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Accessibility Evaluation of a Mobile Application Using WCAG 2.0

An Evaluation of the CREDENTIAL Project's Mobile Application UI V2

Information Systems

Bachelor's Thesis

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Abstract

In a report published by the World Health Organization (Hartley et al. 2011 p.29) it was reported that close to 15% of the world's population are estimated to live with a disability. When developing websites or applications, it is important to think about accessibility. Accessibility is important to enable users who have disabilities to access information and services that those without any disabilities can access.

On the request of the CREDENTIAL project an accessibility evaluation was conducted on the version 2 (V2) of their mobile application UI. The evaluation was done to see if the UI prototypes met EU Directive 2016/2102 and the evaluation was conducted manually by visually examining the UI against the success criteria of WCAG 2.0 (Web Accessibility Guidelines 2.0) level AA, which is the level required by the harmonized standard as stated by the directive.

In addition to the evaluation, in order to identify accessibility problems specific for users with visual disabilities as requested by the CREDENTIAL project, interviews were conducted as well as research of a previously conducted accessibility study regarding visual disability.

The Evaluation resulted in 23 met success criteria, 5 success criteria not being met and 10 success criteria that is not applicable at the time of the evaluation. The interviews and study of previous research showed some possible accessibility problems in regard of users with visual disabilities but concluded that there was a need to conduct user testing to get the users own insight to the specific accessibility of the CREDENTIAL application.

Keywords:

Mobile accessibility, accessibility evaluation, accessibility standards, WCAG 2.0

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1. Introduction

1.1 Background

In a report published by WHO (World Health Organization) and written by Hartley et al. (2011 p.29) it was reported that close to 15% of the world's population are estimated to live with a disability, and that among adults the number of people that have "very significant difficulties in functioning" is at 2.2%. This is a significant portion of the world's population that might be excluded from accessing web pages and mobile apps if they are not made accessible. When developing websites or applications, it is important to think about accessibility. Accessibility is important to enable users who have disabilities to access information and services that those without any disabilities can access. According to World Wide Web Consortium's (W3C) Web Accessibility initiative, accessibility is "essential for developers and organizations that want to create high-quality websites and web tools, and not exclude people from using their products and services" (Lawton Henry 2018a).

In a blog post posted on the website The Institute, an IEEE news source, by Amanda Davis (Davis 2017) she says that "although many countries have website accessibility standards in place, the majority of developers fail to adhere to them." She uses the United Kingdom, where she mentions around 12 million people live with disabilities, as an example and states that in the year 2016 around 70% of websites did not meet the standards decided by the UK's Equality Act. This means that people with disabilities might not be able to access any of the information or services on these sites and causing such websites to lose some potential customers or user whom would otherwise have used the site. A webpage or application that is not accessible could be especially difficult to use for users who have a severe visual impairment that needs screen readers to interact with the content.

Kalbag (2017 p.4) states in her book *Accessibility for Everyone* that accessibility improvements in our physical world like pivoting door handles instead of round ones, subtitles on movies or signs designed to be easy to read are does not make the objects that are made accessible less usable for the people whom do not have the impairments those objects are design to assist, she states that such solutions usually makes the product easier for everyone to use. She says that objects designed inclusively can be used by more people and that because of this these objects have wider commercial appeal. Accessibility on the web and in mobile applications is also beneficial for those who do not have any disabilities. As Lawton Henry states an accessible web can also benefits aging users, those with slow internet connection or users that use devices with small screens like mobile phones (Lawton Henry 2018a).

Kalbag (2017 p.4-5) also says that despite laws in many countries stating that it is considered discrimination to exclude a person from a public place by the way of its design, and therefore illegal, that most laws "haven't yet caught up to the new medium that is the web. Laws vary from country to country and those that do apply to the web are not always enforced". However, as of the 23d of September 2018, a directive, Directive 2016/2102, by the European Parliament and the European Commission (see more about the Directive in Section 2.3.1) regarding web and mobile accessibility will come to effect. Therefore, the necessity for public sector bodies to adapt their web pages and mobile apps to meet the standards set by this new directive is of

great importance. The directive also states that “Member States should also be encouraged to extend the application of this Directive to private entities that offer facilities and services which are open or provided to the public.”

CREDENTIAL is a research project funded by the EU which goal is to “develop, test and showcase innovative cloud-based services for storing, managing, and sharing digital identity information and other critical personal data” (CREDENTIAL n.d). This thesis will, at the request of the CREDENTIAL project, evaluate the accessibility of the CREDENTIAL project’s second version (V2) of the user interface for their mobile application.

1.2 Purpose of the Thesis

As CREDENTIAL is an EU funded project, it should meet the European standards for accessibility. By request of the CREDENTIAL project, this thesis will assess the accessibility of CREDENTIAL wallet app’s second version of its user interface and see if it meets the European standards for accessibility. Additionally, as requested by CREDENTIAL, the thesis will look into what problems that exist specifically for the people who have a visual disability.

1.3 Research Questions

The questions that will be answered by this thesis are:

- Does the CREDENTIAL wallet’s UI meet the European standard for accessibility?
- In the case of not meeting a standard, why is it not met and what can be improved to meet the standards?
- What accessibility problems exist for the users with a visual impairment specifically?

1.4 Target Group

The target group for this report is the developers for the CREDENTIAL wallet. The end user who has a disability could also be seen as a target group as they are the ones that will benefit from the UI meets the accessibility standards.

1.5 Source Criticism

The sources that has been used to find the reports and studies used in this thesis are Karlstad University’s library search function called “Onesearch” with the setting of only showing peer-reviewed documents applied. Google scholar has also been used to find reports and studies.

The W3C webpage has been used to find information regarding accessibility, the WCAG 2.0 guidelines, and books used as course literature at Webb and Multimedia program at Karlstad University have been used as sources of information as well as other books on the subject of accessibility.

Blog posts was used to get an idea how the current attitudes about accessibility on the web and in mobile applications but should not be seen as reliable sources.

1.6 List of acronyms

EU	European Union
IEEE	Institute of Electrical and Electronics Engineers
WHO	World Health Organization
ADA	Americans with Disabilities Act
CEN	*European Committee for Standardization*[1]
CENELEC	*European Committee for Electrotechnical Standardization*[2]
ETSI	European Telecommunications Standards Institute
W3C	World Wide Web Consortium
WAI	Web Accessibility Initiative
WCAG	Web Content Accessibility Guidelines

1.7 Terminology

Time-based media	Audio-only, Video-only or Video-Audio content[3]
Braille	A system of raised dots that can be read with the fingers[4]
Braille display	A device that display braille which can be connected to a PC or mobile device
Synchronized media	Audio or video that is synchronized with other formats to present information and/or with time-based interactive components[5]
Screen reader	A software that allows users with a visual impairment to read text on a screen using a speech synthesizer[6]
Floating buttons	A button that appears on top of all the content on the screen

[1] Originally in French: Comité Européen de Normalisation
[2] Originally in French: Comité Européen de Normalisation Électrotechnique
[3] Time-based Media: Understanding Guideline 1.2 https://www.w3.org/TR/UNDERSTANDING-WCAG20/media-equiv.html
[4]American Foundation for the Blind, What is braille? http://www.afb.org/info/living-with-vision-loss/braille/what-is-braille/123
[5] Synchronized Media: Understanding Guideline 1.2 https://www.w3.org/TR/2007/WD-UNDERSTANDING-WCAG20-20071211/media-equiv.html
[6] American Foundation for the Blind, Screen Readers: http://www.afb.org/prodBrowseCatResults.aspx?CatID=49

2. The Accessibility Directive, Standards and Problems

2.1 Accessibility and Disability

2.1.1 Definition of Disability

According to WHO the term "disability" is an umbrella term that cover impairments, limitations to activity and restrictions to participation. WHO defines an *impairment* as a "problem in body function or structure", an *activity limitation* as a "difficulty encountered by an individual in executing a task or action" and a *restriction in participation* as a "problem experienced by an individual in involvement in life situations"[7]. Horton and Quesenbery say, in their book *A Web for Everyone*, that "disability is a conflict between someone's functional capability and the world we have constructed" (Horton & Quesenbery 2013).

2.1.2 Correct Terminology

The correct way to refer to a person who has a disability in research is a topic discussed in multiple reports and by organizations who work with assisting people with disabilities. The ADA National Network (2017) is an organization that "provides information, guidance, and training on how to implement the Americans with Disabilities Act" and they say that the words that are used and the way individuals are portrayed matters. Therefore, the language needs to be accurate, neutral and objective to portray them in a way that is respectful and balanced. They say to use terms such as "person with a disability" and "people with disabilities" instead of terms like "disabled person" or "the disabled". Both the National Disability Authority (2002 p.42) that is an Irish "independent state body providing expert advice on disability policy and practice to the government and the public sector"[8], and www.gov.uk[9], the governmental website of United Kingdom, also say to use the same terms as ADA National Network. These terms will be the ones used in this report.

2.1.3 Accessibility vs. Usability

Accessibility and usability, despite sounding somewhat similar, are not the same. The Nielsen and Norman Group define usability as "a quality attribute that assesses how easy user interfaces are to use" (Nielsen 2012). Krug states that usability is something "A person of average (or even below average) ability and experience can figure out how to use the thing to accomplish something without it being more trouble than it's worth" (Krug 2014, p.9).

For accessibility Lawton Henry et al. (2016) says that "For the web, accessibility means that people with disabilities can perceive, understand, navigate, and interact with websites and tools, and that they can contribute equally without barriers". Accessibility has to do with users who have a disability being able to have a similar user experience as those who do not have a disability.

Kalbag (2017 p.3) says that "Accessibility in the physical world is the degree to which an environment is usable by as many people as possible. Web accessibility is the degree to which

[7] http://www.who.int/topics/disabilities/en/
[8] http://www.nda.ie
[9] https://www.gov.uk/government/publications/inclusive-communication/inclusive-language-words-to-use-and-avoid-when-writing-about-disability

a website is usable by as many people as possible. We can think about both kinds of accessibility as forms of inclusion".

Both have to do with users being able to use something with ease, and in this case how easily they can use websites or mobile applications, the difference being accessibility focusing on a user *who have a disability* being able to use the website or mobile application. A lack of accessibility might mean that the user could be unable to access any information or services offered on that website or application.

2.2 History of Accessibility

According to Persson et al. (2015, p.512) a process was started in 1950s that changed public policies and design practices when the veterans from the Vietnam war returned home, now disabled from injuries suffered in the war. National standards for barrier-free buildings was created to make buildings accessible to the returning soldiers and other people with disabilities. Persson says that the goal was to avoid institutionalized health care and instead give them opportunities in education and employment. In 1968 the Architectural Barriers Act was made part of the American law presenting principles of barrier-free design of buildings.

Later in 1973 the Rehabilitation Act, an act which banned discrimination based on disability, was implemented (Persson et al. 2015). Ellcessor (2010 p.292-294) states that act "incorporated a civil rights-based approach to disability, as well as the language of the social constructionist model, and laid the groundwork for accessibility requirements."

In 1986 this came to include the requirement to make electronic and information technologies accessible (Persson et al. 2015; Ellcessor 2010). The American Disabilities Act (ADA) passed in 1990, prohibiting the discrimination due to a disability and that not giving equal opportunity and "reasonable accommodations" would count as discrimination (Persson et al. 2015; Ellcessor 2010).

In 1997 the World Wide Web Consortium (W3C) launched the Web Accessibility Initiative with the purpose of the initiative being to "promote and achieve Web functionality for people with disabilities" (W3C 1997). The initiative published its first accessibility guidelines, Web Content Accessibility Guidelines 1.0 (WCAG 1.0), in 1999. The purpose of the guideline stated as to "explain how to make Web content accessible to people with disabilities" (Chisholm et al. 1999). Later in 2008 WAI published the new guideline, WCAG 2.0, that succeeded the previous guideline.

In September 2018 a new European directive, directive EU 2016/2012, for accessibility of websites and mobile applications in the public sector will come into effect.

Accessibility started out as making the physical world accessible to persons who had a physical disability. Today, accessibility is not only important in the context of buildings and accessibility only in the physical world, but also on the web as more business, services, and information has moved online. In 2018 the retail e-commerce sales are 11.9 percent of global sales; this number is predicted to rise to 17.5 percent in 2021 (eMarketer 2018). Without accessible websites, people with disabilities might be unable to access these business, services, and information. Furthermore, as the percentage of the global traffic to websites generated by mobile phones

increase, in 2018 this percentage is at 52% according to We Are Social. (n.d.), the need for not only accessibility on the web but also mobile web pages and applications accessibility has become increasingly important.

2.3 Directives and Standards for Accessibility

2.3.1 EU Directive

The directive EU 2016/2102 is a directive from the European Parliament and the Council of the European Union regarding the accessibility of websites and mobile applications in the public sector. The directive states that the information and user interface components must be *perceivable*, *operable*, *understandable*, and *robust*. These four principles originate in the four principles of WCAG 2.0 (see Section 2.3.3). To fulfill the principles, the website or mobile application needs to meet the harmonized standard. A harmonized standard is a standard "developed by a recognized European Standards Organisation: CEN, CENELEC, or ETSI. It is created following a request from the European Commission to one of these organizations. Manufacturers, other economic operators, or conformity assessment bodies can use harmonized standards to demonstrate that products, services, or processes comply with relevant EU legislation" (European Parliament and the Council of the European Union 2016).

As the harmonized standards have, at the time of writing, yet to be published for this directive it is stated in the directive that the European standard EN 301 549 V.1.1.2 should be considered the minimum requirements to meet the directive according to the directive (European commission 2018).

2.3.2 European Standard

The European standard named EN 301 549 V.1.1.2, is a standard that "specifies the functional accessibility requirements applicable to ICT products and services". Clause 9 in the standard talk specifically of web accessibility. The standard states that web pages need to conform to level A and AA success criteria of the W3C's Web Content Accessibility Guidelines 2.0 (see Section 2.3.3) in order to meet the European standard (ETSI 2015).

2.3.3 Web Content Accessibility Guidelines 2.0

The Web Content Accessibility Guidelines 2.0, or WCAG 2.0, was developed by the Web Accessibility Initiative (WAI), that in turn was created by W3C (Caldwell et al. 2008). The guidelines are used in the European standard's (EN 301 549 V.1.1.2) clause 9 for web accessibility (see Section 2.3.2) as the harmonized standard for EU Directive 2016/2102 (see Section 2.3.1). The guideline is divided into 4 principles and each of these principles has a number of guidelines.

Four Principles of WCAG 2.0

The WCAG 2.0 has four principles, "Perceivable," "Operable," "Understandable" and "Robust." Cooper et al. (2016) say that these principles need to be true for users with disabilities to be able to use the web. These four principles are described as following by Cooper et al.:

- **Perceivable** means that the presentation of the information and the interface components must be in a way that is perceivable to the user.
- **Operable** means that the users must be able to operate the navigation and user interface.

- **Understandable** means that the user must be able to understand and how to operate the user interface and the information presented to them.
- **Robust** means that the content must be able to be interpreted reliably by advancing technologies and user agents. The content must continue to be accessible.

Guidelines of WCAG 2.0

Each of the four principles (see above in Section 0) in the standard includes guidelines for that principle, totaling in 12 guidelines. Under each guideline are a number of success criteria.

Perceivable	1.1 Text Alternatives
	1.2 Time-based Media
	1.3 Adaptable
	1.4 Distinguishable
Operable	2.1 Keyboard Accessible
	2.2 Enough Time
	2.3 Seizures
	2.4 Navigable
Understandable	3.1 Readable
	3.2 Predictable
	3.3 Input Assistance
Robust	4.1 Compatible

Table 1: A compilation of the guidelines in WCAG 2.0.

Success Criteria

The success criteria are a description what is needed to achieve conformance in WCAG 2.0. Each of the guidelines has a number of success criteria tied to them that describe what is needed to meet that specific guideline. WCAG 2.0 also has different levels of conformance to adapt to situations that require greater levels of accessibility, so each guideline has a number of success criteria from different conformance levels. The levels are A, AA and AAA, where A is the minimum and AAA is the highest. Some guidelines could just have A level success criteria and others have multiple success criteria from multiple levels, se and example in Table 2 (W3C 2016).

As the European standard EN 301 549 V.1.1.2 require conformance to level AA the CREDENTIAL application's UI would have to meet all the A and AA level success criteria under each guideline.

Principle X				
Guideline 1		Guideline 2		
Success criteria 1 (Level A)	Success criteria 2 (Level AA)	Success criteria 1 (Level A)	Success criteria 2 (Level A)	Success criteria 3 (Level AAA)

Table 2: An example of the structure of principles, guidelines and success criteria

2.3.4 Criticism of WCAG 2.0

In a study conducted by Power et al. (2012), where they looked into accessibility problems on the web for people with visual disabilities, user evaluations of 16 websites encountered 1382 instances of user problems and it showed that only 50.4% of these was covered by the WCAG

2.0 success criteria. This means that half of the problems that the users with a visual impairment encounter is does not have a related success criterion in the guidelines that solves those problems. Furthermore, it showed that 16.7% of the websites, despite having used WCAG 2.0 techniques to get rid of the user problems that was covered by the guidelines, the user problems that were still there and had not been fixed even though the website did follow the guideline.

Termens et al. (2009) states that there are four main criticism of WCAG, first of them being that WCAG is not based on research that has been statistically verified. They also state that it is lacking regarding the elderly and persons with cognitive disabilities and that it is not understandable for webmasters. Lastly, they say that WCAG "encourage webmasters to seek easy compliance rather than real accessibility" and they conclude that WCAG is a start on the road towards accessibility, but that the only way to accomplish real accessibility is through observation of users, and knowledge of user's needs (Termens et al. 2009).

Farrelly (2011) conducted interviews with 23 website practitioners regarding their experiences and opinions of aspects of accessibility on the web. He states that regarding WCAG, those who were familiar with it said that it was difficult to use. Farrally, like Termens et al. (2009), had criticism towards its exclusion of the needs of elderly people, and people with cognitive disabilities. Farrelly further states that the main part of the criticism was the standards length, lack of clarity, language and confusing organization saying, "Several participants who have each worked as web practitioners for over a decade indicated they found WCAG overwhelming and confusing". As one of the interviewees put it during Farrelly's interview, "It just gets into tech-babble. It must be completely overwhelming for those less experienced" (Farrelly 2011 p.229).

2.3.5 Why not WCAG 2.1?

WCAG 2.1 was published the 5th of June 2018 and includes all success criteria from WCAG 2.0 along with 17 new success criteria. These new success criteria now include success criteria for accessibility in mobile devices, people with low vision and people with cognitive and learning disabilities (Lawton Henry, 2018c). The reason that the WCAG 2.0 and not WCAG 2.1 was used in this thesis is that when the evaluation started the European standard used the WCAG 2.0's success criteria and the WCAG 2.1 had not yet been published at the time.

2.4 WCAG 2.0 and Mobile Accessibility

In the WCAG 2.0 documents the term "web page" is used (Caldwell et al. 2008), but Patch et al. notes in that the guidelines are highly relevant to non-web content, such as mobile content and applications (Patch et al. 2015). The European directive 2016/2102 also states that the directive (and therefore the WCAG 2.0) applies to both websites and mobile applications (European Parliament and the Council of the European Union, 2016)

In 2015 W3C published a document, though it is a working draft, on how the WCAG 2.0 guidelines apply to mobile devices called "*Mobile Accessibility: How WCAG 2.0 and Other W3C/WAI Guidelines Apply to Mobile*" (Patch et al. 2015 p.5-14). As it is only a working document it does not constitute a set of requirements but is instead meant to provide informative guidance.

Smaller screen sizes of mobile devices are one thing Patch et al. discusses in their document. One thing that is relevant for CREDENTIAL is the placement of labels; they recommend placing them above rather than next to the form fields. The form fields in the CREDENTIAL app have their labels either above, inside or under them. In accordance with the Patch et al. the labels are not placed next to the form fields.

Zoom and magnification help people with visual impairment to enlarge parts that are hard to see (Patch et al. 2015).

Contrast is especially important with mobile devices according to Patch et al. for the reason that they are used in environments with different light conditions, like outdoors in the sun. The success criterion P12 Contrast (minimum) state that text contrast must be at least 4.5:1, or 3:1 for large-scale text, but Patch et al. say that allowing the use of the lesser contrast ratio for larger text must be carefully considered for mobile apps.

Touch target size and spacing best practices, according to Patch et al., are for touch target sizes to be at least 9 mm tall by 9 mm wide and that touch targets which are close to that size should be surrounded by a small amount of inactive white space. The placement of buttons should also be easy to reach when the device is held in different positions.

Placing buttons where they are easy to access is important due to the mobile devices' smaller screens that contain many interactive elements according to Patch et al.

Change of the screen orientation is something Patch et al. say that developers should try to support as some user needs to have their mobile devices secured in a fixed position. One such instance could be a wheelchair user having the mobile device attached to their wheelchair.

Consistent layout Patch et al. say that repeated component, that is repeated over multiple pages, should be consistent in its layout.

Positioning important page elements before the page scroll is important as the screen size is smaller on mobile devices and this limits the content amount that can be visible without scrolling (Patch et al. 2015).

Clear indication of actionable elements is needed for users to clearly see which elements are actionable. They must also be detectable by screen readers used by users with a visual impairment (Patch et al. 2015)

Providing the users with easy methods for data reduces the amount of time it takes for users to enter text which can otherwise be a time-consuming process for people who have certain disabilities. Time can be reduced by using select menus, radio buttons, checkboxes or by automatically entering known information.

The following guidelines are not applicable at the time of the evaluation: *keyboard control for touchscreen devices; touchscreen gestures; grouping operable elements that perform the same action; device manipulation gestures; provide instructions for custom touchscreen and device manipulation; set the virtual keyboard to the type of data entry required; and support characteristic properties of the platform.*

2.5 Best Practices for Accessible Mobile Applications

Schulz et al. (2015 p.11) say, in a report from the Norwegian Computing Institute, that including people with disabilities is something that should be considered when designing a mobile application. He states that not all disabilities are the same, so a solution for one person might not help another one and that the point is not to be representative but to create awareness of for different accessibility issues.

It is also important to use standard controls as they can be identified by assistive technology and to have good color contrast. Good color contras help the user to read, find controls and reduces confusion. Touch targets should have the recommended size of the user interface guides of the system at a minimum, and icons, pictures and other visual information should have an alternative text describing what it does (Schultz et al.2015 p.12-13). Schulz et al. states that "Important information, for example, warnings and alerts, should not be presented with just one cue, such as not only color, not only sound, not only text". They say that additional cues should be used make users aware of information when they cannot perceive such changes.

Furthermore, it is important to perform user evaluations with people who has a disability as they are the experts with assistive technologies (Schulz et al 2015. P16). Schulz et al. say that performing these user evaluations can help cover gaps in the guidelines. They also mention a statement made by Power et al. (2012) that "following guidelines alone is not enough to ensure a solution is accessible".

2.6 Accessibility Problems for Users with a Visual Impairment

Napomuceno Carvalho et al. (2018 p.2026-2028) has done a study regarding accessibility and usability problems for people with a visual impairment on the web and applications in mobile devices. According to their study visually impaired users were more affected by the problems identified during the study than the participants without any visual impairment. Napomuceno Carvalho et al. identified the 5 most frequent problem categories that people with visual disabilities come across on the mobile web pages and applications used in the study.

- **Inadequate feedback (Controls, forms, and functionality):** Nothing identifying to the user that an action had an effect. E.g. clicking on something and nothing informs the users of what has changed.
- **No alternative to an image (Images):** The images in the application or webpage does not have alternative text that lets the users with screen readers know what it is.
- **Sequence of interaction not clear:** The sequence in which the interaction needs to be in is not clear, and no explanation for how it should be done,
- **Lack of identification of buttons:** The is nothing identifying what the button does, and the button is only identified as "button" by the screen reader. The example used in the study is a button with an external text below with no association with the button describing what it does and leading to the user not knowing that they have anything to with each other.
- **Interference of functionality that does not exist:** The example used for this category in the study is that when the user identified labels of a form element (i.e., text field, radio button, etc.) and tried to select the text of the label itself thinking that it was the

form element. They thought that the label was the functionality. The problem was the lack of association between the text and the form element.

3. Method

3.1 Prototype

The evaluation of the CREDENTIAL application's UI was done using a prototype. A prototype is a "concrete but partial representation or implementation of a system design" (Benyon 2014 p.175). Benyon says that a prototype can be used early in a design to demonstrate a concept or to, in a later stage of the design, test concept details. It can also be used as a specification for a final product. Benyon talk about two different types of prototype lo-fi prototypes and hi-fi prototypes.

Lo-fi prototypes (or low fidelity prototype) are according to Benyon often called a paper prototype as paper often used to make them. These prototypes are focused broad design ideas like content, form, structure, tone, key functional requirements and the structure of the navigation. Benyon says that they are made quickly and captures the early design thinking in order to aid tin the creation and evaluation of more design solutions.

Hi-fi prototypes (or high-fidelity prototype) are according Benyon (2014 p.176) a prototype created using a software that is similar to the final product in its look and feel but that they do not need to have the functionality of one. Benyon says that they can be used for detailed evaluation of main design elements and are more like a final design.

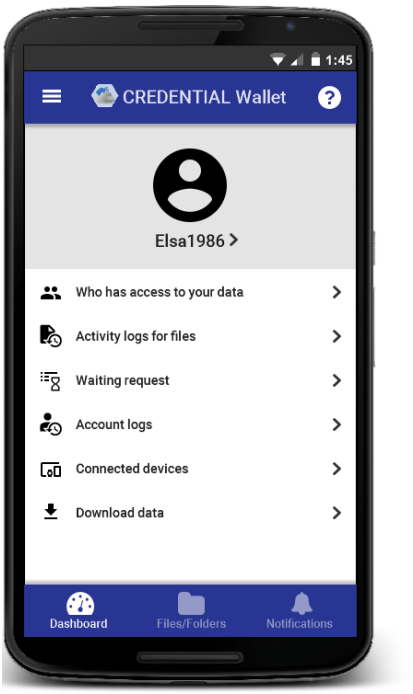

Figure 1: The dashboard of the CREDENTIAL application prototype

The prototype of the CREDENTIAL application used in the evaluation is the second version of the UI that has been developed. The prototype is a graphically hi-fi prototype that has been designed to have the look of a final application, thought it has no functionality and consists only of images. The prototype comprises of 104 separate images and was designed using the software Axure PR which is a software for creating wireframes and prototypes, see Figure 1 for one of the prototype images showing the dashboard of the application.

3.2 Evaluation of Accessibility

The evaluation of the CREDENTIAL wallet's UI was done manually by visually examining the 104 UI prototype images received from the CRENDENTIAL project against the success criteria in WCAG 2.0 using the Web Content Accessibility Guidelines 2.0 and its related documents "How to Meet WCAG 2.0" which is a document by W3C that is a "customizable quick reference to Web Content Accessebility Guidlines" (Lawton Henry 2018b), "Understanding WCAG 2.0", "Techniques for WCAG 2.0" and "Mobile Accessibility: How WCAG 2.0 and Other W3C/WAI Guidelines Apply to Mobile". As stated clause 9 in the European standard EN 301 549 V1.1.2 the UI was evaluated against the success criteria for level A and AA of the WCAG 2.0.

The tool ColorTester by Alfasado Inc was used to assess the contrast ratio of the text against WCAG 2.0's success criteria. Other evaluation tools, software or online services that automatically check against the WCAG 2.0 success criteria, were not applicable in this case as the evaluation was done without an actual functioning application, it had not yet been developed, instead using prototype images of the UI. For this same reason the UI prototypes could not be tested with assistive technologies like screen readers.

3.3 Interviews

As I did not have much previous knowledge of assistive technology for mobile devices I conducted interviews with regular users of such assistive technologies to gain knowledge about the way people with disabilities, primarily focused on people with visual impairments by request of CREDENTIAL, use their phone and any issues they have with the design of mobile applications.

The focus on learning about how people with visual impairments use assistive technologies when using their mobile devices limits the methods available to conduct the data collection as the method chosen needs to be accessible. Interviews were chosen as the method as a specific level of visual ability is not required of the person being interviewed. Interviews were also chosen as it allows not only answers to be given to set questions, but to have two-way discussion about the topic, this was necessary as I as the interviewer did not know enough about the topic ask very specified question. The ideas for some questions originated from the success criteria or parts of the UI that I thought could possibly cause issues for users with a visual impairment. Others came about from the discussion at hand.

For the same reason as the reason for choosing interviews, the participants visual disability, they were not asked to give their thought about the design of the CREDENTIAL application's UI. As both participants had a need of assistive technologies to use their mobile devices, they could not give any feedback in the prototype as they could not use these assistive technologies with the prototype images.

The interview was conducted in Swedish and recorded, then transcribed into English to be used in this thesis. The participant could choose whether or not they accepted the use of a video camera during the interview, the point of the video camera not being to film the participants themselves but to capture the examples given on how they use their mobile devices or any problems they have the design of a specific application.

3.3.1 Participants of the Interviews

The participation in the interview was anonymous, therefore their names and other information that could possibly jeopardize that anonymity will not be mentioned in this report. Instead the participants will here forth be called “A1” and “A2”.

Participant A1 is a man in his sixties with a severe visual impairment whom uses a screen reader to operate his mobile device. His mobile of choice is an iPhone with its native screen reader “voiceover”. He is an experienced user of such technologies and has an interest in both smart phones and computers. A1 also sometimes help with testing new applications (or application updates) to find problems in their UI from the perspective of a person with a visual impairment.

Participant A2 is also in her sixties and has a slightly less severe visual impairment and uses magnification, larger text sizes and contrasting color when using her mobile device. She does not need to use a screen reader and she uses an Android device.

3.4 Ethical Considerations

The Swedish Research Council (Vetenskapsrådet in Swedish) is a governmental agency within the Ministry of Education and Research in Sweden (Vetenskapsrådet 2018) The Swedish Research Council states that there are four main requirements when conducting research. (Vetenskapsråted 2002). These four requirements are the requirement of information (Informationskravet), the requirement of consent (Samtyckeskravet), the requirement confidentiality (Konfidentialitetskravet), and the requirement of usage (Nyttjandekravet).

Requirement of Information: This requirement states that the participants in a study should be informed about their purpose in the project and the terms and conditions that applies for their participation. The participants should also be informed that their participation is voluntary and that they have the right to stop their participation at any time. Furthermore, they state that the participant should be informed of all parts of the survey that could be likely to change their mind about their participation.

The participants in the interview was given a consent form where the information about the purpose of the interview, that their participation was voluntary and that they could change their mind about their participation is presented to them.

Requirement of Consent: This requirement states that the collection of the participants consent I needed. The requirement states that the participants should have the right to decide if they want to participate, for how long to participate and on which conditions. It also states that they should be able to cancel any participation at any time. The participant should not feel pressured about their participation or about the cancelation of their participation.

Before the interview the participants had to sign a consent form. When signing the consent form the participants agree to the terms stated on the form and to have the interview voice recorded. The participants were given the additional voluntary option of consenting to have any demonstrations of functionality on their mobile devices shown during the interview filmed. The participants participation was voluntary, and they were allowed to cancel their participation at any time during the interview. This information was printed on the consent form.

The consent form itself was designed with bigger fonts size (font size 18) and with wider spacing between the lines of text to increase the readability of the document. As the participants had visual disabilities, they were asked if they would prefer to be read the consent form and consenting to it by voice recording in the case of their visual disability being severe enough not being able to read the physical document. The consent form is presented in the Appendix.

Requirement Confidentiality: This requirement states that any information about the participants should be as much confidentiality as possible and that that the information should be stored in such a way that unauthorized person should not get a hold on this information.

The participants in the interview will be kept anonymous, I as the writer of this thesis is the only one whom know of the participants identities.

Requirement of Usage: The requirement states that information collected about separate individuals can be used for anything other than for research purposes.

The information will only be used in this thesis and in the CREDENTIAL project, as stated on the consent form.

4. Evaluation by success criteria

4.1 Perceivable

These following success criteria are related to the principle “Perceivable”: the presentation of the information and interface components must be in a way that is perceivable to the user (Cooper et al. 2016) The success criteria under the perceivable principle will be referred to as “P” and their number by their order of appearance e.g. P1, P2 etc. in this report.

P1 Non-text content: This success criteria states that “All non-text content that is presented to the user has a text alternative that serves the equivalent purpose”. Exceptions are if the non-text content are:

- Controls and input which need a “name that describes its purpose”.
- Time-Based Media, tests, sensory or CAPTCHA which needs a “descriptive identification”.
- Decoration, formatting or invisible which can be ignored (Caldwell et al. 2008).

The UI’s input fields, buttons, toggles, icons, checkboxes have names or text that include a description of their purpose. What is not applicable of this success criteria are the alternative-text (alt-text) as the application is a prototype no such functionality exists.

P2 Audio-only and ideo-only (pre-recorded): The success criterion states that pre-recorded audio-only content need an alternative to time-based media which gives the user equal information, and video-only content need an alternative to time-based media, or an audio track, with equal information (Caldwell et al. 2008).

The application has no video-only or audio-only content.

P3 Captions (pre-recorded): This success criterion states that “Captions are provided for all prerecorded audio content in synchronized media, except when the media is a media alternative for text and is clearly labeled as such” (Caldwell et al. 2008).

The application does not contain any pre-recoded audio content and as the European standard states, if no pre-recorded audio content in synchronized media is included on the webpage the it will automatically satisfy the criterion (ETSI 2015).

P4 Audio description or media alternative (pre-recorded): The success criterion states that “An alternative for time-based media or audio description of the prerecorded video content is provided for synchronized media, except when the media is a media alternative for text and is clearly labeled as such” (Caldwell et al. 2008).

The application has no video content.

P5 Captions (live): The success criterion states that “Captions are provided for all live audio content in synchronized media.” (Caldwell et al. 2008).

The application has no live audio content.

P6 Audio description (pre-recorded): The success criterion states that “Audio description is provided for all prerecorded video content in synchronized media” (Caldwell et al. 2008).

The application has no video content.

P7 Info and relationships: The success criterion states that “Information, structure, and relationships conveyed through presentation can be programmatically determined or are available in text” (Caldwell et al. 2008).

This success criterion was not applicable at the time of the evaluation as the UI is a prototype.

P8 Meaningful sequence: The success criterion states that “When the sequence in which content is presented affects its meaning, a correct reading sequence can be programmatically determined” (Caldwell et al. 2008).

This success criterion was not applicable at the time of the evaluation as the UI is a prototype.

P9 Sensory characteristics: The success criterion states that “Instructions provided for understanding and operating content do not rely solely on sensory characteristics of components such as shape, size, visual location, orientation, or sound” (Caldwell et al. 2008).

Input fields which have been filled in incorrectly is marked a red “x”. Correct data has a green checkmark. There is no text that tells the user that the data is either wrong or right, just the icons. Furthermore, the instructions for the user to click on the question mark to get more information only mentions that the question mark should be clicked, relying on the user to find it visually.

P10 Use of Color: The success criterion states that “Color is not used as the only visual means of conveying information, indicating an action, prompting a response, or distinguishing a visual element” (Caldwell et al. 2008).

In the examples for how the success criterion could be met, one is a form with color indicating required fields that includes text (Cooper et al. 2016). The application has fields in the registration form, which have an underlined colored line when active. This is shown together with a text describing what kind of input should be put in that field, for example “password”, and when the input field is filled in correctly, a green checkmark is shown next to the field (see Figure 2, leftFigure 2: Registration page). When an input field is filled in incorrectly a red “x” takes the place of the checkmark (see Figure 2, right). The color is not shown without text or an icon. Color is also used to indicate a successful sign in with fingerprints, but the color change is accompanied by a descriptive text and an icon (see Figure 3).

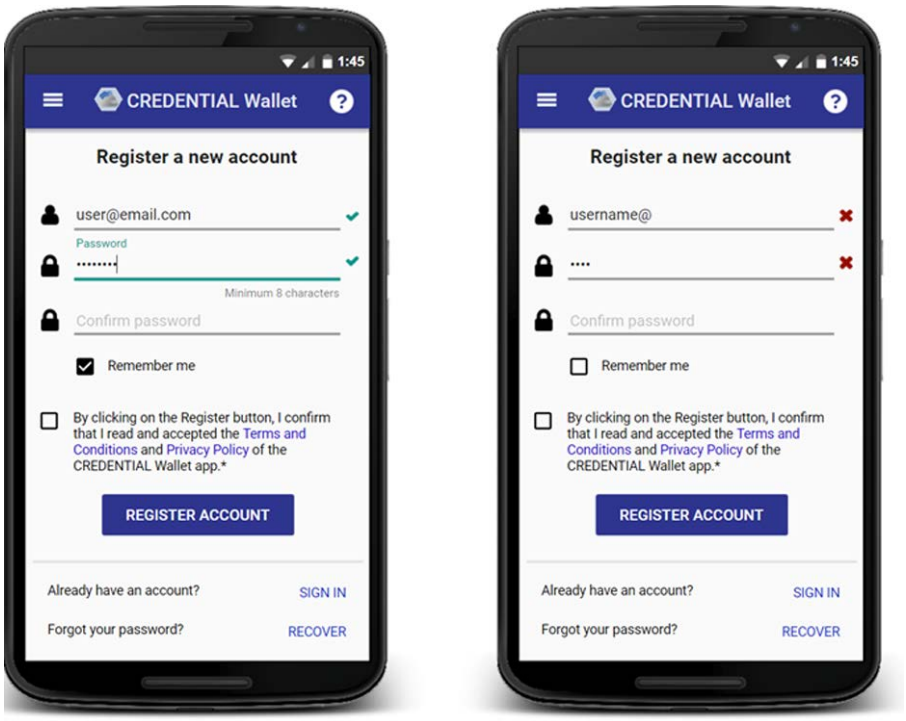

Figure 2: Registration page

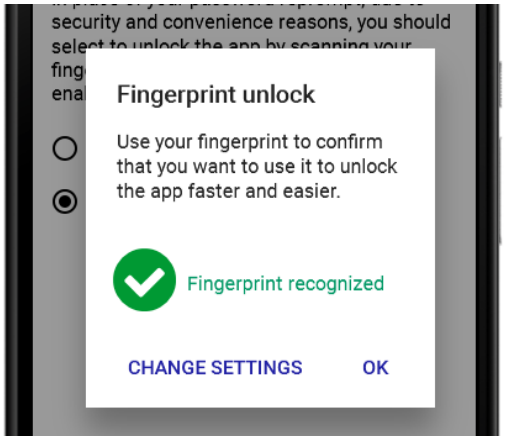

Figure 3: Fingerprint recognized

P11 Audio control: The success criterion states that "If any audio on a Web page plays automatically for more than 3 seconds, either a mechanism is available to pause or stop the audio, or a mechanism is available to control audio volume independently from the overall system volume level" (Caldwell et al. 2008).

No audio is played automatically in the application.

P12 Contrast (minimum): The success criterion states that text and images of text must have a contrast ration of at least 4.5:1. Large text that can have a lower contrast ration of 3:1. Exceptions to this success criteria are text or images of text that are purely for decoration purposes, that are part of interface components that are inactive, that are not visible to any user

or that are part of a picture with other visual content that are significant. Logotypes that contain text or a brand name also do not have a minimum requirement (Caldwell et al. 2008).

Android Accessibility Help (n/a) explains contrast ratio as" a computation of the difference in luminance, or intensity of light emitted, between two neighboring colors when shown on a display. This ratio ranges from 1 to 21 (often written as 1:1 to 21:1), where increasing numbers mean higher contrast".

In the application 31 different combinations of background color and text color was identified. In order to check the contrast ratio, the ColorTester by Alfasado was used, see Figure 4 for an example. A table compiling the colors in the UI and color contrast ratio is presented in Table 3.

Figure 4: View of ColorTester by Alfasado

Color of Text	Color of Background	Color Contrast Ratio	Pass/Fail
#FFFFFF	#000000	21.0:1	Pass
#0000000	#FFFFFF	21.0:1	Pass
#283593	#FFFFFF	10.3:1	Pass
#FFFFFF	#283593	10.3:1	Pass
#757575	#FFFFFF	4.6:1	Pass
#C9C9C9	#FFFFFF	1.6:1	Fail
#009688	#FFFFFF	3.6:1	Fail
#FFFFFF	#009688	3.6:1	Fail
#BCBCBC	#FFFFFF	1.8:1	Fail
#0000CC	#FFFFFF	11.2:1	Pass
#858585	#FFFFFF	3.6:1	Fail
#009966	#FFFFFF	3.6:1	Fail
#000099	#FFFFFF	14.3:1	Pass
#0033CC	#FFFFFF	8.9:1	Pass
#FFFFFF	#323232	12.8:1	Pass
#ABB0D4	#283593	4.5:1	Pass
#0000FF	#FFFFFF	8.5:1	Pass

#FFFFFF	#686868	5.5:1	Pass
#000000	#E4E4E4	16.5:1	Pass
#0000000	#E6E6E6	16.8:1	Pass
#999999	#FFFFFF	2.8:1	Fail
#FFFFFF	#333333	12.6:1	Pass
#333333	#FFFFFF	12.6:1	Pass
#838383	#FFFFFF	3.7:1	Fail
#786EFF	#FFFFFF	3.8:1	Fail
#0404CC	#FFFFFF	11.0:1	Pass
#333333	#C4D7E9	8.5:1	Pass
#000000	#CCCCCC	13.0:1	Pass
#FFFFFF	#666666	5.7:1	Pass
#0000CC	#C4D7E9	7.6:1	Pass
#FFFFFF	#199ED8	3.0:1	Fail

Table 3: Table of the colors in the CREDENTIAL wallet app

10 of the color combinations in the application do not meet the success criteria's limit for small text. Five of these colors were all different shades of gray on a white background.

P13 Resize text: The success criterion states that "Except for captions and images of text, text can be resized without assistive technology up to 200 percent without loss of content or functionality" (Caldwell et al. 2008).

There is a function to change the text size in the application between a value of 1 and 2, where 2 is twice the size of 1 (see Figure 6). To change these, the user need to open the menu (see Figure 7) which is accessible from the whole application, apart from the initial four screens which gives information about the applications feature, seen in Figure 5

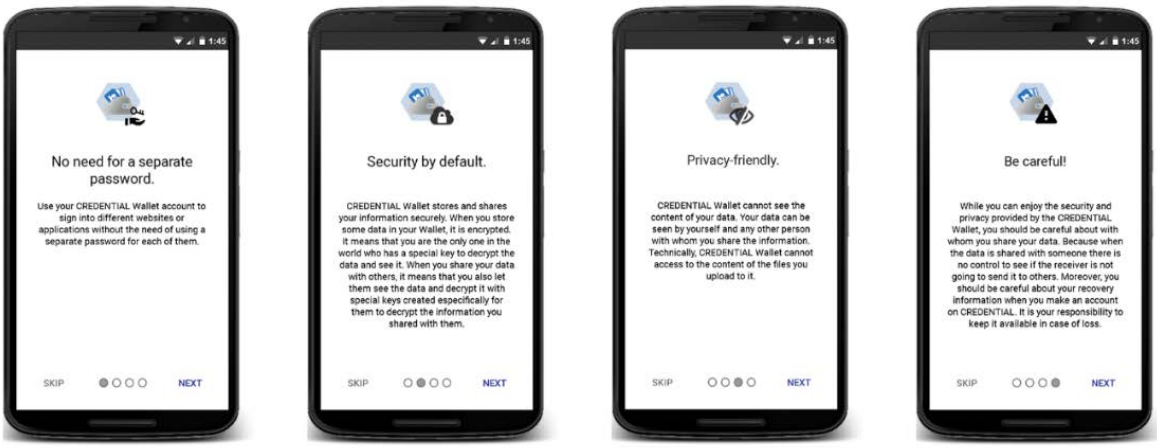

Figure 5: Information screens after the first install.

The user could skip these pages and go directly to registering an account, where the menu is accessible, but then the user can't read the information if they wanted to do so.

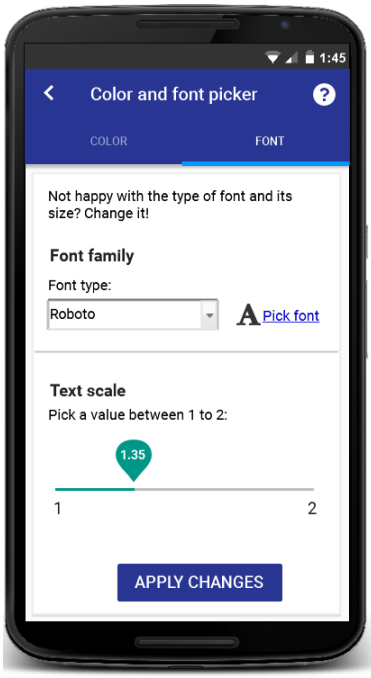

Figure 6: Color and font picker - Text scale

P14 Images of text: The success criterion states that "If the technologies being used can achieve the visual presentation, text is used to convey information rather than images of text". The exceptions are if the image can be visually customizable, or where the presentation of text is essential to the information. Logotypes are considered essential (Caldwell et al. 2008).

The UI does not have any images of text, and the logos used in the application do not have any text in them, the text is placed next to them (See examples in Figure 7 and Figure 8).

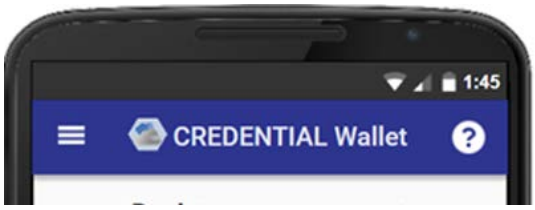

Figure 7: Header with logo

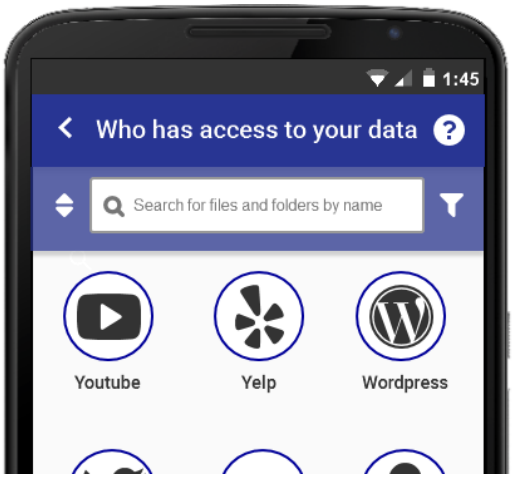

Figure 8: Logos of other service providers

4.2 Operable

These following success criteria are related to the principle “Operable”: the users must be able to operate the navigation and user interface (Cooper et al. 2016). The success criteria under the operable principle will be referred to as “O” and their number by their order of appearance e.g. O1, O2 etc. in this report

O1: Keyboard: The success criterion states that “All functionality of the content is operable through a keyboard interface without requiring specific timings for individual keystrokes, except where the underlying function requires input that depends on the path of the user's movement and not just the endpoints” (Caldwell et al. 2008).

During the proposition of the design elements UI elements that can be accessed via keyboards, e.g. toggle buttons, radio and checkboxes and input fields, were considered and UIs that would require special gestures for task completion e.g. pinching etc. was avoided.

O2 No keyboard trap: The success criterion states that “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” (Caldwell et al. 2008).

Because the UI is a mockup and is not yet implemented this success criteria is not applicable.

O3 Timing adjustable: The success criterion states "For each time limit that is set by the content, at least one of the following is true:

- **Turn off:** The user is allowed to turn off the time limit before encountering it; or
- **Adjust:** The user is allowed to adjust the time limit before encountering it over a wide range that is at least ten times the length of the default setting; or
- **Extend:** The user is warned before time expires and given at least 20 seconds to extend the time limit with a simple action (for example, "press the space bar"), and the user is allowed to extend the time limit at least ten times; or
- **Real-time Exception:** The time limit is a required part of a real-time event (for example, an auction), and no alternative to the time limit is possible; or
- **Essential Exception:** The time limit is essential and extending it would invalidate the activity; or
- **20 Hour Exception:** The time limit is longer than 20 hours” (Caldwell et al. 2008).

It is possible for the user to extend the time it takes for the application to lock or sign out after being idle. There is a maximum time limit for the lock of 30 minutes, it is possible to choose for the application to automatically lock when the screen is off. The user can make the decision to never sign out of the application unless the actively do it themselves. They can also extend the time limit to handle the permission dialogues which has a limit of a 30-minute extension.

O4 Pause, stop, hide: The success criterion states that "For moving, blinking, scrolling, or auto-updating information, all of the following are true:

- **Moving, blinking, scrolling:** For any moving, blinking or scrolling information that (1) starts automatically, (2) lasts more than five seconds, and (3) is presented in parallel with other content, there is a mechanism for the user to pause, stop, or hide it unless the movement, blinking, or scrolling is part of an activity where it is essential; and
- **Auto-updating:** For any auto-updating information that (1) starts automatically and (2) is presented in parallel with other content, there is a mechanism for the user to pause, stop, or hide it or to control the frequency of the update unless the auto-updating is part of an activity where it is essential" (Caldwell et al. 2008).

No part of the UI blink, scrolls or move automatically.

O5 Three flashes or below threshold:

The success criterion states that "Web pages do not contain anything that flashes more than three times in any one second period, or the flash is below the general flash and red flash thresholds." (Caldwell et al. 2008).

No flashes occur in the application.

O6 Bypass blocks: The success criterion states that "A mechanism is available to bypass blocks of content that are repeated on multiple Web pages" (Caldwell et al. 2018).

The only thing repeated in the UI is the header and sub header.

O7 Page titled: The success criterion states "Web pages have titles that describe topic or purpose" (Caldwell et al. 2008).

The pages of the application have titles describing the purpose of that page either on top of the page in the header, under the header or on tabs. E.g. The page where the user sign in has the title "Sign in", see Figure 9.

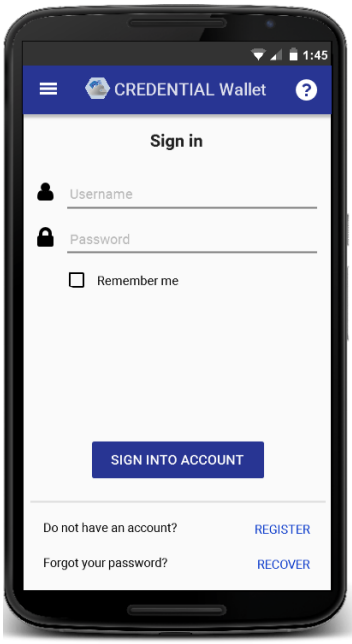

Figure 9: Sign-in page

O8 Focus order: The success criterion states that "If a Web page can be navigated sequentially and the navigation sequences affect meaning or operation, focusable components receive focus in an order that preserves meaning and operability" (Caldwell et al. 2008).

This success criterion was not applicable at the time of the evaluation as the UI is a prototype.

O9 Link purpose (in context): The success criterion states that "The purpose of each link can be determined from the link text alone or from the link text together with its programmatically determined link context, except where the purpose of the link would be ambiguous to users in general" (Caldwell et al. 2008).

All links describe their purpose in the link itself or in the context of the text around it.

O10 Multiple ways: The success criterion states that "More than one way is available to locate a Web page within a set of Web pages except where the Web Page is the result of, or a step in, a process" (Caldwell et al. 2008).

On pages where the user needs to find something specific a search function is available. Furthermore, the user can always access the menu in the header to go from one page to another in the app. Unless they are doing a specific task in that moment, then they need to go finish that task or cancel it first.

O11 Headings and labels: The success criterion states that "Headings and labels describe topic or purpose" (Caldwell et al. 2008).

All input fields and pages have a heading or label describing what the purpose fort that particular field or page is. E.g. A section with an input field have the heading "Select a passcode" and the input field itself has the label "Passcode", see Figure 10.

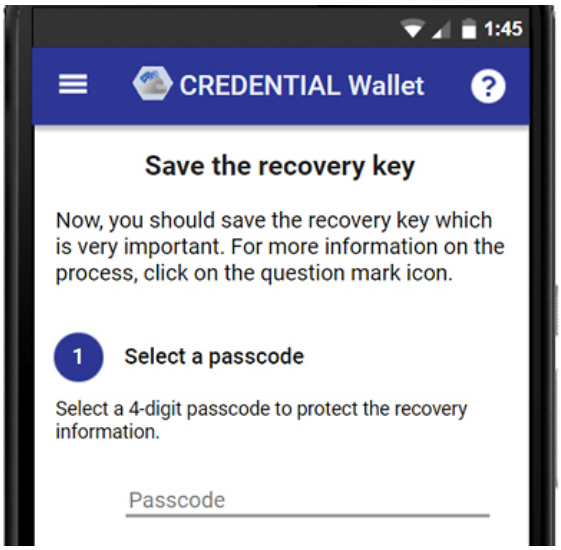

Figure 10: Example of titles and headings

O12 Focus visible: The success criterion states that "Any keyboard operable user interface has a mode of operation where the keyboard focus indicator is visible" (Caldwell et al. 2008).

This success criterion was not applicable at the time of the evaluation as the UI is a prototype.

4.3 Understandable

These following success criteria are related to the principle "Understandable": the user must be able to understand and how to operate the user interface and the information presented to them. (Cooper et al. 2016). The success criteria under the understandable principle will be referred to as "U" and their number by their order of appearance e.g. U1, U2 etc. in this report.

U1 Language of pages: The success criterion states that "The default human language of each Web page can be programmatically determined" (Caldwell et al. 2008).

This success criterion was not applicable at the time of the evaluation as the UI is a prototype.

U2 Language of parts: The success criterion states that "When any component receives focus, it does not initiate a change of context" (Caldwell et al. 2008).

This success criterion was not applicable at the time of the evaluation as the UI is a prototype.

U3 On focus: The success criterion states that "When any component receives focus, it does not initiate a change of context" (Caldwell et al. 2008).

This success criterion was not applicable at the time of the evaluation as the UI is a prototype.

U4 On input: The success criterion states that "Changing the setting of any user interface component does not automatically cause a change of context unless the user has been advised of the behavior before using the component" (Caldwell et al. 2008).

The user is asked for their approval to any changes that are made in the application (see example in Figure 11).

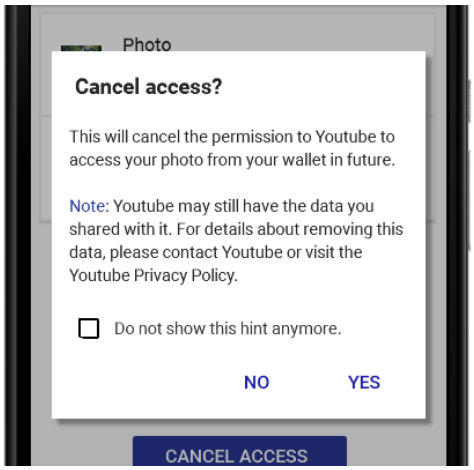

Figure 11: User is asked for approval before permissions change

U5 Consistent navigation: The success criterion states that "Navigational mechanisms that are repeated on multiple Web pages within a set of Web pages occur in the same relative order each time they are repeated, unless a change is initiated by the user" (Caldwell et al. 2008).

The header with the menu in the application, its "tabs," and navigation panel are consistent. Next button and skip button in the same places throughout the application.

U6 Consistent identification: The success criterion states that "Components that have the same functionality within a set of Web pages are identified consistently" (Caldwell et al. 2008).

Most of the icons in the CREDENTIAL app have the same design and have the same label or text, but the icon for "Full name" uses two different icons and are sometimes just called "Name" (see Figure 12).

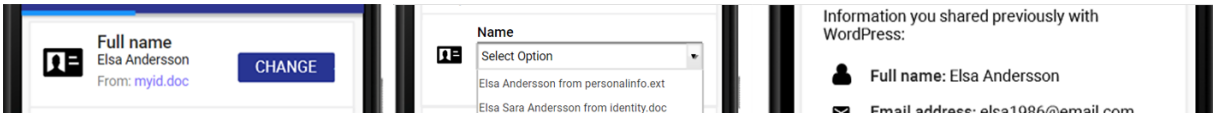

Figure 12: The different icons used for full name

U7 Error identification: The success criterion states that "If an input error is automatically detected, the item that is in error is identified and the error is described to the user in text" (Caldwell et al. 2018).

The input fields show if the data is correct or incorrect with an "x" or a checkmark. Both color and shape are used to identify which input field it concerns. However, when there is an error with the data, there is no text that describe the error to the user.

U8 Labels or instructions: The success criterion states that "Labels or instructions are provided when content requires user input" (Caldwell et al. 2018).

Input fields have labels that describe what kind of data the user should enter and instructions for its length or any formatting rules for the data.

U9 Error suggestion: The success criterion states that "If an input error is automatically detected and suggestions for correction are known, then the suggestions are provided to the user, unless it would jeopardize the security or purpose of the content" (Caldwell et al. 2008).

The input fields during the registration show the user that the input is wrong with a red "X". However, to prevent jeopardizing the security of users, wrong input fields for sensitive contents like passwords are not accompanied by a suggestion for correction.

U10 Error prevention (legal, financial, data): The success criterion states that "For Web pages that cause legal commitments or financial transactions for the user to occur, that modify or delete user-controllable data in data storage systems, or that submit user test responses, at least one of the following is true:

1. **Reversible:** Submissions are reversible.
2. **Checked:** Data entered by the user is checked for input errors and the user is provided an opportunity to correct them.
3. **Confirmed:** A mechanism is available for reviewing, confirming, and correcting information before finalizing the submission" (Caldwell et al. 2018).

Before a change is made the user is shown a description of what is about to be changed, and the user is then asked to confirm the change either by clicking "YES" or using their fingerprint pattern (see Figure 11). Also, when the user gives permission for a lot of their information to be accessed at one time the user is shown an overview of the information before they can continue to confirm, e.g. when they are handling a registration request from a service provider. See Figure 13 for an example of the user giving access to name, email address and birthdate information to the service provider WordPress.

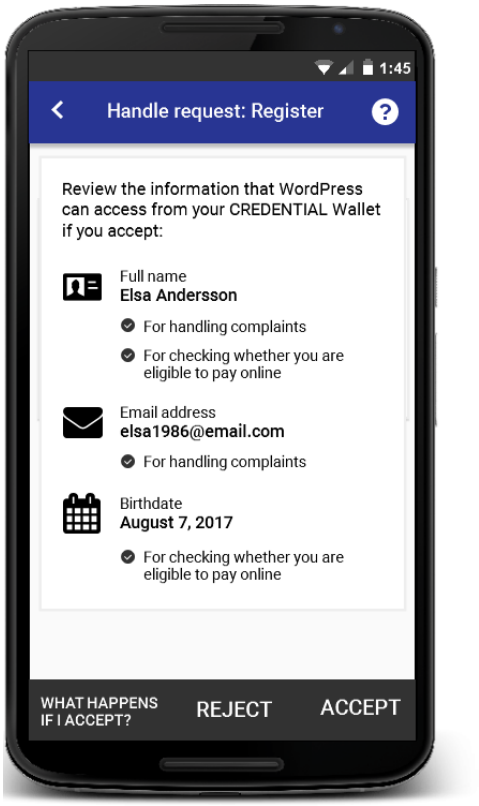

Figure 13: Overview of information

4.4 Robust

These following success criteria are related to the principle “Robust”: the content must be able to be interpreted reliably by advancing technologies and user agents. The content must continue to be accessible. (Cooper et al. 2016). The success criteria under the robust principle will be referred to as “R” and their number by their order of appearance e.g. R1, R2 etc. in this report.

R1 Parsing: The success criterion states that “In content implemented using markup languages, elements have complete start and end tags, elements are nested according to their specifications, elements do not contain duplicate attributes, and any IDs are unique, except where the specifications allow these features” (Caldwell et al. 2008).

This success criterion was not applicable at the time of the evaluation as the UI is a prototype.

R2 Name, role, value: This success criterion states that “For all user interface components (including but not limited to: 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, including assistive technologies” (Caldwell et al. 2018)

This success criterion was not applicable at the time of the evaluation as the UI is a prototype.

5. Results from the Interview

The interview was conducted in Swedish and was translated into English for this report. The text inside the brackets *"[like this]"* are comments added afterwards. They were added to make the text easier to understand, or to make the reader aware of things happening during the interview that could not be recorded by sound.

5.1 Transcript of the interview with A1

As the A1 has a severe visual impairment it was agreed on that he would consent to the consent form by voice recording.

[A1 agree to the consent form and to the use of a video camera]

Type of assistive technology and problems with compatibility:

What kind of assistive technology do you use for your phone?

I use Voiceover.

That is Apples text-to-speech?

Yes, exactly. It is their screen reader in their phones that I use. And at the moment it is still the best one on the market, even if the others are starting to catch up, Apple are still the best.

Do you use any other functions in your phone that assist you? Apps?

[The way I formulated my question was a bit confusing and he interpreted it as: if he used any apps.]

Apps? Yes, I use everything, for messages, internet, mail, everything. I use everything in my phone.

Do you have any problems that you encounter often when you use your phone?

All apps you download, all are not compatible with Voiceover. That is understandable, if you make an app for a Bluetooth thermometer it is in English when it is released. It works somewhat alright with a bit of thinking, you can figure out how it works. Everything is made for sight. In some apps buttons doesn't work because they are not compatible.

The importance of the order of information:

[Video cut off for a few seconds, but he said that it would have been better if the departure time of the buss would have been read aloud first]

Now I have to listen to everything *[all the other information about the buss]* for us it is important that information is put in the right order as well.

Problems with invisible functions:

[He opens a wallet application and opens a train ticket]

Here for example when you close this *[the open ticket]* there is not one *[a close button]* and before I figured out how to close it, I did not understand it, that I had to click on it. *[He had to*

click on the ticket field directly as there was not button] Before I figured it out I was searching and searching for a close-button. I was thinking "can't it read the close-button?", but there wasn't one, you had to click on it [*the ticket field]*.

Nothing explained how to close it?

No, nothing at all. I thought that "well I can try to do it that way", and then it worked. I think that was failure *[with the design]* because when you cannot see, you would like to know that there is a close-button. It is not easy to figure out how to close it, if there is nothing there explaining how to close it.

How audio controls work and repeat of how to use VoiceOver:

[He opens a page on the internet with audio controls to show how he uses them. He focuses on the play button and double tap on the screen with two fingers to start it]

If I wanted to make it quiet *[pause it]* then I just do it like this with two fingers. If I want to start it again I do that. *[tap with two fingers again]*. It is the same with radio and others like this. You can start and stop the latest played like this. If you listen to the radio in the morning and then want to do something else then you just click like that *[to pause it]* and then you can start it up again like that, in an hour or two, or two days. It is the last thing that was played that you can do this with.

So this I how I work with it *[VoiceOver]* either you go step by step or like how I do it, some go step by step and click with one finger or like I do; searching for what I want and then click like this *[holding a finger on the thing he wants to click on and taps the screen with another finger]* it feels more comfortable for me and it is quicker like that.

More compatibility issues:

[He opens the note application]

This is something I don't use, notes *[the app]*, every once in a while, but… Some of the apps that comes with the phone, it's the same with reminders, it is a bit difficult as it is made for sighted people.

One app that is not very good is this app, "Biblio", *[He clicks on the app]* the login is kind of difficult. Now I am logged in already, but the log in is really difficult to work out because it is not really compatible with Voiceover, they are working on it as it is a new app so has become a lot better [*than in the beginning]* they have solved the issues over time ,it didn't read the buttons, like play, forward and pause among others *[now they are fixed]*. When you have logged in I think it is works fine, but the log in is still strange.

Floating buttons:

Floating buttons is fairly common, does it [VoiceOver] read those?

That is something that I don't really know how it works. Let's see…

[He opens up an app that I say has a floating button and I show him where it is placed in the application. After trying for a bit, he gets VoiceOver to read it out loud, but only by clicking

directly on the button. It didn't pick it up when using the swiping method and he could only find it with help.]

Braille display:

Are there other assistive technologies to use with smartphones, like braille displays?

Yes, there are multiple that works with iPhone, for example I think one is called Vario Ultra, and that is a braille display with keyboard for braille. You can use it to write or orient yourself in your phone.

Do many people use them?

No, not that many.

Do people mostly use text-to-speech?

Yes, that is the most common, but some use braille keyboard, and some use a normal keyboard. The advantages of the braille keyboard are that you can check what you have written, and you don't need to have the voice read it aloud. That is the advantage. If you are sitting in a meeting and write notes you can silence the voice on your phone, and when you write you have, for example, a 40-character braille display so that you can read what you wrote. You don't disturb others. If you use a normal keyboard you need to have the voice on and use headphones. Then you hear the voice in the headphones but then maybe you can't focus on the what is said during the meeting. It is people that are good at writing braille that use them.

[He mentioned that he is thinking of buying one at the moment]

Most people use text-to-speech. Some use braille displays for work for tablets and phones. They are quite expansive if you buy them yourself.

Elderly and Assistive Technology:

Do the elderly use assistive technologies?

We had a day *[introducing assistive technologies]* last year in September, and the majority were over the age of 69, and after that day many became interested and bought an iPad or iPhone and have started to use this new technology. There was a lady that didn't have a smartphone, or anything else. No computer. She bought herself an iPad and now she does everything with her iPad, mail, banking, paying her bills and everything. A whole new world opened for her when she could do things by herself. There are two camps; those who go "no, no, no" and those who completely embrace it. Some are a bit in between, but usually you are either scared of it or you are completely sold on it. But, there are a lot now I think, when you are on courses and conferences people of almost all ages have a smartphone now. Regardless if they are 30 or 75, almost all have a smartphone, and it is almost only iPhones.

Cost Android vs. iPhone:

There are completely different prices *[talking about Android Phones compared to iPhone]* then it might be unnecessary to pay 7000 SEK for a phone *[iPhone]* when you only use the magnification. Then you can maybe buy an android for 2000 SEK instead. I usually recommend

to those who only need to use a magnification function, sure if they want an iPhone, but there is just as good alternative for much cheaper. But a large majority uses iPhone among the visually impaired.

BankID and Swish:

How does BankID[10] and Swish[11] work with a screen reader?

It works very well.

Does it not read it [pin code] out loud?

Yes, if I use bankID then I recommend headphones if you are around other people. It will read what you type out loud even if the numbers on the screen turns into stars.

5.2 Transcript of the interview with A2

Type of assistive technology:

You have an Android phone, yes?

I do.

Which functions do you use to assist you?

I use magnification and zoom sometimes, and I have customized the keyboard, so the keys are a bit clearer. *[se example of the keyboard in Figure 14 and Figure 15]*

Figure 14: Example of the high contrast keyboy in an Android phone – Capital letters

[10] BankID is a mobile id application in Sweden
[11] Swish is a mobile payment application in Sweden

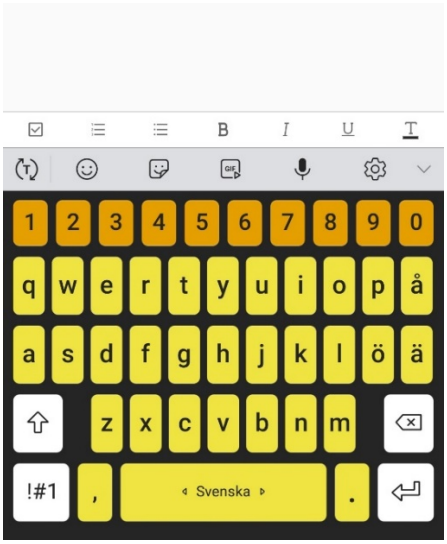

Figure 15: Example of the high contrast keyboy in an Android phone – Lower-case letters

Use of iPhone among persons with a visual impairment:

I have been told that many people use iPhones-

Yes, there are many, many people with visual impairment that do uses it from what I have understood. I can understand that they do because it seems like the screen reader is more easily navigated in the iPhone. But I have yet to start using it.

Accessible Keyboard and Magnification:

[She shows me on her phone how her keyboard looks like]

If I want to write with capital letters I click on this *[she clicks on the button for capital letters*] then they change appearance.

Do you think the magnification works well in Android?

Yes, I think so. So far so good.

BankID and Swish:

Do you use BankID or Swish?

It is on my to do list.

So, you don't use it right now?

No not right now.

Accessibility Problems:

Is there something you have noticed when you user you phone that often is a problem, or a problem that appears in apps or on the internet?

Some websites can be very cluttered and hard to navigate. I think that is that is the biggest issue I have. Many small things and many menus and submenus all over. If I click in one area the something disappears over there. It is probably thing that is not only a problem form me as visually impaired, but probably a general problem.

Do you have a specific webpage that you could think of that has that problem?

If clasohlson.se has not improved; it was terrible. There was a menu that, this is in the computer, when I held the mouse over it the it appeared but as soon as a moved slightly then it disappeared. It didn't stay open. It came and went.

Floating buttons:

Have you ever heard of floating buttons?

No, I don't recognize that term.

[I explain to her what it is]

Is it like this one? *[Shows me the button for Facebook messenger on her phone]*

Yes

Yes, then I have encountered those. Sometimes I accidental push it when I'm doing something else.

Color contrast:

How is it for you with colors? Is it often you come across apps that have bad color contrast?

Yes, I have problems with that. Both on the computer, phone and on paper.

6. Analysis

6.1 Analysis of the Accessibility Evaluation

P1: Non-text content: The success criterion would be met if all the non-text content had alt-texts explaining their purpose. The UI meet the success criterion to the extent of what is applicable as the UI is not a functioning application and alt-texts are not implemented yet. For this reason, this success criterion will be counted as have been meet met but will be marked with a "*" to show that it has non-applicable parts.

P2 Audio-only and Video-only (Prerecorded): As the content of application does not include any prerecorded audio or video the application meets this success criterion.

P3 Captions (Prerecorded): The application does not include any prerecorded audio in synchronized media the application meets this success criterion.

P4 Audio Description or Media Alternative (Prerecorded): The application does not include any time-based media the application meets this success criterion.

P5 Captions (Live): The application does not have any live audio content therefore the application meets this success criterion.

P6 Audio Description (Prerecorded): The application meets this success criterion as there are no prerecorded video content in the application.

P7 Info and Relationships: Being presented with a lot of information could be overwhelming to the user, especially on the smaller screens of mobile devices. To avoid this all information, structures and relationships just conveyed through presentation do not have corresponding text in the UI. However, for visually impaired users to be able to use the app anything that is just communicated by presentation should be programmatically determined.

P8 Meaningful sequence: In some parts of the UI the sequence of which the content is presented affects the contents meaning, e.g. the timeline view (see Figure 16). This should be programmatically determinable to allow users with a visual impairment using a screen reader to grasp the right sequence of the content. This should be considered during further development.

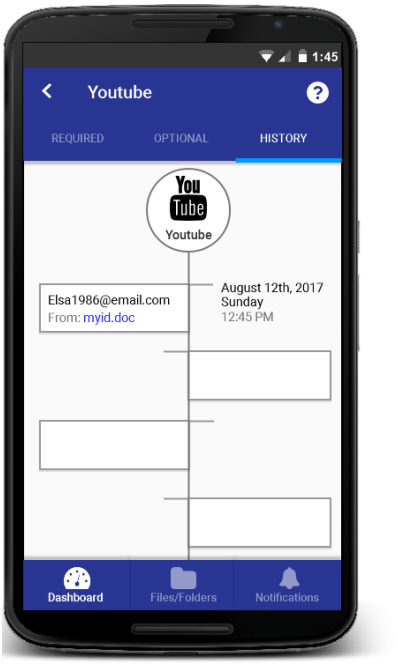

Figure 16: The timeline view in the CREDENTIAL application

P9 Sensory characteristics: The input fields have no text that tells the user if the if the inputted data is correctly or wrongly formatted; it uses icon as the only indicator. It would be good to have text close to the related input field for users with screen readers to know that the inputted data is correct or incorrect.

In some parts of the app a question mark is present for users to click on to get help if they do not understand what to do on that page. But in the text, it only says to click on it if they need more information about the process on the page, not mentioning how to find the buttons location or a description of the button itself. The only way for the user to find it is visually. The success criteria give an example of using both location and color to assist the user. An example of this could be “The blue button with the question mark in the top right corner”. The user is then helped with where to start looking for the button and for users that might have a hard time distinguishing different buttons knows what to look for.

P10 Use of Color: The color is not used as the only way of conveying information, indicating an action, prompting an response or distinguishing a visual element. When a user correctly or incorrectly fills in the input fields in the application they are either presented with a green checkmark or a red “X” depending of the input is correctly formatted; both shape and color are used. The same goes for the icon for successful unlocking with the use of the user’s fingerprint; the text goes green and the text changes to a green checkmark icon. However, it is still important to still think of success criteria P1 as the icons used in this situation are non-text content and they should have alt-text for users with a visual impairment who uses screen reader to operate the application.

P11 Audio Control: As the UI of the application does not include any audio that plays automatically no audio controls are needed. The application meets this success criterion.

P12 Contrast (Minimum): During the evaluation 32 different colors where identified. 10 of these colors did not meet the success criterion and 5 of these 10 colors where different shades of gray text on white backgrounds, other gray colors were also used that did meet the success criterion. It is unnecessary to have these many different shades of one color and as there were other gray colors that passed the contrast ratio one of these could be used instead. The other colors that did not pass should also be changed to ones that meet the success criteria as the texts right now, with the contrast color ratio that it currently has, would be difficult, if not impossible, for people with visual impairments to read.

P13 Resize text: The app has a setting to change the text size in the app, but this setting is not available during the introduction. To access the setting the user would have to close the introduction and go directly to the registration page where the menu where the settings can be found is visible. It might be a good idea to make the resize text, text color and language settings available in the introduction.

P14 Images of Text: As the CREDENTIAL logo does not have text in it (there are text to the side of it, not in the logo) and the logos of service providers have their name next to/below the logo, no text is inside of a logo or an image. This meets the success criterion.

O1 Keyboard: As the consideration for use of the keyboard to operate the application was made during the design of the UI and no special gestures are required this meets the success criterion.

O2 No Keyboard Traps: This success criterion is not applicable at the time of the evaluation as the UI of the application is only a mock-up and not a functioning application. The criterion should however be considered in further development. Every item in the app that is selectable should be able to be focusable by using the keyboard. The user should also be able to defocus every focusable item so not to trap the user on that particular item.

O3 Timing Adjustable: The user is able to turn of the time limit for signing out automatically. There is a time limitation of 30 minutes for locking the application and for the permission dialogues, this does not meet the success criterion of extending the time limit at least ten times the length of the default setting. However, this time limitation is set because of security concerns. This meets the success criteria.

O4 Pause, Stop, Hide: As no part of the content in the application blink or scrolls or move automatically UI meets the success criterion.

O5 Three Flashes or Below Threshold: The application meets this success criterion as not part of the UI flashes more than three times per second.

O6 Bypass Blocks: As the only thing being repeated in the UI is the header and sub header the it should not negatively affect the user’s interaction with the main content, therefore the UI meets this success criteria.

O7 Page Titles: As all pages of the UI have a title describing the main content of that page the UI meets this success criterion.

O8 Focus Order: This success criterion is not applicable as the UI is not implemented but should still be considered in further development of the app. If the sequence of focusable elements in the app is essential to its meaning or operation, then it should receive focus in that order to preserve meaning and operability. E.g. users who use an external keyboard to maneuver the application should be presented with the components in the same order as a person whom do not use a keyboard if that order is important for the user to understand the content correctly.

O9 Link Purpose (In Context): All links have a "name" describing its purpose therefore the UI meets this success criterion.

O10 Multiple Ways: There is a search function available when needed and there are multiple ways of finding a web page among a set of webpages by either the menu in the header or by using the navigation panel. The exception being if the page is a step in a progress were he user needs to complete the process or cancel it before they can go to another part of the application. This meets the success criterion.

O11 Heading and Labels: The UI has labels and headings to show the purpose or topic of the content, this meets the success criterion.

O12 Focus Visible: This success criteria are related to O8 Focus order, every element that is focused need to be visibly distinguishable from other elements in the UI. This is necessary because the user needs to be able to clearly see what is focused on the screen. As O8 Focus Order is not applicable at this time this success criteria are not either, but it should be considered during further development.

U1 Language of Page: As the application is a prototype this success criterion is impossible to evaluate, but is should be considered in further development to make the language of a page should be programmable determined.

U2 Language of Parts: To meet this criterion, which is a stricter version of U1 Language of Page, the application needs to have the language of each passage or phrase in the content to be programmatically determined. For example, a German word in an English sentence.

U3 On Focus: The success criterion says that focusing and defocusing on elements in the application should not initiate any change in the context. For example, a button should not get clicked if it is focused on or a form should not be submitted if one of its elements gets focused on. This would make it very hard for a person using their keyboard to maneuver the application to do so as the they would accidentally click or submit things without wanting to do so. This is not applicable at this time as the UI is not implemented but should be considered in further development.

U4 On Input: The user is asked for approval before making changes, therefore the UI meets the success criteria.

U5 Consistent Navigation: The navigation in the application is consistent; the menu and navigation panel are in the same place and so are the buttons like "skip" and "next". This meets the success criterion.

U6 Consistent identification: The icons and text that has to do with “Name” does appear in different combinations throughout the application. Two different icons, as well as two different titles for the icons with “Name” and “Full name” are being used. According to the success criterion this should be consistent through the app, using different icons and titles could be confusing for users especially if they have cognitive disabilities.

U7 Error Identification: No text is visible in the prototype that describe what the error is when an error is detected in the input fields, only a red “X” is presented to the user to show that something is wrong. The related document for understanding this success criterion states that “Screen reader users, for example, will not know there was an error until they encounter one of the indicators. They may abandon the form altogether before encountering the error indicator, thinking that the page simply is not functional.” (W3C 2016). There should be a text that describe the error in order to meet the success criterion.

U8 Labels or Instructions: The input fields of the application have labels that describe what kind of data the user should enter and instructions for its length or any formatting rules for the data, this meets the success criterion.

U9 Error Suggestion: The input fields show when an input is wrong except when such error suggestions would jeopardizing the security of the application, E.g. with passwords or other sensitive data. The application meets the success criterion.

U10 Error Prevention (Legal, Financial, Data): The user needs to confirm to changes before they are made, either using their fingerprint or click a button depending on what kind of change is about to be made. The user is also shown a description of the change. When a lot is information is provided by the user, e.g. when handling a registration request from a service provider, the user is shown an overview of the information that they are going to give the service provider access to and has to confirm it before the process can be completed. This meets the success criterion.

R1 Parsing: This success criterion is focused on web page design and HTML codes, and it emphasizes that assistive technology should parse the content accurately without crashing (e.g., by using start and end tags properly). App developers should adopt this criterion and tailor it to fit their context of use. The success criterion is not applicable at this time but should be considered during further development of the application.

R2 Name, Role, Value: This success criterion is focused on web page design and HTML codes, and it emphasizes that different UI components should be compatible with assistive technologies (e.g., by providing a role, state, and value information). The success criterion is not applicable at this time but should be considered during further development of the application.

6.2 Table of evaluation results

The following table shows the met, failed and non-applicable success criterion for each of the four principles of perceivable, operable, understandable and robust.

Principle	Met	Failed	Non-applicable
Perceivable	9*	3	2
Operable	9	0	3
Understandable	5	2	3
Robust	0	0	2
Total	23	5	10

Table 4: Table of evaluation results

6.3 Additional Analysis with the WCAG 2.0 for Mobile Document

Smaller screen sizes: The form fields in the CREDENTIAL app have their labels either above, inside or under them. In accordance with the Patch et al. (2015) the labels are not placed next to the form fields.

Zoom and magnification: The CREDENTIAL application has settings where the user can increase the text size in the "Color and font-picker" settings to fit their needs (see Figure 6). This is not magnification per say, but it does help the user similarly as it does increase the size of the text content. Furthermore, Android phones do have magnification and zoom functions-built in.[12]

Contrast: The CREDENATIAL application's UI do not have any large text that has the lesser contrast ratio (That is allowed for bigger text). However, some contrast ratio for the default small text does not meet the contrast success criterion of WCAG 2.0 (see P12 Contrast (Minimum))

Touch target size and spacing: The touch targets in the app do overall to have some amount of whitespace around them, with the exception of the floating buttons as they can cover other objects. This could lead to some issues regarding accessibility for the visually impaired using screen readers. A setting in which the floating buttons could be switched off in the settings menu could be a solution to this problem, but an alternate way for the users who choses this option to access these functionalities would be needed to be designed.

The size of the touch targets is harder to determine presently as this version of the UI is only a prototype (not to scale with a real mobile device screen).

Placing buttons where they are easy to access: The accessibility of the buttons placement would need to be user tested to be properly evaluated.

Change of the screen: In future development it should be considered to enable the application to work in a horizontal orientation as well as the vertical.

[12] https://support.google.com/accessibility/android/answer/6006949?hl=en

Consistent layout: The CREDENTIAL app is consistent with its placement of repeated and navigational components. However, there is an issue regarding the success criteria U6 Consistent Identification.

Positioning important page elements before the page scroll: On most pages in the CREDENTIAL application the user does not have to scroll, but when it is necessary to do so to view the whole page the most important information is placed before the page scroll.

Clear indication of actionable elements: in the CREDENTIAL application the buttons are distinct from other contents by their shape and color, links have a different color compared to the text content, and external links are underlined. Conventional icons are used for the menu (burger icon) and help buttons (question mark) and for the next, back, up, and down controls (arrow icons). The elements should also be programmatically determinable, but as the application is a prototype this is not implemented at this time.

Providing the users with easy methods for data entry: The CREDENTIAL applications uses radio buttons, checkboxes and select menus for the user to select settings or what information to share. The application also gives the user examples of what information from their files they can choose from when handling a request form a service provider.

6.4 Analysis of Accessibility Problems for Users with a Visual Impairment

In the study by Nepomueno Carvalho et al. (2018), mentioned in section 2.6, they identified the 5 most frequent problem categories encountered by users with a visual impairment.

Inadequate feedback: The CREDENTAIAL application's UI does have notifications e.g. when a download is completed (see Figure 17), and the user is informed and asked for approval when changing something e.g. canceling access for a service provider. There are, however, some parts of the UI that are similar to the example given in the study i.e. an expanded panel (see example in Figure 19) that could be confusing to users with a visual impairment. This can however not be stated as facts as user test with real users would be needed to identify these problem areas.

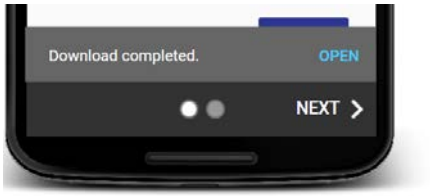

Figure 17: Notification of a completed download

No alternative to an image: The CREDENTIAL application does not present the user with any pictures (except of the ones uploaded by the user themselves), but it does have many different kinds of icons and logotypes. All of these should have alternative text that tell the user what they are. For a similar success criterion see P1 Non-text Content.

Sequence of interaction not clear: This problem is discussed in the success criterion P8 Meaningful sequence. Also, the UI does in many cases present the user with step-by-step

interactions i.e. they need to complete one step to go to the next one. To be sure this is clear to the users it should be tested in user tests. For a similar success criterion see P8 Meaningful Sequence.

Lack of identification of buttons: As the UI is only a prototype this is not implemented yet. But the developers should think of the associations between buttons and any external texts in further development. One example of this in the UI is presented in Figure 18. For a similar success criterion see P1 Non-text Content.

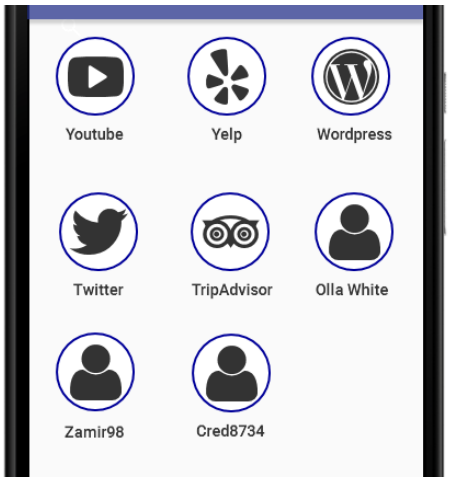

Figure 18: Buttons with external texts

Interference of functionality that does not exist: The CREDENTIAL application does use multiple radio buttons, toggles and checkboxes. Developers should think of the association between them and their accompanied texts labs to make sure that it is clear to the user that it is not the text itself that has the functionality of these form elements. For a similar success criterion see P1 Non-text Content and U8 Labels or Instructions.

Out of the 5 user problems from the study by Nepomueno Carvalho et al. the one that does not seem to have any corresponding (or similar) success criterion in WCAG 2.0 is the Inadequate Feedback. This should be thought about in further development as this could possibly be a big problem for the users who cannot see the applications response from their interaction with the application.

6.5 Analysis of Interviews

6.5.1 Order of information

A1 talked about the importance of the order information is in. He says that when using a screen reader, it is irritating to have to listen through a whole list of other things before getting to the information that he needed. The order of things should be though about when creating alt-texts for UI elements, it might be a small issue as it does not hinder the use of the application per say, but it makes the time it takes for the users with visual impairment to get the information they want longer, and it could feel tedious to use the application. One example where this could be applied to the CREDENTAIAL application is in the timeline view. In a timeline the time something happened is the most important and should reasonably the thing that is presented first to the user.

6.5.2 Floating Buttons

During the interview with A1 he said that he did not know about the presence of such a button used in another application. VoiceOver (Apple's screen reader) did not pick up on the button when swiping from object to object; it skipped it entirely. It did, however, read the button's text aloud when it was clicked on directly, but user needed guidance to be able to find it. A2 had never heard of it but new what it was after having it described to her. She notes that she accidentally clicks on such buttons sometimes, without meaning to. Floating buttons sometimes appears on top of other content, this could possibly be difficult for a user with a visual disability using the CREDENTIAL application, as it was for A1. This should be tested in a user test to see if other user has this problem in the CREDENTIAL application.

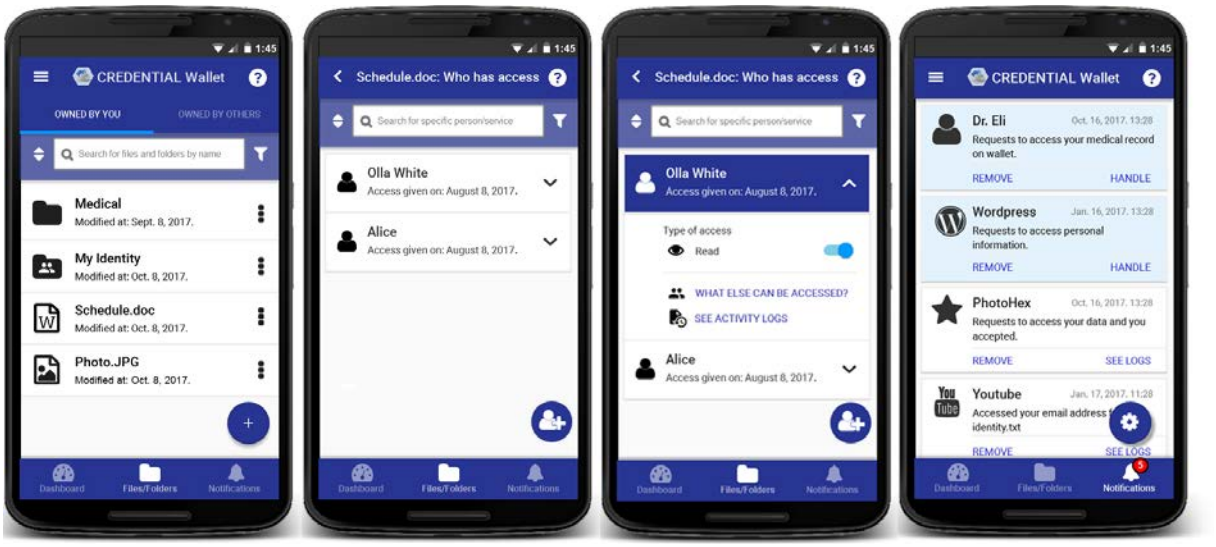

Figure 19: Non-text content: Floating buttons

6.5.3 Application for IOS

Both participants agreed that the most common mobile device among other people with visual impairments that they knew was iPhone, because the opinion among the community is that it has a better screen reader. It should be taken into consideration to make an application for IOS as well as android phones.

7. Conclusion

7.1 Evaluation

The evaluation was done to answer the following two questions:

- Does the CREDENTIAL wallet's UI meet the European standards for accessibility?
- In the case of not meeting a standard, why is it not met and what can be improved to meet the standards?

This accessibility evaluation showed some areas in the V2 of the UI that should be considered for further development. The Evaluation resulted in 23* met success criteria, 5 success criteria not being met and 10 success criteria that is not applicable at the time of the evaluation.

The "*" means that the success criteria have non-applicable parts, but that it is met to the extent of what is applicable to the prototype at this time.

Failed success criteria
P9 Sensory Characteristics
P12 Contrast (Minimum)
P13 Resize text
U6 Consistent Identification
U7 Error Identification

Table 5: Table of failed success criteria

P9 Sensory Characteristics: The input fields need text telling the user of the input is rightly formatted, and when telling the user to find something in the application the user needs to be given more than more guidance not just to find it visually, e.g. click the help button, a better solution would be to use both color and location of the object.

P12 Contrast (Minimum): 10 text colors (against another colored background) used in the application does not meet the success criteria, these should be changed to ensuring that users with a visual disability will be able to read the content.

P13 Resize text: The application should allow users to change the text size from the introduction screens which is not possible in V2 of the UI.

U6 Consistent Identification: The icons for name have two version and are sometimes called "Full name" interchangeably with "Name". These icons should be the same and have the same label.

U7 Error Identification: The application should have text describing the errors that occur when a user uses the wrong formatting when for their data in the input fields**.** This is necessary for users using screen readers.

7.2 Problems for Users with Visual Disabilities

The research question regarding visual disability was:

- What other accessibility problems exist for the visually impaired community specifically?

From the study conducted by Power et al. (2012), it looks like many problems people with visual disabilities experienced are not addressed even when following the WCAG 2.0 as they state that only 50.4% of the problems that the users had experienced was covered by the guideline and that despite following the guideline some of the problems that are supposed to be solved by meeting the guideline still remained.

Nepomueno Carvalho et al. (2018) brings up the 5 main problem categories encountered in his study and 4 of these are similar to what is covered by WCAG 2.0. The one that is not covered by the guideline is the Inadequate Feedback, not receiving feedback could result in confusion of the user. Some parts of the application such as the extended panels could have this issue.

During the interview order of information and the use of floating buttons where discussed. Floating buttons caused problems for A1 as his screen reader had trouble picking up on the button “floating” over the other content. As the CREDENTIAL application has such buttons it should be tested to see if users have problem using them. The importance of the order of information was another thing mentioned by A1, this should be thought about when implementing the application.

Both A1 and A2 were under the impression that most users of screen readers in their community used Apples iPhone and their screen reader VoiceOver. If such a large part of the community uses IOS devices a consideration should be done about making a version of the application for the IOS operating system as well as for Android devices.

7.3 User tests

It is difficult to say exactly what kind of problems people with a visual impairment would experience using the CREDENTIAL application without conducting user tests with said users. This is not only important to do with people with visual disabilities but also with people with other disabilities. User test should be conducted to get the users own insight to the specific accessibility of the CREDENTIAL application. As Schulz et al. (2015, p.16-17) say, people who have a disability are the experts with assistive technology, and they can identify issues that a person who do not have any disabilities can.

7.4 Self-criticism

During the accessibility evaluation interviews were conducted to gain knowledge about how visually impaired users used their mobile phones. The focus on users with visual impairments was requested by the CREDENTIAL project, but to get a complete picture on how users with different disabilities use their mobile phones it would be necessary to interview people with other disabilities too, as users with a visual impairment are only one part of the community that would benefit from a more accessible application.

No definite conclusions can be made from a sample size of only 2 interview participants, if one would like to find problems the persons of the visually impaired community are experiencing one would need to use a bigger sample size. The interviews in this thesis was more to get an insight in of how it was for a visually impaired person using these assistive technologies and gain some first-hand knowledge by talking to them directly.

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Appendix – Consent Form (Swedish)

Samtyckesformulär

Syftet med denna intervju är att undersöka hur tillgängligheten kan förbättras i CREDENTIALs applikations användargränssnitt. Denna undersökningen görs inom CREDENTIAL projektet i samband med en kandidatuppsats av Elin Nilsson.

Om du samtycker till deltagande i denna intervju:

- Kommer en ljudinspelning göras under intervjun. Ljudet kommer sedan att transkriberas och användas i Elin Nilssons Kandidatuppsats och inom CREDENTIAL projektet.
- Du kommer att få några demografiska frågor under intervjun, som ålder och kön.
- Om du godkänner att en videoinspelning görs under intervjun kommer en kamera att användas för att spela in hur du interagerar med din mobiltelefon. Ditt ansikte kommer inte att filmas.

Tänk på att:

1. Deltagandet i denna intervju är frivilligt och helt anonymt.
2. Du kan avbryta intervjun när som helst utan förklaring.
3. All information som du ger under intervjun kommer att hållas konfidentiellt och obehöriga personer kommer ej kunna få åtkomst till den.
4. Inspelningarna och den insamlade data kommer att förvaras under en period upp till 10 år, på grund av universitetets regelverk, om du väljer att delta. Om du väljer att inte delta, under pågående intervju eller efter avslutad intervju, kommer din data att bli raderad och inte användas därefter.
5. Resultaten kan komma att användas inom projektrapporter och Elin Nilssons kandidatuppsats.

Karlstads universitet är forskningshuvudman och personuppgiftsansvarig. Enligt personuppgiftslagen, PUL, (dataskyddsförordningen från och med den 25 maj 2018) har du rätt att gratis få ta del av samtliga uppgifter om dig som hanteras och vid behov få eventuella fel rättade. Du har även rätt att begära radering, begränsning eller att invända mot behandling av personuppgifter. Det kommer även finnas en möjlighet att inge klagomål till Datainspektionen. Kontaktuppgifter till dataskyddsombudet på Karlstads universitet är dpo@kau.se.

Jag godkänner användningen av en filmkamera:

JA □ NEJ □

Jag samtycker till dataanvändningen.

Signatur: _____

Namnförtydligande: _____

Datum: _____

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