by user • Clearly identified targets of the links • Metadata is provided to add semantic information to pages and sites • Information about the general layout of a site is provided • Navigation mechanism is used in a consistent manner • Tables need to make sense when linearized • Purpose of the frames and relations to other frames are described • Label for form controls are properly positioned • Labels are explicitly associated with their control (WCAG 2.1 2018)
Priority 3	<p>A Web content developer may address this checkpoint. Otherwise, one or more groups will find it somewhat difficult to access information in the document. Satisfying this checkpoint will improve access to Web documents. (WCAG 2.1 2018)</p>	<ul style="list-style-type: none"> • Logical tab order is created • Keyboard shortcuts to important links are created • Navigation bars are provided to highlight and give access to navigation mechanism • Distinguishing information is placed at the beginning of headings, paragraphs, lists, etc. • Document collection information is provided • Summaries for tables are provided • Abbreviations for header labels are provided (WCAG 2.1 2018)

4 Current State Analysis of Accessibility and Usability of Online Banking Services in the Case Company

This section describes the results of the current state analysis of the existing online banking services meant for visually impaired in the case company.

4.1 Overview of Existing Online Banking Services Meant for Visually Impaired in the Case Company

The case company's current online bank has been developed in 1997 and there has been constant development during the years. Because technology develops and market changes, it is essential to the business to evaluate current offering and modernise services. For customers, it means improved performance and modern user interface. From the technical perspective, the old legacy systems are renewed and replaced with the current services.

Current online bank can be used by visually impaired customers, but it is not designed for that. The case company did have a text version of the current online bank that was supporting screen readers. Technology outdated and maintaining two separate versions was not sufficient. Based on those arguments, the text version has been decommissioned.

Blind and visually impaired customers can use the current online bank apart of its weaknesses. Daily banking services include; accounts, payments and contacting the case company can be done using a screen reader. The interviewees reported that these mostly used services were accessible and possible to use after few times.

The case company has focused for mobile banking. Blind and visually impaired customers and accessibility have been one of the focus areas when developing new mobile bank. Customer journey from authentication and using mobile app have been designed and developed together with blind and visually impaired customers.

New online bank is available already for corporate customers and the study uses that as a baseline. Change from the current household online bank to the new one means service design, design thinking as well as possible retrofitting. Retrofitting means that the current code is either changed or improved the way that it is accessible as well.

The key word for retrofitting is to prioritise. In order to define a prioritised retrofitting plan, current accessibility barriers need to be identified. That was done by interviewing visually impaired users (described below).

4.1.1 Authentication in the Case Organisation

The case company provides permanent user ID to customers. In addition to this, the customer can choose strong authentication method between three different possibilities; the code application installed in a smart phone or tablet, code calculator, speaking code calculator and code card which usage will end due to Payment Services Directive 2 (PSD2) that is EU directive.

Code app is an application installed on smart device such as a smart phone or tablet and can be used both personal and corporate customer identification and authentication. Code calculator is an identification method for the customer who are unable to use the code app on mobile device. Code calculator is a separate credit card size device to be used in authentication.

For the visually impaired customers, the case company has introduced speaking code calculator. Speaking code calculator has larger keys than the original code calculator and user can attach headphones to the calculator if the user wants to hear the codes listed through it.

4.1.2 Disposal Account Service

The case company provides disposal account service in all digital channels. Disposal account service is a basic banking service that must be provided to customers for daily

banking. Disposal account service enables the customer to receive an incoming payment as well as an outgoing payment.

Using the disposal account is easy: log into Mobile or Netbank, call our Customer Service and identify yourself with your access codes or visit one of our branches (source: the company website).

Service design and web development need to have a focus on the visually impaired customers. This means that account is easily found and can be used by support of screen reader. For the visually impaired customer, the first thing after logging in, is to navigate to accounts. In the accounts view, the customer has an overview of account activities. It is possible to list the account activities or use the search function to find specific account activity.

4.1.3 Payment service

Payment service is used for payments and money transfers between own accounts. Payment service suits customers who want to use the self-service option to pay bills.

After logging in, the customer needs to navigate to the payments view. Payment include mandatory fields. These need to be clearly stated also for visually impaired customers. If any of the mandatory fields are empty, the information needs to be provided to the screen reader and navigating to an empty place must be easy.

4.1.4 Messaging Service

The case company provides several contact possibilities for customers. Customer can go to a branch office to get assistance. The contact centre call service is open 24/7/365. Chat start with bot which can direct to human assistance if not able to reply satisfactory. Customer has possibilities to book meeting and join the meeting online.

One of the traditional contact points is secure messaging. Although it is the slowest channel, customers have this option. Finding messaging and contacting bank options need to be found easily.

4.2 Findings of CSA Related to Customer Needs

Customer needs for online banking were investigated by interviewing selected customers. A group contained five persons. Three of the five interviewees were blind and two had visual impairment. Interviewees use technology in a wide content: one interviewee did not use technology at all, one used with assistant, while three used the current solutions.

Based on the interview results, the most used way to access banking services were using either mobile application or online bank. Need to use banking services varied between daily bases to monthly bases. Technical skills and understanding also varied between the interviewees. Users were using various available devices and browsers where all combination gave either as good or poor user experience.

Based on the results from the interviews, mobile application was seen as better for accessibility support. Especially the code apps enabling strong authentication were experienced as a great improvement compared to the paper list for authentication. The case company provides also a talking device for authentication but that was not taken into use. Mobile application was experienced much more mature for voice over aka screen reader functionalities compared to the online bank.

Based on the interview results, none of the interviewees has experience using virtual assistant like Siri in iOS. It was seen as an interesting possibility for banking services in the future when artificial intelligence enables more sophisticated and trustful solutions.

Importantly, all of the interviewees were stating that overall online banking experience has challenges with contrast that is relevant for people with visual impairment. Another mostly brought up obstacle was challenges with navigation and search. Challenge comes

from two reasons; one is that web pages contain a lot of information while the search is not working as expected with screen reader.

The interviews also revealed that the most commonly used banking services were daily banking like payment and account information. With more complex issues related to loans and investments, the interviewees trusted the contact centre services by phone or visiting a branch office. However, one argument was uncertainty with digital services that do not support these services enough as the other aspect was to trust human advice more than technology.

As a result, the contact centre services were seen as a good service. Three of the interviewees were not aware that mobile application contains a pre-authenticated call which means that after logging in application and choosing call service, there is no need to type user ID and password again. If calling directly to the contact centre, authentication was seen challenging as time to insert user id password were not seen long enough.

Also, all of the interviewees felt that using digital banking services were secure. This applied to other services used online as well. Examples were given from Kela and tax authorities. Table 4 below summarizes of customer needs per each service (based on these interviews).

	Customer needs	Satisfied, fully/partly	Not satisfied currently
Service 1	Disposal Account Service <ul style="list-style-type: none"> - Is easily found using search and / or navigation - Can be used by support of screen reader - Transaction history is easy to navigate and search - Receipt of account transaction can be printed 	X	

	<ul style="list-style-type: none"> - Account statement is easy to print 		
Service 2	<p>Payment Service</p> <ul style="list-style-type: none"> - Is easily found using search and / or navigation - Mandatory fields are supported of screen reader - Information fields need to be in logical order - Validation of fields are clearly informed - Successful payment or error is informed 	X	
Service 3	<p>Messaging Service</p> <ul style="list-style-type: none"> - Is easily found using search and / or navigation - Can be used by support of screen reader - Easy to search message history - Easy to create new message - Successful message sending is informed - Possible to saver draft and delete it afterwards - Delete message and / or message thread 	X	

Table 4. Summary of customer needs per each service (based on the interviews).

4.3 Accessibility Test & Findings from Evaluation of Accessibility in Online Banking Services of the Case Company

Accessibility testing was done for the current corporate beta online bank and provided by a third-party company. Testing session focused on the technical implementation of the service with emphasis on the keyboard and screen reader. Testing was based on WCAG accessibility standards and results were grouped into three categories: critical, serious and minor. Overall accessibility level was poor where 17 issues were identified as critical. This prevents some users from accessing content or using some of the functionalities.

Tested services had several components that were exposed as unlabelled for screen readers as some had unclear or generic labelling. Components did not correspond with its semantic purposes meaning that elements that are as buttons, call to action, are described as link and other way around. Outcome of the accessibility test showed that web designers and developers need *more guidance* what the differences are compared when the user sees or not see anything on the screen.

Evaluation target was to find out templates, style sheets and elements that impact many pages. Those pages should be the ones that are mainly needed for daily banking but also corner cases if any. Evaluation was done according to Thatcher et al. (2006) who proposes to have higher priority in following pages: log in page that is the entry point to the Netbank as well as homepage after log in. Daily banking includes accounts, payments, cards, loans and self-service contact channels. Following Thatcher et al. (2006), it was needed to understand and analyse navigation, path to get to daily banking services from the common entry points and the path to complete transactions such as payment.

WCAG checkpoint was used to identify accessibility barriers by priority to determine the impact of a particular accessibility barrier. Thatcher's approach to retrofitting is to fix all Priority 1 barriers first and the lower priority barriers later. This though may have disadvantages such as going back over templates, style sheets and pages.

The results of accessibility evaluation are discussed below.

4.3.1 Disposal Account Service: Results of Accessibility evaluation for visually impaired

Checkpoints by WCAG are Disposal Account Service:

Priority	Explanation	Evaluation of online banking service 1 in the case company
Priority 1	<p>A Web content developer must satisfy this checkpoint.</p> <p>All functionalities in the service must be operable with keyboard.</p> <p>All UI elements must have proper attributes describing their name, role and value or state.</p>	<ul style="list-style-type: none"> Account balance is inaccessible so that user using screen reader cannot access information about the balance of and individual account. The associated UI element is unlabelled and activating with keyboard does not appear to perform any function.
Priority 2	<p>A Web content developer should satisfy this checkpoint.</p> <p>All data tables need to be marked up in the HTML with regular table tags.</p> <p>Satisfying this checkpoint will remove significant barriers to accessing Web documents.</p>	<ul style="list-style-type: none"> Account view page has a table with data about the account. The content of the table is available for screen reader users, but as the table does not appear to be HTML table, it is very difficult to understand the structure of the information without visual interface.
Priority 3	<p>A Web content developer may address this checkpoint.</p> <p>Satisfying this checkpoint will improve access to Web documents.</p>	<ul style="list-style-type: none"> No priority 3 issues found in test.

Table 5. Evaluation of web content accessibility of online banking service 1 in the case company.

Account view gives the customer information about the balance of accounts. This information is needed also when making payments. Screen reader users cannot access information about the balance of an individual account. The reason is that associated user interface (UI) element is unlabelled and activating it with keyboard does not perform any function.

General observations for account services were that: the browser focus (priority 2) is at a random place in the page, the page titles are generic (priority 3) and the heading structure is incomplete (priority 3).

All information in the service is not available for the screen reader users. The content is presented visually on the page, but it is not exposed to screen readers. All static content in the page templates appeared to be mostly accessible, but all dynamically created content is not available for screen readers. Root cause for this behaviour was not determined during the testing. The information is not exposed to screen readers as regular text that could be announced to user, instead screen reader interprets the element as unlabelled button.

Data table for the screen reader users were found difficult. The page has a table with data about the content; name, balance etc. The content of the table is available for the screen reader users, but the table does not appear as proper HTML table and the structure of the table is difficult to understand without visual interface.

4.3.2 Payment Service: Results of Accessibility evaluation for visually impaired

Checkpoints by WCAG are for payment service:

Priority	Explanation	Evaluation of online banking service 2 in the case company

Priority 1	A Web content developer must satisfy this checkpoint.	<ul style="list-style-type: none"> • If the payment form has an error, the message about this disappears by itself after a while. This means that people with reading disorder or with low vision are not always able to receive the information about the error.
Priority 2	A Web content developer should satisfy this checkpoint. Satisfying this checkpoint will remove significant barriers to accessing Web documents.	<ul style="list-style-type: none"> • No priority 2 issues found in test.
Priority 3	A Web content developer may address this checkpoint. Satisfying this checkpoint will improve access to Web documents.	<ul style="list-style-type: none"> • No priority 3 issues found in test.

Table 6. Evaluation of web content accessibility of online banking service 3 in the case company.

General observations for payment services were that the browser focus (priority 2) is at a random place in the page, the page titles are generic (priority 3) and the heading structure is incomplete (priority 3).

All information in the service is not available for screen reader users. The content is presented visually on the page, but it is not exposed to screen readers. All static content in the page templates appeared to be mostly accessible, but all dynamically created content is not available for screen readers. Root cause for this behaviour was not determined during the testing. The information is not exposed to screen readers as regular

text that could be announced to user, instead screen reader interprets the element as unlabelled button.

If the payment form has an error, the message about this disappears by itself after a while. This means that people with reading disorder or with low vision are not always able to receive the information about the error.

Evaluation found no priority 2 or 3 issues in payment view addition to general ones.

4.3.3 Messaging Service: Results of Accessibility evaluation for visually impaired

Checkpoints by WCAG are for messaging service:

Priority	Explanation	Evaluation of online banking service 3 in the case company
Priority 1	A Web content developer must satisfy this checkpoint.	<ul style="list-style-type: none"> Select topic element in the messages view is not accessible for keyboard and screen reader users. When writing a message, the state of the delete draft element is announced by the screen reader as unavailable. When activating the element, the current message is deleted without warning.
Priority 2	A Web content developer should satisfy this checkpoint. Satisfying this checkpoint will remove significant barriers to accessing Web documents.	<ul style="list-style-type: none"> Sending message is not confirmed. After sending a message, screen reader user receives no confirmation about if the message was sent successfully. The browser focus remains on the send

		button. Without visual interface it appears as if the message is not sent.
Priority 3	A Web content developer may address this checkpoint. Satisfying this checkpoint will improve access to Web documents.	<ul style="list-style-type: none"> • Message status is unclear meaning that message list does not provide information about the status of the sent message; is it sent or draft.

Table 7. Evaluation of web content accessibility of online banking service 4 in the case company.

Messaging service is one channel for the customer to contact bank. Messaging service is seen as secure email where customer is authenticated and identified.

General observations for messaging services were that the browser focus (priority 2) is at a random place in the page, the page titles are generic (priority 3) and the heading structure is incomplete (priority 3).

All information in the service is not available for the screen reader users. The content is presented visually on the page, but it is not exposed to screen readers. All static content in the page templates appeared to be mostly accessible, but all dynamically created content is not available for screen readers. Root cause for this behaviour was not determined during the testing. The information is not exposed to screen readers as regular text that could be announced to user, instead the screen reader interprets the element as unlabelled button.

To start conversation with the bank, the customers need to choose one of the topics. Topic can be for example loans, accounts or investment related. Selecting topic is not accessible for the keyboard and the screen reader users. The user can read old messages but not start a new one without using the mouse.

Customer can write a message and save it as draft to be sent later or deleted. When writing a message, the state of the delete draft element is announced by the screen reader as unavailable. When activating the element, the current message is deleted without warning.

Customer need to know if the message is sent or if there is an error when sending it. After sending a message, the screen reader user does not receive any confirmation if the message was sent successfully or not. The browser focus remains on the send button and without visual interface it appears as if the message was not sent.

Summing up, CSA for existing corporate netbank was done based on the WCAG checklists. Based on this evaluation and user interviews, plan for retrofitting can be created and prioritised during the development work.

As advised by Thatcher et al. (2006), a more effective approach to handle the results in most cases is to do all of the high impact and easy repairs while working on a page, template and style sheet. Addressing harder problems later has several advantages; usually shorter turnaround towards accessibility.

Next three chapters provides founded issues categorised by criticality. Each chapter also gives an insight how these can be repaired in retrofitting.

4.4 Critical Issues

The most common issue was that not all information in the service is available for screen reader users. This means that even though the content is presented visually on the page, it is not exposed to the screen readers. In some cases, the content is announced by the screen reader as unlabelled zero button.

There was also some inconsistency in test pages and the results. All static content in these specific page templates appeared to be mostly accessible, but all dynamically created content was not available to screen readers. This means that it is not possible to determine what is the root cause for this problem during the testing. In some cases, the information

is not exposed to screen readers as regular text that could be announced to the user. Instead exposing the information as regular text, the screen reader interprets the element as an unlabelled button.

There are some user interface (UI) elements in the service that lack proper markup for screen reader users. One example of this is that the navigation menus that are exposed to screen readers as regular text. Without information about the role of each element, visually impaired users need to guess the purpose of each element based on its textual context which is not always possible and is always cognitively demanding.

For all user interface components that may include the form elements, links and components generated by scripts, the name and role can be programmatically determined. States, properties and values that can be set by the user, can be programmatically set; and notification of changes to these items is available to user agents that are also including assistive technologies.

The current implementation of the menus does not comply with one of the new success criteria in the Web Content Accessibility Guidelines (WCAG) 2.1 accessibility standard.

When using a mouse, the focused menu item has visual indication. When navigating with keyboard, the focus is not indicated. This means that persons who view pages visually but operate it with a keyboard have no way of knowing which menu item is currently focused and therefore user is not able to make selection in the menu. According to the WCAG, any keyboard operable user interface needs to have a mode of operation where the keyboard focus indicator is visible. This is done by making sure that there is visual focus indicator in all interactive UI elements when use is navigating on the page with keyboard.

One generally mentioned issue in interviews came up also in accessibility test. This was related to search functionality. It was requested to be one of the working elements of any of the webpage. Result in accessibility test was that it is not possible to properly use the search function with a keyboard. This is as the button is not exposed to screen reader or it is described in a way that is not recognizable. It can also be that the location in the focus

order of the page is not correct- After typing the keyword, it is not possible to move the keyboard focus from the search field. This means that keyboard users are not able to access the search results presented on the page below on the screen view.

Screen reader users cannot access information in several pageviews. In these cases, the associated UI element is unlabelled, and activating it with keyboard does not appear to perform any function. It is mandatory that all functionalities in the service are operable with keyboard. This can be easily tested by anyone by attempting to use the service without a mouse. Several pages were also lacking proper attributes describing their name, role and value/state.

Lacking keyboard focus makes it impossible to continue using the service with a keyboard or assistive technology that is based on the keyboard interface. This is a problem described in the WCAG standard as “No keyboard trap” and it is regarded a critical problem that deems the whole service inaccessible. Same problem occurs when selecting any of the similar tab elements. According to WCAG if keyboard focus can be moved to a component of the page using a keyboard interface, then focus can be moved away from that component using only a keyboard interface, and, if it requires more than unmodified arrow or tab keys or other standard exit methods, the user is advised of the method for moving focus away (WCAG).

Challenges were also seen in navigating between different views or even in the same page. This means that all interactive functionalities should always be implemented with HTML native components if possible. This would ensure wide compatibility with assistive technologies. It also requires less manual work for ensuring the accessibility of the service.

Error messaging was also mentioned in the interviews. This was also raised up in the accessibility test. Problem with the error messages is that those disappear after a while. This means that people with reading disorders or with low vision are not always able to receive the information about the error.

4.5 Major Issues

There was inconsistency with the headings of several pages. The use of headings did not comply with the WCAG standard. Most of the cases the level 1 heading `<h1>` was followed by `<h3>` instead of `<h2>`. Screen reader users who have no visual interface of the content base their understanding solely on the information that assistive technology receives from code. If headings are marked up wrongly, visually impaired persons may think that some of the content on the page is not available for screen readers. Heading structure need to be logical and it need to follow the hierarchy so that each heading level is followed by another same level heading or one level below that.

Some of the elements in drop down menus are also marked up as a regular button. This makes it difficult for screen reader users to understand its purpose and its functionality. All UI elements must be marked up in the code according to their semantic role. When using native code language components, no additional markup is needed. When using custom components, it typically requires adding necessary attributes with different extensions. The state of the expanded or collapsed menu need to be conveyed to assistive technologies with the ARIA-expanded attribute.

The information regarding different accounts is presented visually as a table. This way it is very difficult or impossible for screen reader users to access it. All the essential information needs to be available in text form to enable its availability for people who cannot see the visual presentation. When information is available as text, users can, for example, copy and paste relevant details to use elsewhere if needed. Visual and graphic presentations are useful for many user groups generally, but they should not be the only way to receive information.

There are drop-down menus that have items with checkboxes inside them in different views. This is an unconventional way of providing users ways to select items or adjust them if needed. Especially people who have cognitive impairments find it difficult to understand how the user interface works if it does not follow typical conventions of the web.

It is possible to select one option from a drop-down menu, but having checkboxes associated with the items, it becomes unclear what the purpose of the menu is and how it should be operated. Without a visual interface, it can be very difficult to understand menu items that have checkbox properties even if the elements were marked up properly for screen readers.

Table 8 below summarizes the unserved customer needs identified from the interviews and web accessibility testing and prioritized according to the checkpoints of WCAG.

Priority	Checkpoints for the web content accessibility guidelines	Identified problems & related customer needs in the evaluated services
Priority 1	<p>A Web content developer must satisfy this checkpoint.</p> <p>Otherwise, one or more groups will find it impossible to access information in the document.</p> <p>Satisfying this checkpoint is a basic requirement for some groups to be able to use Web documents. (WCAG 2.1 2018)</p>	<ol style="list-style-type: none"> 1. Account balance is inaccessible so that user using screen reader cannot access information about the balance of and individual account. The associated UI element is unlabelled and activating with keyboard does not appear to perform any function. 2. If the payment form has an error, the message about this disappears by itself after a while. This means that people with reading disorder or with low vision are not always able to receive the information about the error. 3. Selecting topic element in the messages view is not accessible for keyboard and screen reader users. 4. When writing a message, the state of the delete draft element is announced by the screen reader as unavailable. When activating the element, the current message is deleted without warning. <p>Above mentioned findings are related to following customer needs:</p> <ul style="list-style-type: none"> • All non-text elements are provided text equivalent. • All information conveyed with colour is also available without colour. • Changes in natural language are clearly identified (e.g. captions). • Documents can be read without style sheets. • Equivalents for dynamic content are updated when dynamic content changes. • Until user agents allow users to control flickering, causing the screen to flicker is avoided.
Priority 2	<p>A Web content developer should satisfy this checkpoint.</p> <p>Otherwise, one or more groups will find it difficult to</p>	<ol style="list-style-type: none"> 1. When new pages and/or views are loaded in a browser, the location of the screen reader focus is at random place in the page and or view. Focus need to be consistently in the first element of the page in the top left corner of the content for users who have no visual understanding of the user interface. If the focus is somewhere else in the page, screen reader users may believe that it is the top of the content and some important information may go unnoticed.

	<p>access information in the document. Satisfying this checkpoint will remove significant barriers to accessing Web documents. WCAG 2.1 2018)</p>	<p>2. Account view page has a table with data about the account. The content of the table is available for screen reader users, but as the table does not appear to be HTML table, it is very difficult to understand the structure of the information without visual interface.</p> <p>3. Sending message is not confirmed. After sending a message, screen reader user receives no confirmation about if the message was sent successfully. The browser focus remains on the send button. Without visual interface it appears as if the message is not sent.</p> <p>Above mentioned findings are related to following customer needs:</p> <ul style="list-style-type: none"> • Foreground and background colour combinations provides sufficient contrast • Dynamic content needs to be accessible • Refreshing page is done by user • Clearly identified targets of the links • Metadata is provided to add semantic information to pages and sites • Information about the general layout of a site is provided • Navigation mechanism is used in a consistent manner • Tables need to make sense when linearized • Purpose of the frames and relations to other frames are described • Label for form controls are properly positioned.
Priority 3	<p>A Web content developer may address this checkpoint. Otherwise, one or more groups will find it somewhat difficult to access information in the document.</p>	<p>1. Pages and/or views have the same title element. This makes difficult for screen reader users to understand the changes in the content. When a new view and or page is loaded in the browser, the title of the page and or view is the same as the heading of the main content. If the content is created dynamically and no physical page is loaded, the title can be changed programmatically.</p> <p>2. Message status is unclear meaning that message list does not provide information about the status of the sent message; is it sent or draft.</p> <p>Above mentioned findings are related to following customer needs:</p>

	<p>Satisfying this checkpoint will improve access to Web documents. (WCAG 2.1 2018)</p>	<ul style="list-style-type: none"> • Logical tab order is created • Keyboard shortcuts to important links are created • Navigation bars are provided to highlight and give access to navigation mechanism • Distinguishing information is placed at the beginning of headings, paragraphs, lists, etc. • Document collection information is provided • Summaries for tables are provided
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Table 8. Evaluation table with customer needs.

5 Proposal for a Development Plan for Improving Accessibility of Online Banking Services of the Case Company

This section presents the proposal of a development plan to improve accessibility of the case company online banking services.

5.1 Overview of the Proposal Building

Based on the literature review and findings from the current state analysis, the interview was conducted involving lead expert to create a development plan how to improve the accessibility.

Issues identified in the current state analyses gives the baseline for the development work. Based on the interviews about the user needs and accessibility test results, a refactoring code is needed before the online bank can be implemented for a wider audience.

Almost as many major issues were found and fixing these issues need to be planned as well while creating the retrofitting plan.

For the retrofitting work, the proposal helps to understand challenges as well as the support competence needed for the improvement work.

5.2 Development Plan for Improving Accessibility

The proposal follows the proposed accessibility suggestions identified in the theoretical part and puts high priority for fixing especially the critical issues. Critical issues are related to daily banking and usability issues such as account and card information, navigation and search. Issues are related to the screen reader and/or the keyboard usage mean that without solving the issues, users experience with the screen reader and the keyboard usage can be bad or impossible.

The proposal follows the evaluation checkpoints by WCAG, and the customer needs identified for each service.

Customer journey starts with authentication. This service is not discussed here as it has not been part of the interviews and testing.

5.2.1 Development Plan for Improving Accessibility for Disposal Account Service

The proposal for improving accessibility for service 2 follows the evaluation checkpoints by WCAG and proposes the improvements in relation to the identified unserved customer needs identified for the disposal account service.

One of the key customer needs is to find which element has the keyboard focus. This requires that search and navigation options are in place for keyboard users and supported by screen reader. Keyboard needs to be used for search fields.

Users also need to access their search results. Without a visual interface, it is important to indicate what happens after entering the keyword for search. Screen reader needs to indicate what is happening after pressing the Enter key. Dynamically created search results below the search field are not accessible for visually impaired users. Therefore, it is necessary:

- Recode the Search field so that the keyboard focus is moved away from the search field.
- Add a Distinct heading above the search results indicating the purpose of the content.
- Change the Title element to 'Search results' after user presses Enter to reflect the change in the content of the page.

Disposal account service priority 1 is to have the account balance accessible. This means that the screen reader user must access the balance of individual account.

- All functionalities in the service need to be operable with keyboard.
- All UI elements need to have propose attributes describing their name, role and value / state.

The first thing is to test operability and check that all functionalities can be accesses using only the keyboard or keyboard interface. All controls that can be manipulated using mouse should also be accessible using keyboard. The improvement proposal is thus:

- Assign keyboard shortcuts that help to reduce the number of keystrokes required.
- Label associated UI elements.

Disposal account service priority 2 is to make data table accessible for the screen reader users and clarify the structure for visually impaired customer. The improvement proposal is thus:

- Test dynamically created content for screen reader usage.
- Mark up all data tables in HTML with regular table tags.
- Pay attention especially to column headers.

Priority	Checkpoints for the web content accessibility guidelines	Identified problems & related customer needs in the evaluated service 2	Proposed improvements
Priority 1	<p>A Web content developer must satisfy this checkpoint.</p> <p>Otherwise, one or more groups will find it impossible to access information in the document.</p> <p>Satisfying this checkpoint is a basic requirement for some groups to be able to use Web documents.</p> <p>(WCAG 2.1 2018)</p>	<ul style="list-style-type: none"> • All functionalities are not operable with keyboard. • Account balance is inaccessible so that user using screen reader cannot access information about the balance of and individual account. • The associated UI element is unlabelled and activating with keyboard does not appear to perform any function. 	<ul style="list-style-type: none"> • Make sure all functionalities in the service are operable with keyboard. Testing can be done by using the service without the mouse. • Assign keyboard shortcuts that help to reduce the number of keystrokes required. • Label associated UI elements.

<p>Priority 2</p>	<p>A Web content developer should satisfy this checkpoint.</p> <p>Otherwise, one or more groups will find it difficult to access information in the document. Satisfying this checkpoint will remove significant barriers to accessing Web documents. WCAG 2.1 2018)</p>	<ul style="list-style-type: none"> • All columns are not available for screen reader. • Account view page has a table with data about the account. The content of the table is available for screen reader users, but as the table does not appear to be HTML table, it is very difficult to understand the structure of the information without visual interface. 	<ul style="list-style-type: none"> • Mark up all tables and column heads with the <th> tag. This allows screen readers to announce the name of each column in association with the value of each cell. This provides context of the cell without which understanding of the meaning of the value is very difficult only by listening to the screen reader. • Test dynamically created content for screen reader usage. Pay attention especially to column headers.
<p>Priority 3</p>	<p>A Web content developer may address this checkpoint.</p>	<p>No priority 3 issues.</p>	

	<p>Otherwise, one or more groups will find it somewhat difficult to access information in the document.</p> <p>Satisfying this checkpoint will improve access to Web documents.</p> <p>(WCAG 2.1 2018)</p>		
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Table 9. Improvements to the web content accessibility of online banking service 2 in the case company.

5.2.2 Development Plan for Improving Accessibility for Payment Service

The proposal for improving accessibility for service 3 follows the evaluation checkpoints by WCAG and proposes the improvements in relation to the identified unserved customer needs identified for the payment service.

One of the key customer needs is to find which element has the keyboard focus. This requires that the search and navigation options are in place for the keyboard users and supported by the screen reader. Keyboard needs to be used for the search fields. User also needs to access their search results. Without a visual interface, it is important to indicate what happens after entering the keyword for search. Screen reader needs to indicate what is happening after pressing the Enter key. Dynamically created search results below the search field are not accessible for visually impaired users. Therefore, the following improvements are needed:

- Search field needs to be recoded so that the keyboard focus is moved away from the search field.
- Distinct heading above the search results indicating the purpose of the content needs to be added.
- Title element needs to be changed to 'Search results' after the user presses Enter to reflect the change in the content of the page.

Payment service priority 1 is to have the error message information available as long as it is needed and until the customer discards it.

Improvement proposal is to keep the error messages and other vital pieces of information available to the user until they choose to discard it.

Priority	Checkpoints for the web content accessibility guidelines	Identified problems & related customer needs in the evaluated service 3	Proposed improvements
Priority 1	<p>A Web content developer must satisfy this checkpoint.</p> <p>Otherwise, one or more groups will find it impossible to access information in the document. Satisfying this checkpoint is a basic requirement for some groups to be able to use Web documents. (WCAG 2.1 2018)</p>	<ul style="list-style-type: none"> • If the payment form has an error, the message about this disappears by itself after a while. This means that people with reading disorder or with low vision are not always able to receive the information about the error. • Information occurrence time is too short. 	<ul style="list-style-type: none"> • All interactive functionalities must always be implemented with HTML native components. This ensures wide compatibility with assistive technologies and requires less manual work for ensuring the accessibility of the service. Visual appearance of native elements can be designed with for example CSS. • Do not limit the time for information occurrence.

<p>Priority 2</p>	<p>A Web content developer should satisfy this checkpoint.</p> <p>Otherwise, one or more groups will find it difficult to access information in the document.</p> <p>Satisfying this checkpoint will remove significant barriers to accessing Web documents. WCAG 2.1 2018)</p>	<p>No priority 2 improvements for Payment Services.</p>	
<p>Priority 3</p>	<p>A Web content developer may address this checkpoint.</p> <p>Otherwise, one or more groups will find it somewhat difficult to access information in the document.</p>	<p>No priority 3 improvements for Payment Services.</p>	

	Satisfying this checkpoint will improve access to Web documents. (WCAG 2.1 2018)		
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Table 10. Improvements to the web content accessibility of online banking service 3 in the case company.

5.2.3 Development Plan for Improving Accessibility for Messaging Service

The proposal for improving accessibility for service 4 follows the evaluation checkpoints by WCAG and proposes the improvements in relation to the identified unserved customer needs identified for the messaging service.

One of the key customer needs is to find which element has the keyboard focus. This requires that the search and navigation options are in place for the keyboard users and supported by the screen reader. Keyboard needs to be used for the search fields. User also needs to access their search results. Without a visual interface, it is important to indicate what happens after entering the keyword for search. Screen reader needs to indicate what is happening after pressing the Enter key. Dynamically created search results below the search field are not accessible for visually impaired users. Therefore, the following improvements are needed:

- Search field needs to be recoded so that the keyboard focus is moved away from the search field.
- Distinct heading above the search results indicating the purpose of the content needs to be added.
- Title element needs to be changed to 'Search results' after user presses Enter to reflect the change in the content of the page.

Priority 1 issues in messages view include the inaccessible topic selection and the false state delete draft command. Topic selection is implemented as a drop-down list. Ideally, the list is short and in alphabetical order for the screen reader to read it and the user to remember different topics. Message is automatically saved as a draft. Call to action button Delete the draft needs to have information for the screen reader what it is about.

The improvement proposal is to shorten the topic list to better fit the screen reader user needs. It is also recommended to list the available topics in the alphabetical order. Also, a text for all call to action buttons is needed to support the screen reader users need.

Priority 2 issue in the message view is that sending the message is not confirmed. Screen reader receives no confirmation about if the message is sent successfully or not. Also, the browser focus remains on the Send button.

The improvement proposal is to inform the visually impaired user if the message is sent successfully and move the browser focus from Send button after a successfully sent message. Browser focus can be moved for example in the Messages main section.

Priority 3 issue in the message service view is that the message list does not provide clear information if message is sent or is it draft. The improvement proposal is to make a clear status indicator that is supported for screen readers.

Priority	Checkpoints for the web content accessibility guidelines	Identified problems & related customer needs in the evaluated service 4	Proposed improvements
Priority 1	<p>A Web content developer must satisfy this checkpoint.</p> <p>Otherwise, one or more groups will find it impossible to access information in the document. Satisfying this checkpoint is a basic requirement for some groups to be able to use Web documents. (WCAG 2.1 2018)</p>	<ul style="list-style-type: none"> • Selecting topic element in the messages view is not accessible for keyboard and screen reader users. • When writing a message, the state of the delete draft element is announced by the screen reader as unavailable. When activating the element, the current message is deleted without warning. • Screen reader support it not in place. 	<ul style="list-style-type: none"> • Change topic element to be accessible for keyboard and screen reader. • Create text equivalent for deleting the message of delete draft. Screen reader user need to be informed which is happening. • Create support for screen reader

<p>Priority 2</p>	<p>A Web content developer should satisfy this checkpoint.</p> <p>Otherwise, one or more groups will find it difficult to access information in the document. Satisfying this checkpoint will remove significant barriers to accessing Web documents. (WCAG 2.1 2018)</p>	<ul style="list-style-type: none"> • Sending message is not confirmed. After sending a message, screen reader user receives no confirmation about if the message was sent successfully. The browser focus remains on the send button. Without visual interface it appears as if the message is not sent. • Message status is not informed to user. 	<ul style="list-style-type: none"> • After successfully sending the message, move the browser focus away from the Send button. Preferably there should be a text providing this information and the focus is placed on this text after the sending. Regular text can be made focusable with the <code>tabindex="-1"</code> attribute. • Inform user for message status and call to action button outcome
<p>Priority 3</p>	<p>A Web content developer may address this checkpoint.</p>	<ul style="list-style-type: none"> • Message status is unclear meaning that message list does not provide information about the status of the sent message; is it sent or draft. 	<ul style="list-style-type: none"> • Provide information about the message status if it is sent or draft. Create text equivalent for keyboard and screen reader users.

	<p>Otherwise, one or more groups will find it somewhat difficult to access information in the document.</p> <p>Satisfying this checkpoint will improve access to Web documents.</p> <p>(WCAG 2.1 2018)</p>		
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Table 11. Improvements to the web content accessibility of online banking service 4 in the case company.

5.2.4 Summary of the Proposed Development Plan

While retrofitting, it is necessary to make sure that *all user interface elements* are focusable and have proper descriptive attributes for screen readers.

Without a visual interface, it is not clear what happens after entering the keyword for search. When the user is using the screen reader, it seems like nothing happens even after pressing the Enter key. Visually impaired users cannot see the dynamically created search results below the search field. Solution for retrofitting it, is that all functionalities of the content is *operable through a keyboard interface* without requiring specific timings for individual keystrokes. Only exception is when the underlying function requires input that depends on the path of the user's movement and not just the endpoints.

Also, it is vital to retrofit and *change the code* to make sure that the keyboard focus can be moved away from the search field. Adding *a distinct heading* above the search results indicating the purpose of the content below, is beneficial for the user using screen reader.

Form elements can be repaired by adding the certain attribute to the code for the elements opening the menus. The state of the menu also needs to be conveyed with the *ARIA-expanded attribute*. Using the navigation drop-down menus with a mouse requires good motor abilities, as the menus can collapse automatically as soon as the mouse pointer leaves the menu area. Instead, once the menu is expanded, it needs to *remain open* until the user clicks on one of the menu items or somewhere else on the page.

Keyboard focus is repaired by making sure that that the browser focus is set to an element on the page that is logical to screen reader and keyboard users. Preferably the focus should be on the same tab element in this case.

All UI elements need to be focusable and have proper descriptive attributes. It is recommended to use text links, rather than small visual symbols, to make their purpose easier to understand. Size of the symbols should be bigger.

When new pages/views are loaded in the browser, *the location of the screen reader focus* is at a random place in the page. For people who have no visual understanding of the user interface, it is important that the focus is consistently in the first element of the page in the top left corner of the content. If the focus is somewhere else such as in the middle of the page, screen reader users may believe that it is the top of the content and some essential information may go unnoticed. It is vital that the browser focus is at the start of the page when new views are loaded.

Online bank contains several views that includes *call to action (CTA)*. This is a button or similar to sighted person to click. Several CTA's gives no confirmation about if the message was sent successfully for screen reader user. As an example, sending message was mentioned. The browser focus remains on the Send button but without a visual interface, it appears as if the message was not sent.

After successfully sending the message, the browser focus is *moved away from the Send button*. Preferably there should be a text providing this information and the focus is placed on this text after the sending.

Best practice is to provide *alternative ways* to perceive the same information. When the essential data is available as text, graphic elements that have the same content can be hidden from the screen reader users. This makes browsing the content simpler for the screen reader users and helps them concentrate on the content in text form.

Table 12 below shows the summary of the development plan for improving web accessibility of the online ranking of the case company.

Priority	Checkpoints for the web content accessibility guidelines	Identified problems in the online banking of the case company	Improvement proposals
Priority 1	<p>A Web content developer must satisfy this checkpoint.</p> <p>Otherwise, one or more groups will find it impossible to access information in the document.</p> <p>Satisfying this checkpoint is a basic requirement for some groups to be able to use Web documents. (WCAG 2.1 2018)</p>	<ul style="list-style-type: none"> • Account balance is inaccessible so that user using screen reader cannot access information about the balance of an individual account. The associated UI element is unlabelled and activating with keyboard does not appear to perform any function. • If the payment form has an error, the message about this disappears by itself after a while. This means that people with reading disorder or with low vision are not always able to receive the information about the error. • Selecting topic element in the messages view is not accessible for keyboard and screen reader users. • When writing a message, the state of the delete draft element is announced by the screen reader as unavailable. When activating the element, the current message is deleted without warning. 	<ul style="list-style-type: none"> • Make sure all functionalities in the service are operable with keyboard. Testing can be done by using the service without the mouse. • Assign keyboard shortcuts that help to reduce the number of keystrokes required. • Label associated UI elements. • All interactive functionalities must always be implemented with HTML native components. This ensures wide compatibility with assistive technologies and requires less manual work for ensuring the accessibility of the service. Visual appearance of

		<p>Above mentioned findings are related to following customer needs:</p> <ul style="list-style-type: none"> • All non-text elements are provided text equivalent. • All information conveyed with colour is also available without colour. • Changes in natural language are clearly identified (e.g. captions). • Documents can be read without style sheets. • Equivalents for dynamic content are updated when dynamic content changes. • Until user agents allow users to control flickering, causing the screen to flicker is avoided. 	<p>native elements can be designed with for example CSS.</p> <ul style="list-style-type: none"> • Do not limit the time for information occurrence. • Change topic element to be accessible for keyboard and screen reader. • Create text equivalent for deleting the message of delete draft. Screen reader user need to be informed which is happening. • Create support for screen reader
Priority 2	<p>A Web content developer should satisfy this checkpoint.</p> <p>Otherwise, one or more groups will find it difficult to</p>	<ul style="list-style-type: none"> • When new pages and/or views are loaded in a browser, the location of the screen reader focus is at random place in the page and or view. Focus need to be consistently in the first element of the page in the top left corner of the content for users who have no visual understanding of the user interface. If the focus is somewhere else in the page, screen reader users 	<ul style="list-style-type: none"> • Mark up all tables and column heads with the <th> tag. This allows screen readers to announce the name of each column in association with the value of each cell. This provides context of the cell without which understanding

	<p>access information in the document.</p> <p>Satisfying this checkpoint will remove significant barriers to accessing Web documents.</p> <p>WCAG 2.1 2018)</p>	<p>may believe that it is the top of the content and some important information may go unnoticed.</p> <ul style="list-style-type: none"> • Account view page has a table with data about the account. The content of the table is available for screen reader users, but as the table does not appear to be HTML table, it is very difficult to understand the structure of the information without visual interface. • Sending message is not confirmed. After sending a message, screen reader user receives no confirmation about if the message was sent successfully. The browser focus remains on the send button. Without visual interface it appears as if the message is not sent. <p>Above mentioned findings are related to following customer needs:</p> <ul style="list-style-type: none"> • Foreground and background colour combinations provides sufficient contrast • Dynamic content needs to be accessible • Refreshing page is done by user • Clearly identified targets of the links 	<p>of the meaning of the value is very difficult only by listening to the screen reader.</p> <ul style="list-style-type: none"> • Test dynamically created content for screen reader usage. • Pay attention especially to column headers. • After successfully sending the message, move the browser focus away from the Send button. Preferably there should be a text providing this information and the focus is placed on this text after the sending. Regular text can be made focusable with the <code>tabindex="-1"</code> attribute. • Inform user for message status and call to action button outcome
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		<ul style="list-style-type: none"> • Metadata is provided to add semantic information to pages and sites • Information about the general layout of a site is provided • Navigation mechanism is used in a consistent manner • Tables need to make sense when linearized • Purpose of the frames and relations to other frames are described • Label for form controls are properly positioned. 	
Priority 3	<p>A Web content developer may address this checkpoint.</p> <p>Otherwise, one or more groups will find it somewhat difficult to access information in the document.</p>	<ul style="list-style-type: none"> • Pages and/or views have the same title element. This makes difficult for screen reader users to understand the changes in the content. When a new view and or page is loaded in the browser, the title of the page and or view is the same as the heading of the main content. If the content is created dynamically and no physical page is loaded, the title can be changed programmatically. 	<ul style="list-style-type: none"> • Provide information about the message status if it is sent or draft. Create text equivalent for keyboard and screen reader users.

	<p>Satisfying this checkpoint will improve access to Web documents. (WCAG 2.1 2018)</p>	<ul style="list-style-type: none"> • Message status is unclear meaning that message list does not provide information about the status of the sent message; is it sent or draft. <p>Above mentioned findings are related to following customer needs:</p> <ul style="list-style-type: none"> • Logical tab order is created • Keyboard shortcuts to important links are created • Navigation bars are provided to highlight and give access to navigation mechanism • Distinguishing information is placed at the beginning of headings, paragraphs, lists, etc. • Document collection information is provided • Summaries for tables are provided 	
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Table 12. Development plan for improving web accessibility of the online ranking of the case company.

6 Validation of the Proposal

This section describes the results of validation of the proposed improvements to the company's online banking for visually impaired users. First, this section describes the key steps in validation. Second, it summarizes the findings from Data 3, validation. Thirdly, at the end of this section, the final proposal and recommendations are presented.

6.1 Overview of the Validation Stage

In this study, validation refers to the feedback from a key stakeholder and evaluation of the proposal (Data 3).

The current state analysis and proposal building in this study used qualitative research methods for data collection. The interviews focused on customer needs of the visually impaired users; other methods included accessibility testing, analysis of customer feedbacks, and a discussion session with the lead expert in the case company. The sequence was, first, the accessibility testing for the visually impaired users using the beta online bank. Second, the interviews with the visually impaired users how they experience digital accessibility of the banking services. Third, customer feedback was analyzed. Based on these findings, the stakeholder input was collected, and final validation and proposal was carried out.

Issues identified in the current state analyses gave the baseline for the development work. Based on the interviews about the user needs and accessibility test results, a improvements were needed before the online bank can be implemented for a wider audience. The interviews were conducted involving web designers and developers to create a development plan how to improve the accessibility. Almost as many major issues were found and fixing these issues need to be planned as well while creating the retrofitting plan.

In the validation stage, the validation discussion was done when conducting an expert interview, with a lead designer. All the issues identified in the current state analysis and then proposed were discussed. The results are summarized below.

6.2 Findings from Validation

Third data collection was collected from the expert interview that guided the final proposal. Data 3 consists of stakeholder feedback to the initial improvement proposals.

Table 13 below shows the improvement proposals and expert comments. Table is divided into general, priority one, two and three comments.

Table 13. Expert suggestions (findings of Data 3) to the Initial proposal.

	Customer needs (technical testing)	Improvement proposal.	Expert Comment
General		Recode Search field, so that the keyboard focus is moved away from the search field.	If the user enters the search string, then hits ENTER, the results should be shown in a static state that allows the user to move up and down on the results list. There should be a CTA for Clearing results.
		Add Distinct heading above the search results indicating the purpose of the content.	This should be done, yes.
		Change Title element to 'Search results' after user presses Enter to reflect the	Yes, I believe this is the only way to show that the content shown is the result

		change in the content of the page.	of a search. There should also be a CTA for Clearing results.
Priority 1	- Access account balance	- Assign keyboard shortcuts that help to reduce the number of keystrokes required. - Label associated UI elements.	Keyboard shortcuts make life easier for users of screen readers, but I would not treat them as primary compared to data accessibility. I would reverse this order. All UI elements need to be labelled with alt texts/aria tags, so that to support screen readers.
	- Selecting topic need to be accessible for keyboard and screen reader users.	- Create support for screen reader	A clear yes.
Priority 2	- Data table is accessible	- Test dynamically created content for screen reader usage. - Mark up all data tables in HTML with regular table tags. - Pay attention especially to column headers.	Dynamically created content needs to be accessible, yes. On the use of tables: the old netbank uses them extensively. The fundamental problem with tables is that they are inherently visual ways of organising information. There simply is no great way of doing, for example,

			an accessible date picker using a table. In some cases, column headers could be coded into the alt texts, so that the column header would be read together with the data in the table cell.
	- Sending message is not confirmed.	- Inform user for message status and call to action button outcome	A clear yes.
Priority 3	- Message status is unclear	- Inform user for message status and call to action button outcome	Yes, the status should be accessible with a screen reader.

Table shows that the findings from accessibility tests, customer need interviews and improvement proposals were found relevant and valid by the lead expert in case company. There were also comments and some further suggestions proposed. They are incorporated below into the developments to the initial proposal presented earlier in Section 5.

6.3 Developments to the Initial Proposal Based on Validation

Based on the analysis results and the validation, there is a need to focus retrofitting and fine-tuning the web service before launching it for a wider public. This would give most of the customers equality and more convenience when using the banking services in the web based online bank. These recommendations were made based on the validation suggestions to add to the Proposal presented in Section 5.

6.3.1 Developments for General Issues

General comments need to be scanned through all separate pages and views that is used in the online bank. This can be done by testing separate views with screen readers. One of the key features is that the keyboard focus is always in the right place apart from which service, page or view is at issue. This is especially valid in the search field.

Search word can appear in multiple pages and views. Adding distinct heading above the search results for indicating the purpose of the content should be definitely done. To make search feature even more convenient, changing the title element to the search result after the user presses Enter is needed to reflect the change in the content of the page. Lead expert from the case company also stated that CTA (“call to action” feature) should be in place for clearing the results.

6.3.2 Developments for Priority 1 Issues

It is proposed to assign keyboard shortcuts that help to reduce the number of keystrokes required and label associated UI elements. Although improvements in the Proposal, Section 5 were not in any specific order, the lead expert in the case company would reverse the proposed order in priorities when accessing the account balance. Reversing is rationalised so that the keyboard shortcuts can make life easier for users of screen readers, but it is not as primary as data accessibility where all UI elements need to be labelled with alt text or aria tags, so that to support screen readers. This gives the input for retrofitting order as well.

Next priority one issue is in the message service. It is clearly stated by the lead expert of the case company, that selecting topic needs to be accessible for the keyboard and support for the screen reader needs to be supported.

6.3.3 Developments for Priorities 2 and 3

It is necessary to make the data table accessible by testing dynamically created content for screen reader usage, mark up all data tables in HTML with regular table tags and to pay special attention to column headers. Lead expert of the case company agrees that dynamically created content need to be accessible. Fundamental problems with tables is

that they are, inherently, visual ways of organizing information. and there simply is no better way of doing, for example, an accessible date picker using a table.

Second priority 2 improvement is necessary since sending a message is not confirmed. Informing the user about a message status and call-to-action outcome is a must-do according to the lead expert in case company. Thus, latest improvement is meeting the customer need in priority 3 issue. A customer need is to inform if the message status is draft, sent or deleted. The status should be accessible with a screen reader.

7 Conclusions

This section summarizes the key findings of this study and suggest further steps for the case company.

7.1 Executive Summary

The study explores accessibility of banking services; how accessibility is implemented and how it could be improved. Purpose of the thesis was to investigate the needs for accessibility of the visually impaired customers, which was done based on the interviews and accessibility test to find out what is already done in the beta version of the online banking services in the case company and what need to be developed further.

The purpose of the study was to find out how visually impaired people experience the case company's banking services. Scope of this study was to explore the user experience based on the needs and challenges that visually impaired customers are experiencing in the banking services in the case company, and what are the requirements that need to be taken into consideration. Both interviews with users for their required needs for online banking as well as the result of the accessibility test, showed that retrofitting is needed before the online banking services can be implemented for wider markets. It was also clear that planning and designing accessible web services before such implementation is the safest way to do any kind of web development.

Business challenge for the study was to meet accessibility requirements in online banking service for the visually impaired customers. For directing customers anytime, anywhere, online banking, usability and accessibility issues need to be fixed.

Research approach used in this study was the case study that relied on qualitative research methods. The current state analysis (CSA) was based on the interviews regarding the needs, expectations and challenges for banking services as well as the results of a usability test done with beta version of the current online banking services. The proposal was validated, and the final proposal was amended based on the feedback from the key stakeholder, the lead expert in the case company.

Based on the results from current state analysis, number of weaknesses were identified regarding search, navigation and lack of screen reader support. The most popular ways to access banking services were either by using a mobile application or an online bank. All the interviewees were stating that, overall, the online banking experience has challenges for people with visual impairment. Another mostly brought up obstacle was the challenges with navigation and search. These challenges come from two reasons; one is that web pages contain a lot of information, while the search is not working as expected with the screen reader. It was found that the online bank beta version contains multiple views and generic issues were found in relation to the browser focus, generic page titles, and heading structure that is not complete. None of the generic issues were critical. Purpose of the browser focus is that the user who has no visual understanding of the user interface, browses his focus consistently on the first element of the page in the top left corner of the content. However, a generic page title makes it difficult to the user to navigate and understand which view is currently open. Incomplete heading structure means that visually impaired persons may think that some of the content is not available for screen readers.

Based on the literature review and findings from the current state analysis, the interview was conducted involving the lead expert to further improve the development plan how to improve the accessibility.

Issues identified in the current state analyses and suggested in the proposal gave the basis for the development work. Based on the interviews about the user needs and accessibility test results, a refactoring code is needed before the online bank can be implemented for a wider audience. Almost as many major issues were found and fixing these issues need to be planned while creating the retrofitting plan. Utilising best practices from WCAG guidelines, current state analysis and stakeholder suggestions, the study proposed to add improvement issues to the current development work backlog and suggested to focus on the accessibility issues while developing of the online bank continues.

In the validation stage, the unserved customer needs were reviewed. Improvement proposals were also discussed that were created based on WCAG guidelines. The lead

expert from the case company reviewed the outcome and gave relevant inputs and insight that were used for the final version of the proposal.

As a result of this thesis, retrofitting identified problems and by matching those with customer needs, gave improvement suggestions to the case company that can increase its competitive advantage in the private sector online banking.

7.2 Managerial Implications

The case company has focused on launching a new mobile application and has successfully achieved this goal. After that, the next focus is the web development of the online banking services provide with this application and with the web-pages. As this study found, a few areas need special attention form the company:

Before implementing the online bank for a wider use, the current ongoing project needs to include accessibility issues into the plan. The company works and develops in agile set up which allows more flexible possibilities to include the refactoring development in the plan.

Logical next step for the company is to include improvement proposals in the development backlog. The development plan proposed in this thesis shows the priority order that follows best practice WCAG guidelines. As a leading financial institution in its market area, implementation and focus on the accessibility issues will create a significant competitive advantage among this group of users for the company.

Best possible outcome and implementation for accessibility issues is to implement it across the whole value chain in service design. The core group of developers should contain the people with visual impairment, expert UX and web designers with passion to accessibility issues, as well as technical skills within developer team. As mentioned in thesis, a better accessible web page will better serve also users without disabilities.

7.3 Closing Words

Writing the thesis has been a long journey. It is also unfortunate to see that expectations or attitudes for accessible web development did not receive enough focus as it requires when I started this work. Fortunately, this has changed during the years and accessibility issues in digitalisation has been seen as a strong competitive advantage for the company, instead of legally mandatory work to be done.

This thesis shows the importance of accessible web design. Users with disabilities are a minority, but the web page that works for them, works for all. By looking and reviewing the existing design and code, by making improvements that increase customer satisfaction, it is possible to get a more accessible and equal digital world.

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Appendix 1.

Interview structure

1. Background information
2. Expectations for application
 - a. What kind of applications are usually used?
 - b. Think some of the good application you use: what is good in it? What is not that good in it?
3. Expectations for banking services
 - a. Which banking services you used mostly?
 - b. Any other need related to banking?
 - c. Which needs are primary?
 - d. When did you used banking services last time? Describe situation: what was good and not that good in it?
 - e. What is your technical readiness level? Are you heavy user or against? What kind of digital services do you use?
 - f. How do you experience your banking relationship? Do you prefer personal service or self-service?
 - g. Which channels you prefer when contacting bank?
 - h. How do you describe good or ideal banking relationship?
4. How often you use banking services a) online (web) and / or b) mobile?
5. What is the purpose using banking services? (work, personal, other)
6. What kind of devices are in use; desktop, laptop, smart phone, tablet
7. Primary contact: on phone (call), in branch, personal video call
8. Do you prefer web or mobile or does it matter? (Online vs mobile bank)
9. How easy is to use online bank and / or mobile bank?
10. Has there been need for assistance either or with online / mobile bank and if yes, what kind of?
11. Have you encountered challenges with banking services; if yes, what kind of?
12. How secure you feel using online and / or mobile bank?
13. Do you save your user profile to ease log in?
14. Has there been problems with passwords and if yes, what kind of?

15. Browser / application native tools (e.g. font size) functionalities
16. Has there been challenges in any banking service? (E.g. has payment ever failed and if yes, why?)
17. Bar code reader and user experience

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