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Developing a Process for Accessibility Testing

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The purpose of this study was to explore accessibility testing and develop a process for accessibility testing. This study is relevant because accessibility is important today in producing digital content, and there are only few case studies available about the results of developing accessibility testing. The thesis started by analyzing the work done by the accessibility testing team in the City of Helsinki between 03/2020 – 12/2020.

This study used Action research methodology and applied qualitative research methods. The data used in this study was gathered from internal documents, data, and interviews conducted between 03/2020 – 12/2020. The practical goal of the study was to further develop the tools which can be beneficial in accessibility testing. The theoretical framework of the study focused on the newly introduced legislation around accessibility, existing accessibility guides and instructions and guidelines to improve accessibility.

As a result of this study, there were indicated effective ways to do accessibility testing which were presented as a process model for accessibility testing. The study also demonstrated from the analysis of existing practices that doing accessibility testing manually takes a lot of time and should be co-operated with the designers (content or application) in order to get best results out of it. The study proved that manual accessibility cannot be replaced totally by automatic monitoring yet. The automatic monitoring tool can only be as good as it is coded. Thus, it was proven by practice that accessibility testing should be done by integrating manual testing AND automatic monitoring.

From the author's point of view, this study had some significance, because purpose of this study is relevant and because of the digitalization. Services are going rapidly into electric form and accessibility is important part of digital service development. If accessibility is taken care properly in service development, services become generally usable for anyone.

Keywords	Accessibility testing, WCAG, visually impaired, blind, the City of Helsinki

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1 Introduction

Nowadays services are going rapidly into digital form. United Nations has predicted that if accessibility is not taken care of properly there is a chance that a significant amount of the world´s population are in danger to become digitally outcast. Figure 1 shows incidence of disability by age in US, UK and Canada. Paragraph was posted at 06/2018 and then updated at 02/2021 [Powermapper – Disability statistics (2021)]
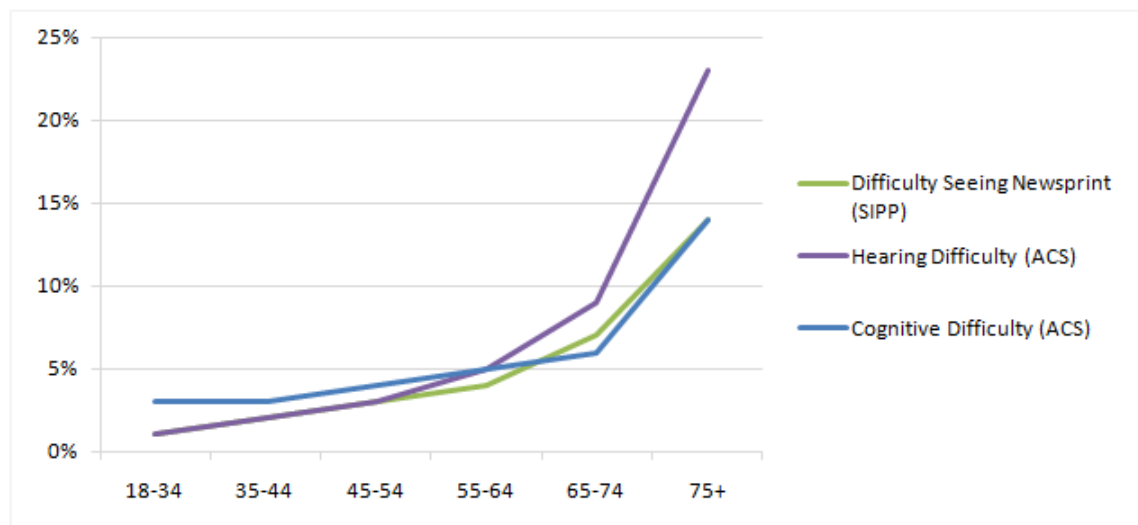
Figure 1.   Incidence of disability by age in US, UK and Canada. [Powermapper - Disability statistics 2021]

European Union published a directive (EU 2016/2102) in 2016 about accessibility of the web-sides and mobile applications of public sector bodies [EU-Directive (2012). Ehdotus-Julkisen sektorin elinten verkkosivujen saavutettavuudesta] Directive says that "The trend towards a digital society provides users with new ways of accessing information and services. The providers of information and services, such as public sector bodies, rely increasingly on the internet in order to produce, collect and provide a wide range of information and services online which are essential to the public. In the context of this Directive, accessibility should be understood as principles and techniques to be observed when designing, constructing, maintaining, and updating websites and mobile applications in order to make them more accessible to users, in particular persons with disabilities".

The Finnish government declared a law for digital services. The law was put into operation on 1st April 2019. The law stated that public digital services must match the accessibility requirements. This law also executed the European union´s directive EU 2016/2102. [EU-Directive (2012). Ehdotus-Julkisen sektorin elinten verkkosivujen saavutettavuudesta]

Although it may sound scary, accessibility is not really a complicated thing. It provides users with accessible, usable services and thus ensures good levels of reach and equality to all users. Presently, accessibility is declared by law for digital services. Therefore, a process model how accessibility testing could be done is needed, making it really helpful and a necessary tool in designing new web-sides and mobile applications.

Accessibility is based on wcag (web content accessibility guidelines) criterion. Web content accessibility guidelines define 3 levels how to match accessibility requirements. Levels are A, AA and AAA. These guidelines cover a set of recommendations with which web contents accessibility can be improved. Organizations are often trying to reach A or AA level in accessibility.

Accessibility has also been labelled under design for all trademark (Dfa). Dfa reckons people's diversity, social participation and equality in designing digital services. Dfa´s main goal is not to offer one big solution, it is a user centered design principle which automatically take into account people s abilities, skills and requirements. Due to the current situation in the world, remote work is coming a more common way to do work. It should also take into account the service planning towards Dfa designing.

1.1   Case Company

The case company in this thesis is the City of Helsinki. Helsinki is the capital of Finland, with the population of over 630 000 citizens. Helsinki wants to use digitalization in a clever way. Digital services are easy to use, one can get easily help in using them and there has to be an alternative for traditional services. [City of Helsinki (2019).Digitalization program's site.]

In order to reach as many people as possible, the digital services offered by the city must be accessible. Constant growth of citizens in Helsinki puts enormous pressure to citizen

services. Employees are expensive, so digital services are the best way to offer city services to citizens, in time that suits best for them. Good example of this is Helsinki's main page (www.hel.fi) which is accessible so that any citizen is able to get the necessary information about Helsinki and its services.

1.2   Business Challenge

Although currently the City of Helsinki produces and offers a wide variety of digital services, accessibility is not completely understood as a part of digital service and web media production. Accessibility is understood more like a project and not as part of digital service and web media production and maintenance.

The law on the digital services was put into action 1.4.2019. The law defined a one and half year transition period within which the web service owner should ensure that their web service provides web service accessibility to its users, and state it in the accessibility statement. Due date to this action was 23.9.2020. The City of Helsinki had several hundred web services in internet which were without such an accessibility statement.

Over this period, the City of Helsinki has noticed and is working had to address the accessibility issue. Helsinki's goal is to produce AA – level accessibility in its digital services. [City of Helsinki (2020). Helsinki's intranet accessibility pages]

It is a massive project to update Helsinki's digital services to match the digital service requirements of the law of the digital services. There was lot of work to do and there was not that much time to do the necessary work.

1.3   Objective and Scope of the Thesis

The Objective of this thesis is *to create a process how to do accessibility testing.* The City of Helsinki wants to be the best city in the world in utilizing digitalization. Helsinki has its own digitalization program and the City of Helsinki's developing pipe is producing new services very rapidly.

The Outcome of this thesis is a written accessibility testing process. This thesis is conducted via creating the process for accessibility testing and interpreting testing results.

From this thesis, the reader can also get basic knowledge about accessibility and basic knowledge how accessibility should be measured.

For the City of Helsinki, this project started earlier. To form a testing process, testing and testing data were needed. In order to gather the testing data, there were also testers needed. The City of Helsinki formed a testing team in 03/2020 to do accessibility testing. Between 03/2020 – 12/2020, the City of Helsinki's team did over 50 accessibility tests. However, this job was not fully finished at that time. So, this Thesis finalizes the job started earlier by the accessibility testing team by documenting and completing the accessibility testing process.

1.4 Key Terms

The following key terms are used in this thesis that are explained by the researcher in the following way:

Accessibility: Accessibility is a new way to produce services. An accessible web site is designed for all and it can be used by anyone.

Web site: Digital textual content, files, forms and other information content which is on the web site and is identifiable by domain.

Mobile application: Mobile application is an applications software designed and developed for public use with mobile devices such as smartphones or tablets.

Digital service: Digital service means website or mobile application and its related functionalities.

Pair model: Pair model is necessary method to accessibility testing. Testing has to be done in multidimensional way. If testing is done in comprehensive way testing requires a pair of testers. A blind member who does the testing via screen writer and a visible member which does the visible observation. The visible member often writes the testing report.

Testing report: This is a document that comes as a result of testing and points to shortages in accessibility. Shortages are categorized from crucial, significant and other accessibility matters**.**

Ndva: It stands for non-visual desktop access that is a screen reader program. Nvda is used by people who has impaired vision or completely blind. Testing with screen reader will expose a lot of accessibility faults.

Accessibility testing: Operation to make your web side, digital service and/or mobile application usable to as many people as possible

Accessibility statement: Key requirement of the law for digital services. Public web service have accessibility statement included which tells to the service user the state of service accessibility. This was also the main goal in accessibility testing is to produce it.

Wcag criterion: Wcag criteria state the rules which can used to measure accessibility and to expose shortages. Wcag criterion is made from 4 principles which all consists of 13 rules altogether. Four accessibility principles are 1) perceivable 2) operable 3) Understandable and 4) Robust. Wcag criterion is constantly updated to match the newest accessibility demands

Wcag term Perceivable: All content and parts of the interface are detectable by technologies used by the users

Wcag term Operable: Navigation of the user interface and content must be easily used by different technologies and the features of the user interface mustnot interfere of prevent use

Wcag term Understandable: Content must be structured well, language must be understandable and functionality must be easy to handle

Wcag term robust: The site must be available to different end devices, different operating systems, assistive technologies and to all common browsers.

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EU Directive: Directive is a legislation guide for EU member states. Directive doesn't change the legislation of the member state but is gives instructions to the national legislator

2 Method and Material

This section describes the research approach, research design, and data collection and analysis methods used in this Thesis.

2.1 Research Approach

This sub-section introduces the research approach and research design for this thesis. In this study, the research approach is applied research. Applied research is designed to answer specific questions aimed to solve a practical problem. This thesis was done using Action research methodology that was specified into the gate model, as shown in Figure 2 below.
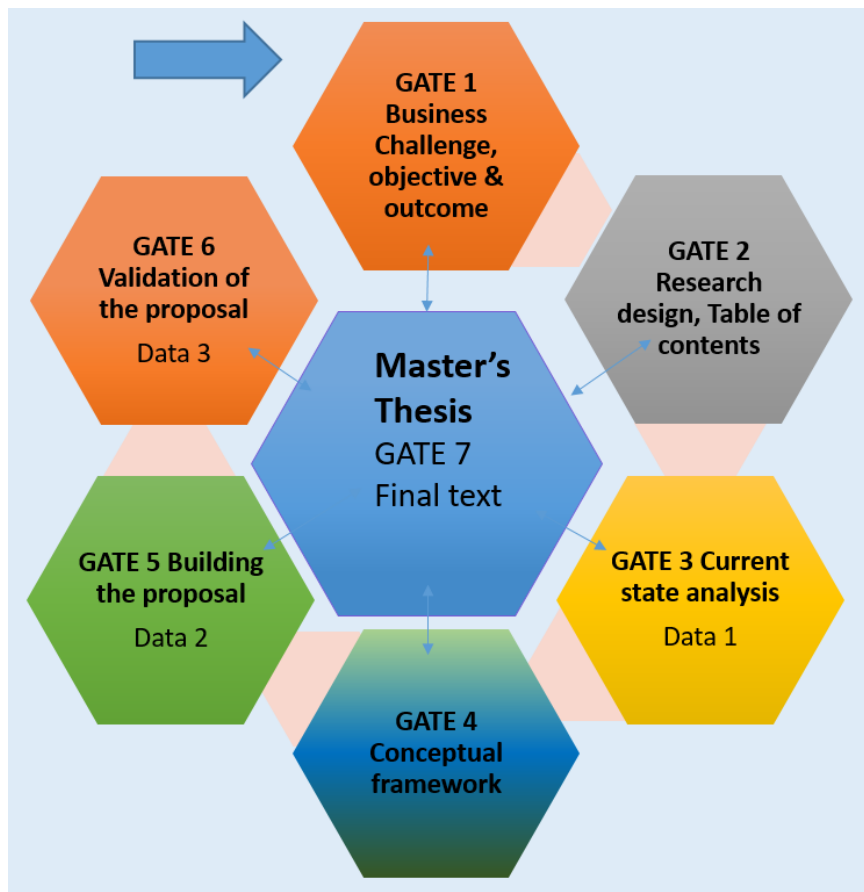
Figure 2.   The Gate Model approached used in this Thesis.

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As shown in Figure 2, the gate model consists from seven parts. Gate 1 focuses on defining the business problem, thesis objective and thesis outcome. Gate 2 is about creating the research design and sketching the preliminary table of contents. Gate 3 is about doing research to specify and narrow down the business problem and refine the objective. In this thesis, Gate 3 concentrated on exploring literature and best practice firs, before analyzing the current state of the business problem in the organization. Gate 4 identified in the current state analysis. Gate 5 reported on building the proposed solution to this business problem which is the objective of this thesis. Gate 6 contained validation of this proposed solution, and Gate 7 is about finalizing the thesis via discussing conclusions and self-reflect and self-evaluation.

2.2   Research Design

This sub-section contains a diagram showing the research design of this thesis. Figure 3 below shows the research design of this study.

Figure 3.   Research design of this thesis.

As shown in Figure 3, this study was conducted in five steps. The study starts from exploring the existing knowledge. Then, comes the current state analysis. Based on combining the previous two, a proposal is formed which is followed with validation of the proposal. This approach was chosen because the accessibility is better realized with this approach.
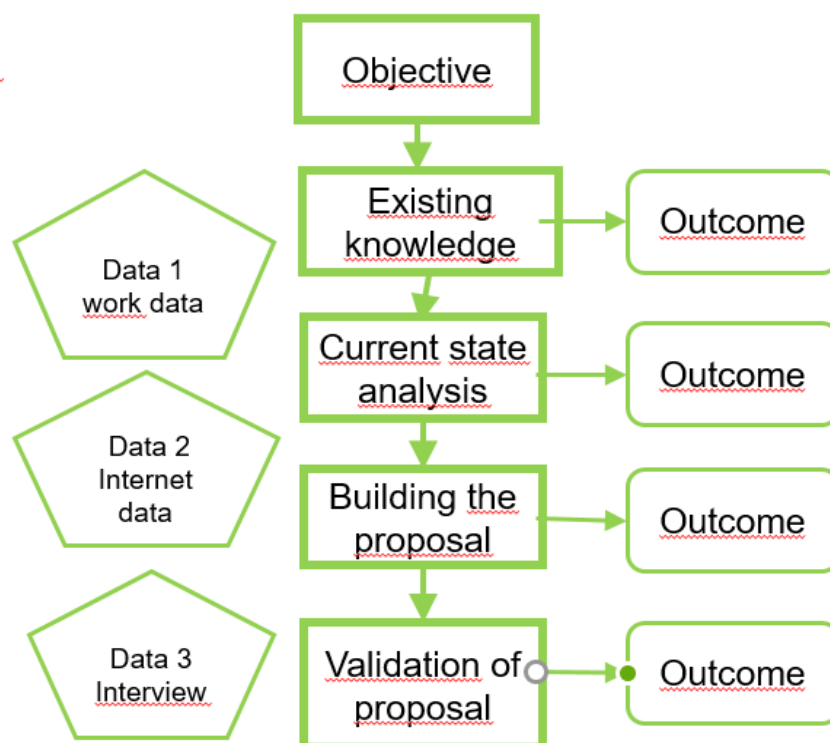
2.3 Data Collection and Analysis

This study draws from a variety of data sources, and the date was collected in several data collection rounds. Table 1 shows details of Data collections 1-3 used in this study.

Table 1.   Details of Data collections 1-3 used in this study.

Used data type / Outcome	Public data	Hands on data	Meeting data	Analytics data
Current state analysis	Existing knowledge	Previous, current and coming test cases	Meeting Memo's with the team, Feedback from Antti	Testing analytics and customer analytics
Building the proposal	Combining Existing knowledge + csa	Small workshop with accessibility expert	feedback from Antti	Analytics update from statistics

As shown in Table 1, the research data was collected from hands-on work data and from interviews in 3 data collection rounds.

In Data collection 1, the business problem was refined by analyzing the current state of accessibility work. This focus was chosen because of the lack of knowledge in understanding accessibility and doing accessibility testing. In Data collection 1, the thesis gathers hands-on data about accessibility shortages from both manual and automatic testing.

In Data collection 2, the thesis gathers hands-on data to overcome the accessibility shortages from both manual and automatic testing and creates a written description of the accessibility testing process model and a process chart.

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In Data collection 3, the thesis gathers hands-on data to validate the proposed accessibility testing process model and a process chart.

From the data plan shown in Table 1, the reader can learn where the thesis data is acquired from and how data types for different outcomes have been formatted. Thus, the central data type in this thesis was the real-life, work-related data.

3 Existing Knowledge and Best Practice on Digital Accessibility

This section on existing knowledge looks into different ways to do accessibility testing. The section start with discussing the legal foundations, then moves to overviewing the most significant current research on accessibility, and finally moves on to analyzing the guides to accessibility.

3.1 Legislation

EU directive is a legislation guide for member states. Directive does not change national legislation. It gives guidance to national legislator. Though is national legislators duty to implement directive content in legislation but every member state can choose way and habit of implementing the directive. Directive proposal about accessibility was made in 3.12.2012. [EU-Directive (2012) Proposal on accessibility of public sector bodies websites]

Purpose of this proposal was bring closer member state laws which concern accessibility of public sector bodies. Article mentioned that, in 2009, in 27 member states, over one million employees worked in web page designing in 175000 companies whose sales revenue was 144 000 000 000 euros. Article presumed the market worth in businesses around web content accessibility in 2012 was 2 000 000 000 000 euro. [EU-Directive (2012) Proposal on accessibility of public sector bodies websites]

Accessibility directive was formulated in 26.10.2016. In Accessibility directive, the purpose is very well explained in 1 article places one and two. "The trend towards a digital society provides users with new ways of accessing information and services. The providers of information and services, such as public sector bodies, rely increasingly on the internet in order to produce, collect and provide a wide range of information and services online which are essential to the public. In the context of this Directive, accessibility should be understood as principles and techniques to be observed when designing, constructing, maintaining, and updating websites and mobile applications in order to make them more accessible to users, in particular persons with disabilities." [EU-Directive (2012) Proposal on accessibility of public sector bodies websites]

With accessibility directive EU officials try to make certain that public sector bodies web sides and mobile applications accessibility is improved with common accessibility requirements. "Convergence of national measures could also enable union public sector bodies and companies to benefit economically and socially from expanding provision of online or mobile services to cover larger amount of citizens and customers. This should increase internal potential websites and products and services related to accessibility of mobile applications." [EU-Directive (2012) Proposal on accessibility of public sector bodies websites]

Law for digital services was formulated 15.3.2019. Law is divided into five chapters. Law's purpose was to promote digital accessibility for more accessible content, better quality, better security and improve everyone capability to be able use digital services equally. With this law will be executed EU directive for accessibility of public sector bodies online services and mobile applications. Law for digital services is divided into five chapters. Act 1 is common rules and law purpose. Act tells key rules and how they are interpreted. Act 2 contains Key definitions in this law including: 1) website. It is defined a storage of web content which is identified by domain. 2) Mobile application. It is defined as a public application software which is used with smartphone or tablet. 3) Digital service means website or mobile application with its related functionalities 4) Accessibility means principles and techniques which are to be followed in designing of digital services. 5) Official means an operator which runs a public assignment such as state official, government official, public utility and municipality 6) Time related media means sound and video or combination of both, which may include interaction. In act three is told Coverage of the law. Coverage what defines officials, persons and things to whom law is suited for. Law is suited for 1) public official digital services 2) Digital services under public law 3) corporation, union, foundation or other commune which gets its annual digital service update or maintenance funds from public body. 4) Digital services under strong identification 5) Digital services of public undertakings 6) Payment institution and credit institution digital services. [Finlex (2019) Laki digitaalisten palveluiden tarjoamisesta]

This law is not suited for 1) work places extra- or intranet which is built before 23.9.2019 2) if web content is produced in early childhood education during teaching and it is available only limited amount of time 3) Public radio practitioner's digital services 4) to online maps and map services if map is targeted into navigation use. If map includes essential knowledge for user. Essential knowledge has to offer in alternative way in digital format

which meets accessibility requirements 5) web content which is produced by a third party and finally 6) Historical collections which cannot meet accessibility requirements.

Law for digital services chapter 2 tells how to arrange public for the public. Act 4 how to design and maintain digital services. Law says that authority must design and maintain its digital services in a way that ensures security, easy to use, discoverability and data protection. Authority must also ensure availability of its digital services to commonly used software and telecommunications connections. Authority must see that digital services under its influence have electronic data transmission methods at use not just opening hours. Service breaks must schedule in time where service use is slight. Service breaks have to be to the public by a release. Authority must inform alternative way to handle issues during service break. Act 5 is how to offer digital services. Authority must offer every user chance to deliver messages and documents concerning running errand using digital service or using digital data transfer services. Authority must also see that user can receive messages or documents in secure way via message service or in secure way via other electric data transfer system if needed. Authority must also inform a release in its services how everyone take run issues with authority in electric. Authority must also publish contact info where everyone can get help in using digital service. Act 6 is about identification into digital service. Authority can demand identification only when necessary for the used service, or because of the digital service data content or because of the disposition rights of the service. [Finlex (2019) Laki digitaalisten palveluiden tarjoamisesta]

Chapter three is about digital service accessibility. Act 7 is about accessibility requirements and fulfilling them "The service producer must ensure the visibility and comprehensibility of the content of its digital services as well as manageability and reliability of the user interfaces and navigation in accordance with accessibility requirements. Accessibility requirements are defined in the references to harmonized standards, or parts, published by the European commission in the official journal of the European Union. Digital service must meet the accessibility requirements if service users can reach into the information content. However if information published in digital service is time related; I must meet accessibility requirements in 14 days after first publication. Act 8 is about unconscionable burden. Service provider can appeal into unconscionable burden if making content accessibility endangers the whole business like it takes too much money compared to sales income to get content accessible. When estimating unconscionable burden has to be noticed the service provider, economical state of the provider, width of

activity and user segment (what kind of persons are using the content). Act 9 is about accessibility statement. Every service provider must maintain accessibility statement. Following information should be found on it: 1) Which part of the content is not accessible and explanation why they aren't. 2) An instruction how user can have content that is not accessible in alternative way 3) Service providers contact info where user can send accessibility feedback. 4) Authority's contact info or link to authority's web page where user can make accessibility complaint if needed or demand clarification about contents web accessibility. Accessibility statement must match accessibility directive article 7 point 2. National supervising authority must keep correct accessibility statement example in its web page available. Service provider must place accessibility statement in its web page into easy locations and keep it accessible. Act 10 is about accessibility feedback. Everyone has right send feedback if accessibility requirement departure is located from visited content or ask clarification when service provider has appealed into unconscionable burden. Service content which isn't accessible, which benefits or includes common knowledge from public body, user has right to demand content in alternative way which meets the accessibility requirements. [Finlex (2019) Laki digitaalisten palveluiden tarjoamisesta]

Chapter 4 is about controlling the accessibility demands and legal protection around it. Act 11 is basically that everyone has right to make a complaint if accessibility requirements are not meet in way that is told in chapter 3. Act 12 is about supervising authority and its duties and its jurisdiction. Its duty is to give guidance and help to meet the demands in chapter 3 and supervise that accessibility requirements are followed in that is decreed in accessibility article. Act 14 is about information and checking right. Supervising authority has right to get confidential info free it it is necessary in case of handling accessibility complaint. Authority can also command a accessibility check in the content if it is necessary. Service needs to give to the authority necessary to do the check. Act 15 is about correction. If supervising authority demands a report about contents accessibility faults; service provider have to appeal it from court.

Chapter 5 is about inception. Act is 16 says: Law for digital service came into force 1.4.2019 Act 17 is about transition periods. Law was very demanding so legislator wanted to give some time to service providers to reach the accessibility demands. First transition period ended in 20.9.2020. Due to that date the old pages should have moved in accessibility requirements. Mobile applications should be accessible in 23.6.2021 which is the next due date. [Finlex (2019) Laki digitaalisten palveluiden tarjoamisesta]

Below, there are a few example contents and functionalities that law for digital services concerns; more detailed list can be found at webpage saavutettavuusvaatimukset.fi:

- writings (news, guides, blog writing)

- pictures , infographics and charts

- videos and podcasts which are embedded or saved to a webpage, application or published in social media

- user interfaces and navigation

- links

- net forms and appointment services

- Chat services which are embedded to a web page

- Files that are produced with office programs (Files and forms (pdf and word).

For example, in text one must take into account clear and logical heading. Language should also be understandable. Pictures and infographics should also give alternative description and videos should also be texted. One should also be able to navigate in webpage by only using keyboard. Pdf and word files must take into account may things such as color contrast, heading and alternative texts in images. [AVI (2020) Digi kuuluu kaikille]

Accessibility demands of the law concern all websites and mobile applications of regulated entities that are available in internet. The site or application may be open to everyone or it requires login. The scope of the service or target group is not relevant from laws point of view.

3.2 Recent Accessibility Research

In the researcher´s opinion, the most interesting researches are currently coming from webaim. "Webaim is an organization which has provided web accessibility solutions since 1999. Weabaim's mission is to expand the potential of the web for people with disabilities by providing the knowledge, technical skills and tools for example to empower organizations to make their own content accessible to people with disabilities." [Webaim (2018). Site for automatic monitoring provider]

3.2.1 Webaim million

1. Webaim analyzes annually 1 000 000 webpages and reports about the accessibility findings about their analyzation publicly. Most significant message about this research is that out of 1 million webpages over 98 percent had accessibility faults. Picture below webaim million project 2020 results. This research is done with webaims standalone – ap tool. Officially, API is a programming interface which is a collection of software functions and procedures through which other software applications can be accessed or executed. In this case It is used a tool which measures accessibility faults from home pages or when installed locally from local web content. "The million home page list was derived from various sources, primarily from majestic millions list". Majestic million is a list of the million most important sites on the web. [Webaim (Annual) projects/million/]

According to Webaim, 98.1 % of the homepages had wcag faults. Percent has risen 0,2% from year 2019. From this research, it has to notice that these wcag failures are detected automatically and because automatically detected wcag failures constitute only a small portion of all possible wcag failures, this means that result is likely to be much lower. [Webaim (2018). Site for automatic monitoring provider]

Webaims research gives the reader a good overview to the current state of web accessibility. This reasearch is logical and accessibility shortages are expressed clearly. This reasearch gives designer a good check list about accessibility. [Webaim (2018). Site for automatic monitoring provider]

According to WebAIM Million Report

98.1% Home Pages With At Least One WCAG 2.0 Failure   **60.9** Average Number of Errors Per Home Page

Causes of Most Common Accessibility Failures (% of Home Pages)

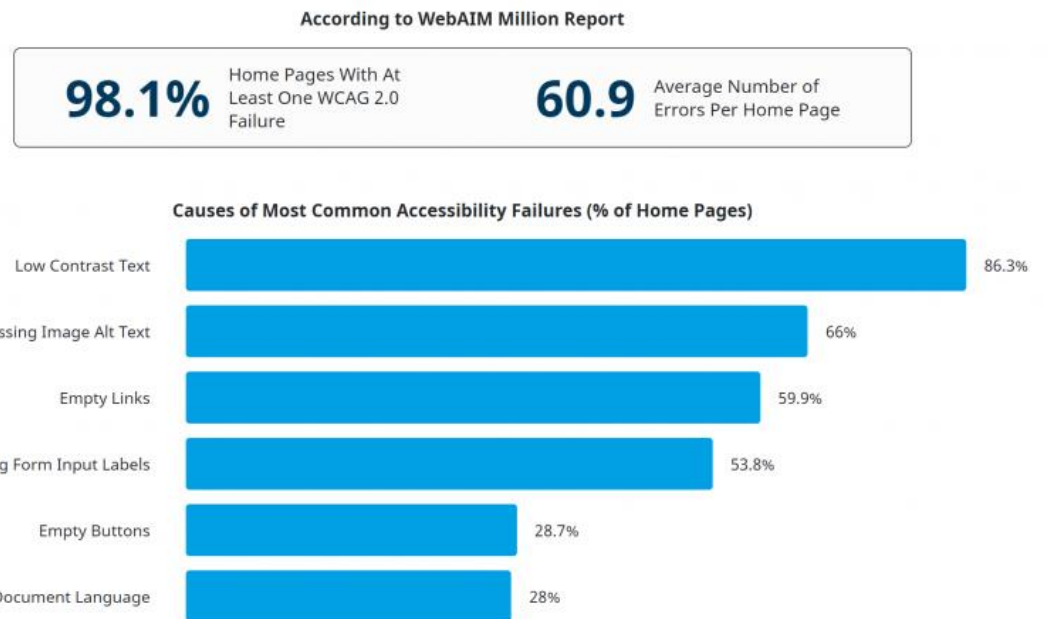|	
Low Contrast Text	86.3%
Missing Image Alt Text	66%
Empty Links	59.9%
Missing Form Input Labels	53.8%
Empty Buttons	28.7%
Missing Document Language	28%

Figure 4.   Results of 2020 webaim analysis of million home pages for accessibility. [Webaim (Annual) projects/million/]

Figure 4 shows accessibility shortages found in the analysis done by webaim of million homepages monitored with their automatic tool. [Webaim (Annual) projects/million/]

After discussing the legal status and recent research on accessibility, this section moves on to analyzing some current examples of accessibility guides.

3.3   Digital Accessibility Guides

Presently, in the researcher´s opinion, accessibility is not yet seen as a part of development. It is seen more like a project that an organization can buy from professionals. Since accessibility is a relatively new thing, there is not that many operators that could do it. Since there are only a few operators that can do this, accessibility testing is also expensively which leads potential customers to do testing by organizations themselves.

Since accessibility is mainly seen as a project rather than a service, there are various accessibility guides correctly available. Many operators offer guides to digital accessibility. Digital accessibility guide gives a picture what accessibility is and how it can be reached. As an example guide, the researcher analyzes the City of Helsinki's guide: "Accessible content – guide to design and content production".

3.3.1   Example guide

The Guide that is analyzed in this section is primarily intended to city of Helsinki's designers whom are doing content production. Primary target of this guide is to give tools to produce accessible content production. Accessible content guide defines accessibility as habit of showing information in a way that everyone can understand it despite the way of presentation. Guide relates accessibility into digital services, web services, web applications and publications.

In this guide's "introduction part", it is also told which demands are settled by the law. In November 2018, the law was published for digital services which defined dates how pub sector web pages and web applications should fulfill accessibility's demands. By the law came 3 important dates: new web pages should have been accessible by 23.9 2019, old web pages should have been accessible by 23.9.2020 and mobile applications should be accessible by 23.6.2021. The law also says that even if this law relates accessibility only to digital services this concept should be expanded into all content providing and publishing. Finally, it is said that digital services that are under this law's influence must have accessibility statement visible in their service or web page. Accessibility statement should inform the following things: what parts do not match accessibility demands and why, alternatives to the parts of the services which are not accessible, if visitor wants to give accessibility feedback how visitor can give it and if visitor is not happy to feedback where visitor can complain. [The City of Helsinki. "Accessible content – guide to design and content production"]

3.3.2   WCAG 2.1 demands

Guide tells that wcag is international guideline which sets demands to law for digital services and tells to reader the 3 target level in matching accessibility. Target levels are A, AA and AAA. Helsinki's target in accessibility is level AA. Wcag guideline defines followings targets to content accessibility site program or application should be: perceivable, operable, understandable and robust.

The target level gives instructions how content can be seen or heard. More detailed instructions are – 1) all pictures and non-textual content should be able to read as text. 2) Pre-recorded videos and recordings should also be offered as text. 3) Pre-recorded videos should be texted. 4) Videos where voice is essential part of content should also be shown in alternative way. 5) Content html elements should be shown logically, and 6)

content order should be logical to understand the original content. 7) All content links, buttons and other active elements should create visually in a way that they are easily noticed and understood. 8) Content meaning must not be based in using colors. 9) Don't put voice files in repeat as content reloads. Voice files over 3 seconds must be able to control by user. 10) Live transmissions voice content must be texted. 11) Text and background contrast ratio must be at least 4.5:1. 11) Content should able to scale up to 200% without breaking page structure or functionality. 12) Do not use pictures to replace written text. [The City of Helsinki. "Accessible content – guide to design and content production"]

Target operable gives instructions how easily content can used with different techniques. 1) Content should be used only with keyboard 2) Content which can be entered with keyboards must also be able to come back to contents main level with keyboard. 3) In time limited functions user must have at least one of following options: stopping the clock, adjusting the length and requesting more time when time ends. 4) User must be able to stop moving and updating content. 5) User must be able to stop or hidden content which flashes, rolls and updates on itself. 6) Content must not flash up to 3 times per second. 7) User should have possibility to skip repeated elements in content and to be able move into desired part of the content. 8) Content must have title which has description. Title must describe content / meaning of content 9) Moving between elements must be logical when using keyboard. 10) Every link in content must have meaning which can be seen in the text / title. 11) Offer alternative ways to found content 12) Use header texts that describe the content and form input fields. 13) Making sure that element that is activated with keyboard is clearly seen. [The City of Helsinki. "Accessible content – guide to design and content production"]

Target understandable gives instructions how content and functionality can be made understandable. 1) Lang attribute must be settled into html root element 2) Element must change the content becoming active 3) When form content changes, Content must not change if it isn't told to the user 4) when fault is detected in automatic feed. Field where fault is must be shown to the user correctly 5) in site content where user is expected to give a feed. Content where feed is needed must be labelled clearly with instructions to the user to give correct feed to content. 6) User must informed when language changes in a web content 7) Navigation must be implemented same way in the whole content 8) elements, links and user activated functions must be unique in the content 9) Errors in form field must be informed with clear error message 10) Give user a chance check

typing errors and to correct them if needed. [The City of Helsinki. "Accessible content – guide to design and content production"]

Target robust gives instructions how web content should work with different terminals and with assistive technologies. Here guide gives two instructions. 1) Use faultless HTML code. Contents HTML – element structure and used attributes should comply with demand specification determined used case. 2) Import user interface elements that are programmatically read attributes for browsers and screen readers. [The City of Helsinki. "Accessible content – guide to design and content production"]

3.3.3   Vision

Next in this guide there is more detailed information about eye sight. First there are instructions about colors. There is example picture how color blind people see colors. Then there is checklist what to remember when using colors content designing:

1) Content meaning should not expressed just by colors 2) Removing color should not affect into content meaning 3) Colors should distinct from each other 4) Colors must not be oversaturated 5) color contrast is enough but not too strong 6) colors don't mislead 7) Colors are basic calm colors. Next guide continues with eyesight from users point of view. First there is explanation about blind users and users with low visibility. Blind or having low visibility users cannot get information properly with their eyesight. In order to get the information previous users need assistive technologies such as screen readers. Screen reader is an application which turns webpage into speech; and it reads the textual content aloud. Screen readers don't see or understand picture files. So pictures, videos should give alternative content which screen reader can read. This is done by giving pictures alt – text which tells to the screen reader user what there is in the picture. Screen reader reads content to the user by giving possibility to follow links or move from title to another. Designer can make it easy to screen reader users by minimizing listened content and enabling easy content founding. Content designer should see that page content is organized, titled and pictures have alternative texts. One can found a checklist for blind users. 1) page information should be available as text 2) pictures should have alternative text 3) Page content should be divided into logical parts 4) Page content should able to read or all information should be in downloadable accessible file 5) HTML structure is used well in page content 6) Link text tells where the link is leading 7) In text there is

used good heading structure 8) All page content should be reachable with using keyboard only. [The City of Helsinki. "Accessible content – guide to design and content production"]

Next in the guide, there is text about low visibility. User with low visibility can use content with own visibility but not in same way than people with good visibility. Several people with low visibility use content enlarging (Zooming), operating system aids or other optical aid. Content producers can influence well that page content is accessible to people with low visibility by adding symbols to the page content, grouping page content into clear parts, using plain language, enabling to enlarge font size and to enable to zooming on page content. [The City of Helsinki. "Accessible content – guide to design and content production"]

At the end of the page, there is again checklist named: check at least these things. 1) Used font size should be clear and easy to read 2) text font should be big enough 3) text and contrast ratio should be clear 4) Page structure should be logical 5) Use HTML elements in right way 6) Make sure that page structure doesn't get broken when zoomed. 7) Color enough cannot make significance in content. [The City of Helsinki. "Accessible content – guide to design and content production"]

3.3.4 Hearing

Next, there is instructions how designer could take attention into hearing fault. Deaf or hearing impaired person should give special attention when designing voice content. When representing prerecorded content; content must available in alternative way. An alternative way could be texting the video, descriptive interpretation or sign language interpretation. When video or other time scheduled media is published in web; published media should be done accessible in 14 day from video is published. [The City of Helsinki. "Accessible content – guide to design and content production"]

At the end of the page, there is again checklist about how to deal people with shortage in hearing aid. 1) Video has text or video has descriptive interpretation. 2) Content is not shown only video file or voice file 3) Content is divided in clear parts 4) Visual way are exploited in showing the content 5) Make sure that user contact multiple ways ; not just in a phone. [The City of Helsinki. "Accessible content – guide to design and content production"]

3.3.5 Physical or motoric restrictions

Next in the guide, there are guidelines how to bring accessibility to the people who have physical or motoric restrictions. Restriction can due to illness, accident or high age for example. Physical restrictions don't prevent users using web contents but users might need assistive tools to do it. Physical and motoric restriction spectrum is wide. In the restrictions there are for example shiver, unintentional moving, shortage to focus in tasks which need sharpness and short body movements. [The City of Helsinki. "Accessible content – guide to design and content production"]

Often the people who has physical or motoric restrictions cannot access content with a mouse or moving the cursor moves with keyboards or aid. The designer should use in designing large and clear elements and enough blank space between elements to separate them and also good element order designing. [The City of Helsinki. "Accessible content – guide to design and content production"]

At the end of the page, there is a checklist named check at least these things: Elements that use can choose are separable and big enough, make sure elements and links are attached too close to each other, all the content must be able access without mouse and do not restrict content functions with timer. [The City of Helsinki (2020) "Accessible content – guide to design and content production"]

3.3.6 Web content designing in short

This accessibility guide gives all the basic information from accessibility and how to take care accessibility in web content designing. Three topics that everyone should read from this guide are: 1) What accessibility is (page 4) 2) what law says about accessibility (page 5) and 3) how accessibility fulfillment is defined (page 6). Researchers point of view page 6 (wcag guidelines) and pages 7-9 (wcag AA- level demands for publication) are also important pages. Pages 4-9 are common knowledge about accessibility guidelines. Pages 10 - 20 give basic knowledge about accessibility. Pages contain specific knowledge about user restrictions (vision, hearing and motoric). [City of Helsinki (2020). Opas saavutettavaan sisältöön]

Figure 5 below shows the Helsinki guide.

Figure 5.   Helsinki's guide: Saavutettava sisältö. (The City of Helsinki. "Accessible content –
            guide to design and content production".)

3.3.7   Helsinki Modell – a more extent guide for accessibility

Helsinki has done also more extent accessibility guide – The Helsinki Modell. It is a direct
and inclusive guide how to design accessible services. Helsinki model guide is bit distant
to this research. Modell defines how accessibility is taken care in everyday work. Modell
also helps to ensure accessibility in whole lifecycle of service production.

Helsinki model is divided into the following modules. Module 1 defines targets to this
service. Helsinki model's goal is to recognize user groups and their needs in digital ser-
vice production. Demands are service specific. Minimum demand for service is that fulfills
wcag criterion for accessibility. Module says that Module 2 is about use cases. Use case
describes user basic service need and what tasks are performed in the service. Digital
web service is created via development process which is based in agile development.
Large scale cases can rely on waterfall model or some quality gates which service must
pass before certain work steps can be competed. Module 3 is about software definition.
In the definition phase it is ensured that the visual and technical structure of the service
work together. Module 4 is about is implementing and software testing. In the working
phase solutions of the service such as user interface and page structure are being im-
plemented and tested. Module 5 is about accessibility use case testing. How can acces-
sibility of the service be assessed and improved through special user groups. Module 6
is about accessibility testing and accessibility statement. In accessibility testing, acces-
sibility of service is being assessed as a whole rather than individual components or

service paths. When testing is done along Helsinki model it products automatically accessibility statement. Module 7 is about maintaining the service and development past publication date. How .to take care accessibility when creating and publishing new content to the web page. What is to be considered when expanding the service. Model 8 is about training. Modell includes training sessions for different parts of the service production life cycle and also training for basic users about common accessibility. Model says that accessibility is not learnt in training, it is learnt by doing. Helsinki also demands that its services need to be done by following the Helsinki model. [City of Helsinki (2020). Opas saavutettavaan sisältöön]

Next, the thesis moves to analyzing the current state of accessibility in the City of Helsinki services and production process.

4 Current State Analysis of Accessibility in the Case Organization

This section discusses the results of the analysis of the current state of accessibility in the City of Helsinki.

4.1 Overview of the Current State Analysis

The current state analysis discusses the current state of accessibility in the case organization and its accessibility testing process. The current state analysis was conducted based on the internal documents such as meeting memos, emails and testing reports, as well as the interviews with the case organization and a few external experts.

The current state analysis was conducted in three steps: first, the internal documents and data were analyzed; secondly, open access data was searched from internet; and third, analytics were constructed out of working data to demonstrate the results.

Thus, the internal documents and interviews made the best data sources for the current state analysis. Among the internal documents, the most significant source were the accessibility testing reports. The internal document analysis was complimented with discussions on accessibility, especially with the internal accessibility consult among other stakeholders who provided essential data to this study.

4.2 Description of the Case Organization and Its Accessibility Practices

The case organization of this thesis, the City of Helsinki, has a goal is to use digitization smarter. Helsinki wants to remove unnecessary bother from its citizens [City of Helsinki (2019). Digitalization program's site]. Helsinki has its own digitalization program, which has its own web page where citizens can follow it (digi.hel.fi). Digitalization is a megatrend. According to this this megatrend everything that could be automated or digitalized are going to happen. Helsinki invests into digitalization because of population growth. Helsinki is growing very rapidly and Helsinki needs to offer citizen to growing amount of citizens. In order to utilize digitization Helsinki has created digital foundation and if it starts working properly basic citizen services are managed by digitalization and Helsinki workers get more time to solve more complicated challenges from citizens of Helsinki. Several people own a smartphone and to several people using internet is a daily routine.

Becoming accessibility demands from accessibility directive were noticed in Helsinki in September 2019. Helsinki had a lot of web content in several pages under different domains which were going to be affected by accessibility directive and then law for digital services. Meetings were under different city officials what city could do about it. There were not a lot interest about accessibility initially. The former boss suggested that the team should form an accessibility testing service. His reasons were the basic reasons. 1) accessibility is important in digital service designing 2) Helsinki has a lot of digital services which were influenced by the law for digital services 3) Branches want to be independent and branches have different needs and there was no guarantees how they were going to take care of this. So internal testing service was needed as an alternative solution.

In autumn 2019, meeting by meeting, the internal service got readier. First, the business idea was needed. Business idea was the internal accessibility testing service. Then, the strategy was needed. There were connections around accessibility and because the city of Helsinki wanted something soon, these connections were helping in this initiative. It came pretty clear that accessibility experts were needed and an automatic measuring tool. The City of Helsinki gets lot of contacts from vendors who wants to come to present their activity, and there was an interesting solution eventually where the team could get employees. Outsourcing was not an option, as it should have been the City of Helsinki employees. There were two very good candidates to this job. Three kinds of specialists were needed; someone to run this new service, and the experts with good focus and able to write in plain (i.e. accessible) language. Because accessibility was multidimensional, the team also needed the people with visual imparity/blind people. Accessibility testing is also based strongly on a pair model working. Testing with low visibility seeks observations with the screen reader, and a tester with good visibility seeks observations with its eyes. Employee recruiting was conducted and the next thing was to acquire the automatic tool. The team got info about the appropriate automatic tool and it came pretty clear that acquisition was going to be very expensive, so competitive tendering needed to be arranged.

It was February 2020, when a monitoring tool was acquired. The team also acquired enough employees to do accessibility testing. The team was able to form two pairs from employees. The team learnt how to do accessibility testing but that was not enough. 2,5 day training sessions were arranged where the team got educated via self-learning and

pear-learning how to become accessibility professionals. The first training session included following topics: what is accessibility, how to measure accessibility, what wcag criterion is, how the wcag criterion is interpreted, and then looked into the guidelines case by case how it shows in the webpage and what it means in a webpage that certain guideline is missing. After the first training session, a rehearsal was arranged. A Web page was selected where the team did search accessibility shortages. The next training session was more about accessibility testing. The team looked how to do it, how to form a testing report, and how to form the accessibility statement. After these training sessions, the team started to do testing.

The idea was simple. The team offered testing service among others. Accessibility testing was expensive (and still is). So, the team needed to be a little cheaper and needed to form a certain form of quality assurance quite soon. The team advertised this new service in the city's intranet and in the accessibility working group. When the first customer contacted us, the first order was to test its web contents accessibility. First, the team looked the totality that how much work there is to do (how big and how broke). After this, the team formed an offer about the available service work and if a customer accepted the offer, the team started to do the work.

The offered accessibility testing was done with a pair model. There was a tester with low visibility which made observation with the screen reader. There was also a tester with good visibility which did observations with eyes. Both testers wrote their observations in a report. The tester with good visibility formed and fixed the testing report in a condition that it could be sent to the customer who ordered it. In managing the pair model, the pair principle was also used. One responsible team member (the researcher) handled the employees, and the responsible team member handled the competitive things (orders, customers and advertising). Thus, the team managed to build a competitive service and grew the number of customers.

The team also developed a vision with which it was possible to save a lot of tax payers´ money. The team developed own accessibility experts and did have an automatic tool to help in the auditing/ testing process. In February 2020, the automatic monitoring tool became available; it allowed to cover all the expenses that came from manual testing / auditing work. From the start of March 2020, however, it all started going downhill. The team stopped getting enough orders and expenses kept rising. One of possible explanations is the corona pandemic that changed economic conditions. Everybody had so much

more to do and think than accessibility, and there was simply not enough time to sell this new service. The team has also got internal problems. Still in May 2020, the team was waiting for orders and learning the accessibility testing process. At that time, the news came that money or new resources (internal or external) would not be not invested in this service. It was time to be efficient and get the most out of the current resources. The key thing was to ease the pressure; in the team meetings, the team searched for open-access tools which could help our task. As a side work, the team created an automatic report draft which was shaped according to the original testing report.

After that, as soon as in May 2020 the due date 23.9.2020 was announced to be ready with accessible web-pages in the city, the team started getting orders again, even a queue was formed. One city branch had also become an "all inclusive" customer. The team decided how to handle the queue. How much time it would take, and how to evaluate the orders into hard or simple work, as well as how to classify the orders according to its hurry state. Orders were divided to the corresponding employees, and a list was formed to everybody what they could do in June 2020 . Magically, at August 2020 almost all the jobs from the lists were done and the team of beginners had grown into team of professionals.

Due day (23.9.2020) was close and Helsinki's branches woke up and started ordering. Ordering stopped magically when the due 23.9.2020 passed. It was a *dejavu* experience. In the end of 2020, it came clear that accessibility was understood more like a project and not like an ongoing effort of digital content designing.

Regarding the results, over this time, 63 web sites were analyzed for the City of Helsinki in order to found what kind of accessibility shortages there were. Shortages were found both, manually and automatically. Manually found shortages were found 191. Automatically found shortages were found 160. Difference between the manual and automatic testing was made with three wcag criterion: 1.4.1 use of color (example of this criterion is that the link should be able noticed easily. If the link text is typed with the same color as the text in original web page that is not enough.) 2.11 keyboard (example of this criterion is that all the site content must be useable with the keyboard. The shortage is if the web content includes sometimes buttons such as contact details which cannot be accessed by the keyboard). and 2.4.4 link purpose (example of this criterion is that link text should be descriptive. The link text "katso lisää tai lue lisää" is not enough).

Differences between shortages (automatic vs. manual 16 % less) findings were also due to the fact that the automatic measuring tool used a weak artificial intelligence and that's why it doesn't see same things as the human eye at the moment.

The team created a report out of the completed Helsinki web sites analyses. Web sites used in this report are under the same Helsinki city industry.

4.3   Analysis of the Current State of Accessibility in the Case Organization (Based on Internal Interviews)

For this part of thesis, three persons were interviewed in November 2020 about accessibility. Questions number one was: what is accessibility's state generally in the case organization. The expert who is person whom does this for a living said that:

> "Due to legislation accessibility is taken care more than before". (The City of Helsinki Expert)

He continued that accessibility is understood more like a project for existing web content and accessibility's state has improved generally. This expert hopes that wcag criterion is not taken lightly in the future which he hopes to lead wcag understanding and directly to better digital services. In addition, the internal consultant said that:

> "Accessibility is pretty unknown in IT business at then moment and there is only handful of experts in accessibility that really know what they are doing. web side testing in general varies and accessibility in its lower end is waiting for a foothold." (Internal consultant)

Question number two was: what is accessibility's current state in Helsinki. The expert answered to the question that:

> "There are great variation between branches and services. There is a need for commonly agreed level of requirements and common operating models and tools." (The City of Helsinki Expert)

> "The accessibility directive came into force 2016. Four years later web side accessibility seems to be a mystery for many people. Assuming new way of

acting in designing digital services needs planning and time in Finnish bureaucratic system. Situation in City of Helsinki doesn't differ from this; accessibility and its related practices have been shaped but coherent and cost effective approaches have not yet created. Web content purchasing process doesn't back ongoing professional developing. In organization level it is often mystery who owns the content and who is responsible of the content, who is responsible for data security and who is responsible that the web content is accessible. Helsinki's Helsinki design system tool is a step for right direction but it not change the fundamental problem which relates to how web content or service is purchased, implemented and supervised. Responsibility about web content or web service divides into the organization level which don't have the technical knowledge or resources to do quality services." (Internal consultant)

Helsinki's accessibility pioneer responded also this question about Helsinki's state in accessibility:

"Helsinki is so big that it is hard to say unequivocally Helsinki's state in accessibility. Helsinki has set alignments and targets for accessibility services. Accessibility guide is made to support digital service designing. There is also arranged training: what accessibility is and how to do accessible content. Helsinki design system* is created (*It is a library which has elements what designer can use in web content designing. Helsinki design system contains only accessible elements. - A comment by the researcher). *Also Helsinki model has been created. It gives tools to create accessible content in the life cycle of digital service production. Helsinki recognizes accessibility but don't understand that it is a way to do effective digital services. It is often though that if I do digital services in accessible way it is harder and expensive. Helsinki has taken accessibility seriously and services are becoming more accessible whole time."* (The City of Helsinki, accessibility pioneer)

Question number three was: how do you think accessibility is going to affect the creation of digital services and webpages in the future. Our consult answered that:

"According to good practice, services should be under different testing methods that usability and technical certainty are acquired. Accessibility testing

should also be added into digital service's natural lifecycle as an development or maintenance point of view. This kind of change requires time, planning and adjustment. The automation of accessibility testing and manual testing practices should be linked as part of other development work (such as regression testing, service designing and user testing). In the long run, accessibility will be a normal part of the development of online services. For the time being, accessibility must be take into account through service designing, monitoring and separate work groups." (The City of Helsinki Expert)

The expert answered that he presumes that accessibility demands effect into the production of digital services.

Based on the interviews, all in all, digital service industry was considered as undeveloped in terms of practices and working methods were not always professional. Single factor can solve implementation methods very independently and originally. Service end user are not always taken care properly and the idea of appropriate use is often lost on the way. Accessibility demands will take digital service designing into a more professional direction.

4.4 Analysis of the Current State of Accessibility via Automatic Accessibility Testing (Based on Internal Reports from the Case Organization)

Currently, in the City of Helsinki, accessibility is not fully understood as a term and it is not fully understood as part of digital service designing and what is means to service life cycle. Accessibility is pushed strongly into automatic testing. Unfortunately, automatic testing does not provide direct answer to this problem because it uses weak artificial intelligence at the moment and does not see all the accessibility shortages that there is to see. Also another problem automatic testing is that the automatic tool is that wise than its taught to be. In other words it has to be coded properly to know the accessibility shortages. Also coders should also know accessibility pretty well to be able code an automatic tool which can bring all accessibility shortages into testing report automatically.

Example report was taken out of 63 sites which were accessibility tested. Difference between manual and automatic testing in example sites was 16 percent favor for favor of manual testing at the moment (Figure 6). Unfortunately margin may be lot bigger because automatic testing depends about the fact that what criterions robot is programmed

to go through and what is coded into the monitoring system. That is why manual testing cannot be replaced at the moment.

As identified by the analysis conducted by the team, testing reports contains different type of shortages. The figures below present the report on the differences between manual testing and automatic monitoring.

Manual	vs	Automatic	
1.1.1	12	1.1.1	13
1.2.1	0	1.2.1	0
1.2.2	2	1.2.2	0
1.2.3	0	1.2.3	0
1.2.4	0	1.2.4	0
1.2.5	0	1.2.5	0
1.3.1	40	1.3.1	75
1.3.2	4	1.3.2	0
1.3.3	0	1.3.3	0
1.3.4	0	1.3.4	0
1.3.5	0	1.3.5	0
1.4.1	13	1.4.1	2
1.4.2	0	1.4.2	0
1.4.3	5	1.4.3	8
1.4.4	0	1.4.4	0
1.4.5	0	1.4.5	0
1.4.10	8	1.4.10	0
1.4.11	1	1.4.11	0
1.4.12	0	1.4.12	0
1.4.13	0	1.4.13	0
2.1.1	11	2.1.1	0
2.1.2	0	2.1.2	0
2.1.4	0	2.1.4	0
2.2.1	0	2.2.1	0
2.2.2	0	2.2.2	0
2.3.1	0	2.3.1	0
2.4.1	3	2.4.1	6
2.4.2	2	2.4.2	0
2.4.3	7	2.4.3	0
2.4.4	19	2.4.4	13
2.4.5	0	2.4.5	0
2.4.6	2	2.4.6	1
2.4.7	7	2.4.7	8
2.5.1	1	2.5.1	0
2.5.2	0	2.5.2	0
2.5.3	0	2.5.3	0
2.5.4	0	2.5.4	0
3.1.1	6	3.1.1	2
3.1.2	17	3.1.2	1
3.2.1	0	3.2.1	0
3.2.2	3	3.2.2	6
3.2.3	1	3.2.3	0
3.2.4	11	3.2.4	0
3.3.1	1	3.3.1	5
3.3.2	4	3.3.2	18
3.3.3	0	3.3.3	0
3.3.4	0	3.3.4	0
4.1.1	0	4.1.1	6
4.1.2	25	4.1.2	23
4.1.3	2	4.1.3	0
Criterion:	207		187
Shortage	191		160

Figure 6. Report on the differences between manual and automatic testing completed by Helsinki accessibility team in 2020 (internal document). (Appendix 1)
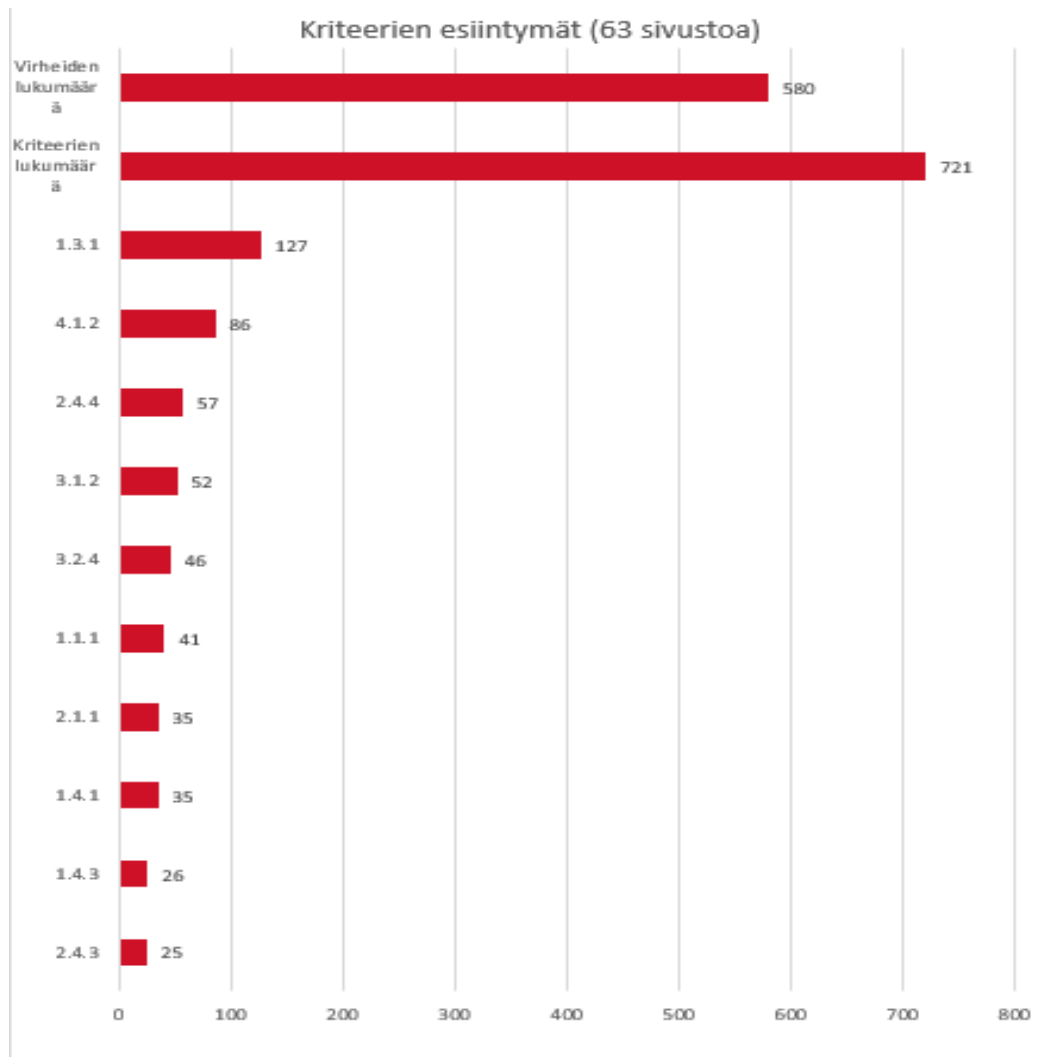
Figure 7. Shortages contacted to wcag versus no contact to wcag (from the report completed by Helsinki accessibility team in 2020).

As seen from the figures above, there are shortages which are contacted into certain wcag criterion. Then there are shortages that have no contact to wcag. Previous can occur for two reasons. Either shortage is close to AAA level accessibility shortage or it performs in very large page so it has to be mentioned in testing report or shortage has no bound to wcag criterions but it offends common usability so it has to be mentioned in testing report.

The upper Figure 6 shows that manual accessibility cannot be replaced by automatic monitoring so far. The monitoring tool is as good as it is coded. Thus, it was proven by practice of the City of Helsinki's team over the year 2020 that accessibility testing should be done by integrating manual testing AND automatic monitoring.

4.5   Summary of Key Findings: Strengths and Weaknesses

This analysis examined the best practice from the team of the City of Helsinki on accessibility testing work. The key finding is that with a written accessibility testing process that is carefully planned and tested in both hands-on and automated environment the work will deliver best possible results. The key recommendation is to still automate every part of the process as much as can be reasonably done.

The biggest strength in this process is the process itself. The accessibility testing process was established and updated during this work. It is solid, work proven and it works. The strength is also that doing accessibility testing gives employee extra positive content to working and interacting and creates pleasant working experience. Another strength is that accessibility testing doesn't have to be complicated.

The weakness is that accessibility professionalism is rare; mainly accessibility has to learn from internet or from other professionals and the accessibility testing team needs to be trained in order to reach its full potential. The testing team needs at least one employee which understands the code, another one which can write text in plain language, and two testers (the employee with low visibility and the employee with normal visibility). Another weakness is that this process is expensive. Manual work is expensive and when there is multiple persons doing manual work, it is going to be very expensive. The testing teams conclusion was that accessibility is not fully understood how it is being tested. An automatic monitoring tool is a very popular solution to measure digital services accessibility state, but it is not enough at the moment. Thus, the conclusions from the practice of the City of Helsinki's team over the year 2020 is that accessibility testing should be done by integrating manual testing AND automatic monitoring.

Table 2 below summarizes the strengths and weaknesses identified in the current accessibility testing process.

Metropolia
University of Applied Sciences

Table 2.   Summary of key findings form the current state analysis.

Summary table (findings, strenghts and weaknesses)		
Key Finding: Written carefully planned process will deliver RESULTS. Automate every part of the process that can be automated	**Strengths:** Process itself and accessibility work's good influence into working day experience	**Weaknesses:** Testing team needs special abilities and manual work is expensive

By identifying the weaknesses, the thesis makes them **the focus** areas for the proposal/improvement discussed next in Section 5.

5   Building the Proposal for the Process for Accessibility Testing

This section merges the results of the current state analysis and the conceptual frame-work towards the building of the Proposal using Data 2.

5.1   Overview of the Proposal Building

The Proposal was built in the following stages.

First, the study focused on revising the previous testing data. Second, the study revised the other results from the current state analysis of accessibility testing. Third, the re-searcher conducted a process workshop with accessibility expert from the team. In the workshop, the accessibility findings were discussed and revised with the testing team's previous accessibility consult. Finally, based on all these inputs, the proposal was drawn as an accessibility testing process model with a process tool and a written description of it for use in the case organization.

5.2   Initial Proposal

Helsinki's vision is to be able produce accessible web content. Helsinki has created Hel-sinki model; which is collection of guides and methods in accessibility and takes care about the big picture around accessibility. At the moment, strategy is that industries and businesses are responsible to follow accessibility by themselves in a way what is suitable for them

Figure 6 below summarizes the proposed process for accessibility testing for the case organization.
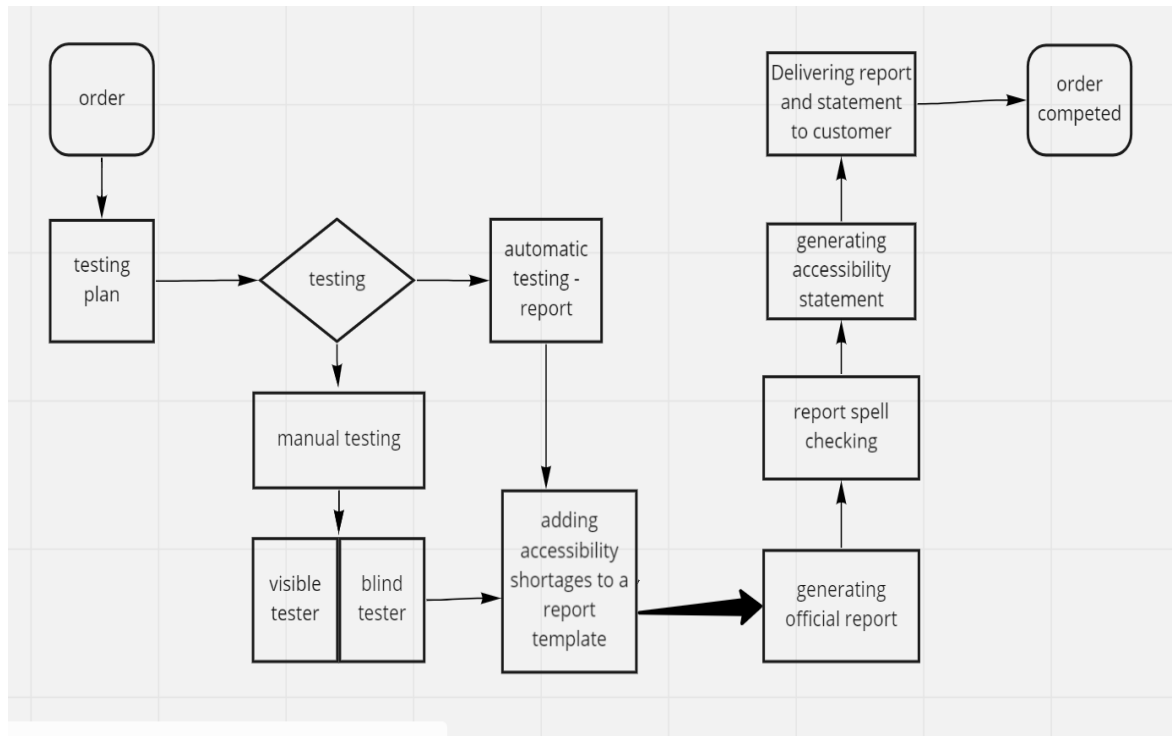
Figure 8.   Initial proposal for the accessibility testing process.

As seen from Figure 8, the proposed process has the following steps.

The proposed Accessibility testing process starts from the order. A Customer wants to know if its service or web page is accessible. *A Testing plan* is the most crucial part of this process. A Testing plan's mission is to specify, for example, the use cases, the testing methods, and testing equipment. A Testing plan will vary case by case. Actual testing often starts with an automatic monitoring report about the service or webpage which is in the testing process.

The accessibility *manual testing* part is done often via a pair model; there is the visible tester and the blind tester. The Pair of testers is needed because often the visible tester might not be as familiar with assistive technology, and the blind tester cannot do notifications with its poor eye sight. Both testers use the screen reader. That is because blind tester cannot see; so visible tester checks that attentions blind tester has made are correct. The Testers write down the WCAG issues that draw their attention into the test template.

The next part of the accessibility testing process contain producing *the Report.* The Report template should be automatic because it helps to form the actual report. For example

documenting wcag shortages takes a lot of time in accessibility testing that's why shortage documenting should be developed and automated as far as possible. That could be for example done by adding most common shortage explanations into report template. The Actual report is formed and then the third person proofreads it and corrects possible typos. After that, the testing team generates the accessibility statement and then the report and statement is sent to the customer. Sometimes customer needs explaining about the report. Usual questions why this is a problem, where the problem is in the web content and how the problem can be fixed. In customer explaining it helps if one has accessibility worker who has understanding of programming and content providing. Accessibility worker with that knowledge can explain the report to the customer.

Thus, the main weakness of the accessibility process identified in the current state analysis (that the manual process is expensive, yet the accessibility team needs these special abilities) is proposed to be tackled in the following way. Manual work cannot be ruled out of accessibility work yet. The accessibility team should be formed around the automatic monitoring tool combined with accessibility specialists who has necessary know-how about accessibility work. Necessary know-how could be for example knowledge about wide variety of different website technologies and/or experience from content production. According to experiences in 2020 when automatic monitoring tools start to use strong AI then all accessibility testing can be done mostly via automatic monitoring tools.

This process makes essential part of the accessibility testing service. The process includes a series of actions which produce a defined outcome, the accessibility testing report and accessibility statement.

6   Validation of the Proposal

This section discusses the results from validation of the proposed accessibility testing process.

6.1   Validation Overview

The purpose of this thesis was to create a written process about accessibility testing. Accessibility is important at the moment because society is going through digitalization. Existing knowledge shows that there is no written "ready-made" accessibility testing process currently available in open access, so this job was appreciated and needed.

In the validation session, the proposed accessibility testing process was discussed and evaluated with one accessibility expert, the accessibility consult who participated in the CSA and proposal building. As the basis of the proposed process, the study used the accessibility testing best practices by the testing team at the City of Helsinki, the job which is now has been outsourced to external accessibility testing services, and upgraded it to the final, proposed accessibility testing process (in section 5).

6.2   Validation Results

Practical validation was done was done by analyzing the proposed accessibility testing process and revising the previous testing data and discussing the results and the proposal. Validation was completed in the validation discussion with the accessibility consult approving of the proposed accessibility testing process.

The practical outcome of this work was that a process for accessibility testing was finalized. It made the final version for the accessibility testing process of The City of Helsinki as described in this study.

7 Conclusions

This section concludes the Thesis. It contain the Executive summary, managerial implications and thesis evaluation with final words.

7.1 Executive Summary

The business challenge in this thesis was that accessibility manual testing is expensive when it is conducted by accessibility professional. The objective was to create a process with which accessibility testing can be done. The context of this study is the IT services of the City of Helsinki. The thesis raised this problem because accessibility is important today in producing digital content, and there are few case studies available about the results of developing accessibility testing by teams in the public sector.

This study used Action research methodology and applied qualitative research methods. The data used in this study was gathered from internal documents, data, and interviews conducted between 03/2020 – 12/2020. The practical goal of the study was to further develop the tools to help in accessibility testing.

The theoretical framework of the study focused on the newly introduced legislation around accessibility, existing accessibility guides, and instructions and guideless to improve accessibility.

This study was mostly done by analyzing the best practices of the City of Helsinki's accessibility testing team. Other data sources were the internal documents and interview data. The current state analysis found that accessibility is understood more as a project than an ongoing activity. The key findings pointed to a written process that is carefully planned and tested in hands-on work to deliver results. The key finding is also include the suggestion to automate every part that is possible to automate. The biggest strength in this process was found is the process itself. The weakness is that this that accessibility testing team needs to be built carefully in order to reach its full potential. The testing team needs at least one employee which understands the coding, another one which can write text in plain language, and two testers (the employee with low visibility and the employee with normal visibility). Another weakness is that this process is expensive. Manual work

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is expensive and when there is multiple persons are doing manual work it is going to be very expensive.

The thesis revised and finalized the accessibility testing process that was started during the work of the accessibility testing team in the City of Helsinki between 03/2020 – 12/2020. It was solid, work proven process and it worked at that time, although it also showed certain weaknesses. This study proposed solutions to the weaknesses and finalized the process. It has been validated with a former accessibility consult. The process is tested in the period 03/2020 – 12/2020. The feedback was received from former colleagues. Business impact of this study is that it offers direct, practice proven and then revised, steps how to form an accessibility testing service.

This study had significance because the purpose of this study is relevant for the case organization and because of the digitalization. Services are going rapidly into electric form and accessibility is important part of digital service development. If accessibility is taken care properly in service development are services generally usable for anyone.

7.2   Managerial Implications and Next Steps

Digitalization continues in rapid speed and accessibility will raise in importance. Accessibility testing should be able to done automatically. However, the results of this study show that accessibility testing cannot be done only automatically at the moment. Manual accessibility testing is needed while waiting for the next generation automatic monitoring tool which would detect digital accessibility 100 % automatically. While waiting for the perfect monitoring tool, this study offers manual accessibility testing process to help in manual accessibility testing work.

Accessibility is often understood very complicated. Lighter next step towards more accessible society would be to absorb usability testing as a part of software – or content designing. As said in the article software accessibility, usability testing and individuals with disabilities: usability testing is to ensure that product design is usable by members of targeted user population. [Burgstahler (2004)]

7.3 Evaluation of the thesis and Final Words

The topic of this thesis was important to the case organization, but it creates only one aspect to this topic. Accessibility makes an important part of software development and service digitalization, but there is not much talking about accessibility testing processes in the public services.

My initial objective was to form a written process to do accessibility testing. In this thesis I outlined a process how to do accessibility testing. My thesis is not quite the same as I thought it would be in the initial objective. I thought that this study would be a much easier task. Along with doing this study I realized that this is only one dimension of this task.

Also, doing this thesis was a challenge. It took me a while to get into the academic mind-set. Remote work was my savior. All by myself at home, it was possible to get into the academic mindset and put my ideas on paper. I hope the readers will appreciate it.

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Appendices

Appendix 1: comparison data: Manual testing versus automatic testing

	Manuaalinen		Automaattinen		Erotus
Ei-tekstuaalinen sisältö	1.1.1	12	1.1.1	13	-1
Pelkkä audio tai pelkkä video (tallennettu)	1.2.1	0	1.2.1	0	
Tekstitys (tallennettu)	1.2.2	2	1.2.2	0	2
Kuvailutulkkaus tai mediavartino (tallennettu)	1.2.3	0	1.2.3	0	
Tekstitys (suorissa lähetyksissä)	1.2.4	0	1.2.4	0	
Kuvailutulkkaus (tallennettu)	1.2.5	0	1.2.5	0	
Informaatio ja suhteet	1.3.1	40	1.3.1	75	-35
Merkitykseen vaikuttava järjestys	1.3.2	4	1.3.2	0	4
Aistinvaraiset ominaispiirteet	1.3.3	0	1.3.3	0	
Asento	1.3.4	0	1.3.4	0	
Määrittelesyötteen tarkoitus	1.3.5	0	1.3.5	0	
Värien käyttö	1.4.1	13	1.4.1	2	11
Audion kontrollointi	1.4.2	0	1.4.2	0	
Kontrasti (minimi)	1.4.3	5	1.4.3	8	-3
Tekstin koon muuttaminen	1.4.4	0	1.4.4	0	
Tekstiä esittävät kuvat	1.4.5	0	1.4.5	0	
Responsiivisuus	1.4.10	8	1.4.10	0	8
Ei-tekstimuotoisen sisällön kontrasti	1.4.11	1	1.4.11	0	1
Tekstin välitys	1.4.12	0	1.4.12	0	
Sisältö osoitettaessa tai kohdistettaessa	1.4.13	0	1.4.13	0	
Näppäimistö	2.1.1	11	2.1.1	0	11
Ei näppäimistöansaa	2.1.2	0	2.1.2	0	
Yhden merkin pikanäppäimet	2.1.4	0	2.1.4	0	
Säädettävä ajoitus	2.2.1	0	2.2.1	0	
Tauota, pysäytä, piilota	2.2.2	0	2.2.2	0	
Kolme välähdystä tai alle raja-arvon	2.3.1	0	2.3.1	0	
Ohita lohkot	2.4.1	3	2.4.1	6	-3
Sivuotsikot	2.4.2	2	2.4.2	0	2
Kohdistusjärjestys	2.4.3	7	2.4.3	0	7
Linkin tarkoitus (kontekstissa)	2.4.4	19	2.4.4	13	6
Useita tapoja	2.4.5	0	2.4.5	0	
Otsikot ja nimilaput	2.4.6	2	2.4.6	1	1
Näkyvä kohdistus	2.4.7	7	2.4.7	8	-1
Osoitineleet	2.5.1	1	2.5.1	0	1
Osoitinlaitteella tehdyn valinnan peruuttaminen	2.5.2	0	2.5.2	0	
Nimilappu nimessä	2.5.3	0	2.5.3	0	
Käyttö liikkeen avulla	2.5.4	0	2.5.4	0	
Sivun kieli	3.1.1	6	3.1.1	2	4
Osien kieli	3.1.2	17	3.1.2	1	16
Kohdistaminen	3.2.1	0	3.2.1	0	
Syöte	3.2.2	3	3.2.2	6	-3
Johdonmukainen navigointi	3.2.3	1	3.2.3	0	1
Johdonmukainen merkitseminen	3.2.4	11	3.2.4	0	11
Virheen tunnistaminen	3.3.1	1	3.3.1	5	-4
Nimilaput tai ohjeet	3.3.2	4	3.3.2	18	-14
Virheen korjausehdotus	3.3.3	0	3.3.3	0	
Virheiden ennaltaehkäisy (oikeudellinen, taloudellin	3.3.4	0	3.3.4	0	
Jäsentäminen	4.1.1	0	4.1.1	6	-6
Nimi, rooli, arvo	4.1.2	25	4.1.2	23	2
Tilasta kertovat viestit	4.1.3	2	4.1.3	0	2
Kriteerejä		207		187	20
Virheitä		191		160	31

Arviointikertomus, Digisarti, HAM, ai.hel.fi, HDS, iltapäiväte mintahaku, työarsti, votavoimala, neuvo

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Appendix 2: Quick guide to word

A quick guide to creating accessible Word files

1. Design a clear structure for the file: think about what kind of titles you will use.

2. Write in clear and easy-to-understand language.

3. Use styles to format headings and other file structures.

• Mark Main Headings as Heading 1 and Subheadings as Heading 2. If necessary, use the Heading 3, Heading 4, etc. styles for the subheadings.

• Mark lists with list styles.

• Change the appearance of text by changing style settings.

4. Name the titles descriptively.

• When you read only the headings, you understand what the file is about.

5. Give the images and charts an alternative description.

• In the alternative description, briefly tell the essential content of the image to a person who cannot see the image.

6. Use tables to present information, not text layout.

• Create tables using the Add Table function

7. Name the file descriptively and give the file a title in the file properties.

8. Make sure the file language is set correctly

9. Check the file using the Check Ease of Use feature.

• The file storage format must be .docx.

10. At the very least, check for yourself that the alternative text for the images makes sense and that the file has a title in the properties of the file.

11. If you want to publish the file in PDF format, make sure that "Document Structure Tags for Ease of Use" is selected in the settings during the save phase.

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