DIGITAL EQUALITY IN DIGITAL SOCIETY - ACCESSIBILITY FEATURES OF MOBILE APPLICATION

A narrative literature review

AUTHOR   Pekka Heikkinen

SAVONIA UNIVERSITY OF APPLIED SCIENCES

THESIS
Abstract

Field of Study	
Social Services, Health and Sports	
Degree Programme	
Master's Degree Programme in Digital Health	
Author(s)	
Pekka Heikkinen	
Title of Thesis	
Digital Equality in Digital Society – Accessibility Features of Mobile Application	
Date 7.12.2021	Pages/Appendices 38
Client Organisation /Partners	
Finnish Social Security Institution	

Abstract

The purpose of this thesis was to find out and describe what factors in mobile applications indicated accessibility of mobile applications. The aim of the thesis was to gather this information for the client of this thesis, Kela, and to provide it in a compiled manner for the development process of accessible mobile applications.

The research method of the thesis was the methods of the narrative literature review. The narrative literature review is used in studies aimed at creating the widest possible overview of the topic under investigation. The literature review data consisted of nine studies(n=9) and the data was collected from the following databases; Pubmed, EBSCOhost / Cinahl complete, ScienceDirect and Scholar Google. The dataset was limited to 2015–2021 and used search terms were accessibility, mhealth, mobile health, mobile phone, smartphone, mobile application, app, usability, user needs and self-management. The data was analyzed by thematic analysis method.

The results of the research showed that accessibility is reflected in mobile applications as technical features and cognitive properties. Technical accessibility is related, for example, to the mobile application user interface, which must be clear and logical and available using assistive technology if necessary. Proven features also include applications predictability and mobile intuitiveness. An accessible mobile applivation can provide tips and instructions when needed. Cognitive accessibility, on the other hand, describes the clarity of the content and information of the mobile application. All user group benefits from the accessible services.

Keywords
Accessibility, mhealth, mobile health, mobile application, application

CONTENTS

LIST OF FIGURES AND TABLES

1   INTRODUCTION

Accessibility is intended to promote equality. In the digital world, accessibility means that every user, regardless of their characteristics, is able to use a digital service or application. Accessibility can be seen as a model in which the starting point is to pay attention to people's diversity and different ways of acting and perceiving information. Accessibility is a broad concept. What is achievable for me can be completely unaccessible for another person. It is estimated that 20% of Finns need accessible services in order to be able to operate in a digital environment (Selovuo 2019, 15).

According to the digital services act (306/2019), mobile application provided by a public authority or other comparable operator must be accessible from 23 June 2021. The mobile application must be such that each user, regardless of physical or cognitive limitations, is able to use it or, if necessary, is assisted by assistive technology. Accessibility is an important factor in considering the digital services of the future in social and health care. Mobile healthcare solutions (Mhealth) can be one factor in responding to more equitable access to healthcare.

The client organisation of this thesis is Finnish Social Insurance Institution, Kela. The purpose of the thesis is to find out in the form of a literature review what factors affect accessibility from the user's point of view. This information can be utilized by the client in the development work of the Kanta mobile application. In this thesis, accessibility is assessed on the basis of WCAG (Web Content Accessibility Guidelines) guidelines and criteria. The WCAG guidelines consist of four different factors, which are perceivable, understandable, operable and robust. WCAG criteria provides a good basis for assessing digital accessibility. The criteria do not provide direct answers to all accessibility challenges, but they do serve as a good guide for application design and development.

This thesis does not provide direct technical guidance on how to build an accessible mobile application. The literature review gathers information on the accessibility of mobile applications and this information can be applied to other development work. The results can also be used and applied in other digital service design work.

2 DESCRIPTION OF THE BACKGROUND ORGANIZATION OF THE THESIS

The following section introduces the background organization of the thesis. The presentation is made for the reader of this thesis to understands in more detail the context in which the thesis is placed. The section briefly describes the operations of Kela and Kanta services.

2.1 The Social Insurance Institution of Finland and strategic objectives

The Social Insurance Institution of Finland, Kela, established in 1937, provides social security coverage for Finnish residents and Finns who are living abroad. Kela provides basic economic security in a situation when a person can't providet it for self. Examples of social security coverage offered by Kela can be basic social assistance, rehabilitation, family assistance, health insurance, basic pensions and finance aid for students. (Kela 2021.)

Kela provides customer services in many ways and a customer can choose the option which suits the best. Services are available online, by phone or e-mail and in local customer service locations. Online and Interner services are fast way to handle Kela matters. Via online services customer can for example apply most Kela benefits and see application and payment details. Strong identification is needen when accessing to online services. Phone service is provided in Finnish, Swedish and English and the service is devided into different life situations. Customer service location are open at weekdays between 9.00 to 16.00. Customers can also get service at a citizen service checkpoint where where application and online service is also provided. (Kela 2020.)
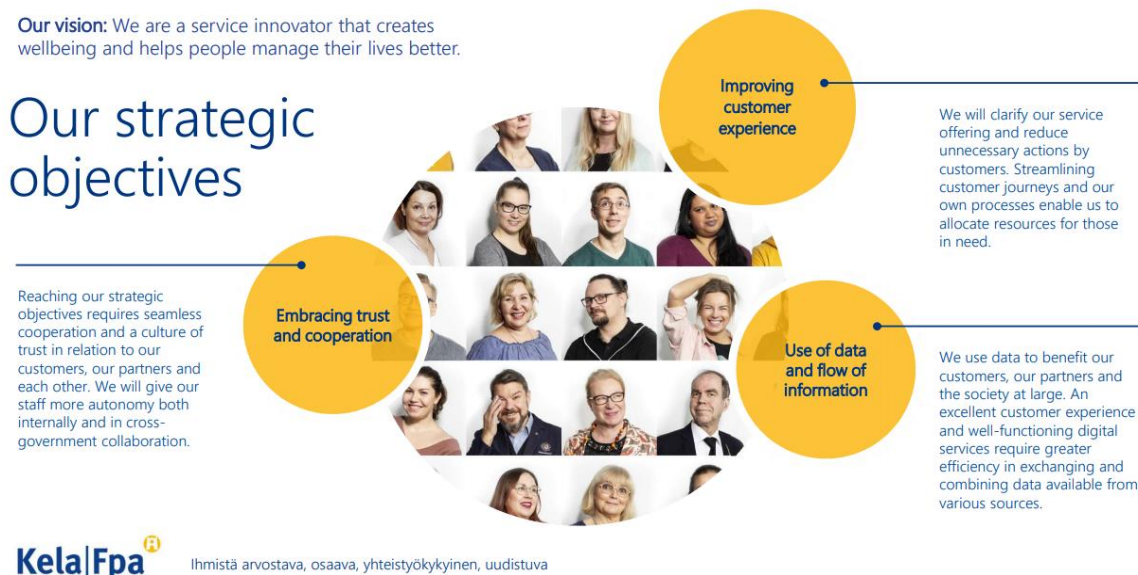
FIGURE 1. Strategic objectives of Kela (Kela 2021)

Figure 1. clarifies Kela´s strategy. Kela´s strategic objectives are; embracing trust and cooperating, improving customer experience and use of data and flow of information. Embracing trust and cooperating can be exist when trust inside one´s organization and between partners increases. Customer centricity and digitalization requires trust between customers, partners and each others. Improvement of customer service exprecience can occure when Kela´s staff have an experience of different customer servicer segments and knowledge of how to provide service in different digital services.

Use of data and flow of information means that Kela´s data and information will be utilized at the level of the individual and society. Developing the customer experience and promoting digitalisation requires combining different sources of information. (Kela 2020.)

The results of my thesis can be utilized in the development of a customer-oriented mobile application. Considering accessibility increases the customer's ability to use the application and at the same time reduces the need to contact with the authorities. Consideration of customers' experiences is a significant part of Kela's strategy.

2.2   Kanta-services

Kanta produces digital social and health care services and it is maintained by Finnish Social Security Institution, Kela. The users of Kanta services are Finnish citizens, public and private social and health care services and pharmacies. Kanta servcies consists of my kanta-pages where a user can browse own medical record, prescription and make an online repeat for prescription. All prescription are issued electronically and dispensed via Kanta services. Kanta-services also include a medicine database. It provides information on medicines and their prices, for example. Patient data repository and client data archive for social welfare services allows centralized archive of electronic social and health care storage. Kanta services includes also the ability to exchange health certificates as well as the Kelain service, where a doctor can make an electronic prescription. Every Finnish citizen benefits from the services. Patient information is always up to date and the patient receives the right kind of care. In addition, the information stored in Kanta allows for better information management and better decision-making. (Kanta 2021.)

The development of the mobile application for Kanta services is related to Kela's strategic objectives. The aim is to develop customer experience and streamline customer processes with different partners. The purpose of the mobile application is to make it easier to use Omakanta-service. This will also enable the reform of social and health care processes. Mobile application will be more interactive than the current Omakanta. Triggers have also been identified in almost all Kanta-services, such as patient data repository and client data archive for social welfare services. The aim is to improve the service and get more users to Omakanta, add a positive image of Kanta services and increase the safe use of the service. (Nurmi 2021.)

3 ACCESSIBILITY, USABILITY AND USER-CENTERED DESING IN MOBILE APPLICATIONS

The following section discusses the most important concepts of the thesis. The key concepts are Ehealth and subcaterogy Mhealth. The concept of Ehealth is also referred to as telehealth and tele-medicine, which are parallel terms. The term Mhealth is used in this thesis. In addition to this, the concepts that support the thesis as a whole are user-centered design and, as the main theory of the thesis, the theory of accessibility. This entity is finally intertwined with a theoretical description of usability. A more detailed description of each concept can be found in its own paragraph.

3.1 Mhealth as an enabler of more equitable health care services

Digital health or Ehealth refers to the use of ICT technology in support of health. Mobile health, mhealth, is a subset of ehealth and it can be defined as a use of wireless and mobile use of technol-ogy for supporting health. (WHO 2019, 1.) Mhealth services are projected to improve the availability of health services in the future. The applications are also estimated to improve health and well-be-ing. Mhealt sees the easy access to its own health information as an advantage. The user can view own health information wherever they are. (Holopainen 2015.) Mhealth means the use of mobile and wireless technologies to contact, communicate and promote individuals health and well-being (Musselwhite, Freeman & Marston 2017, 4).
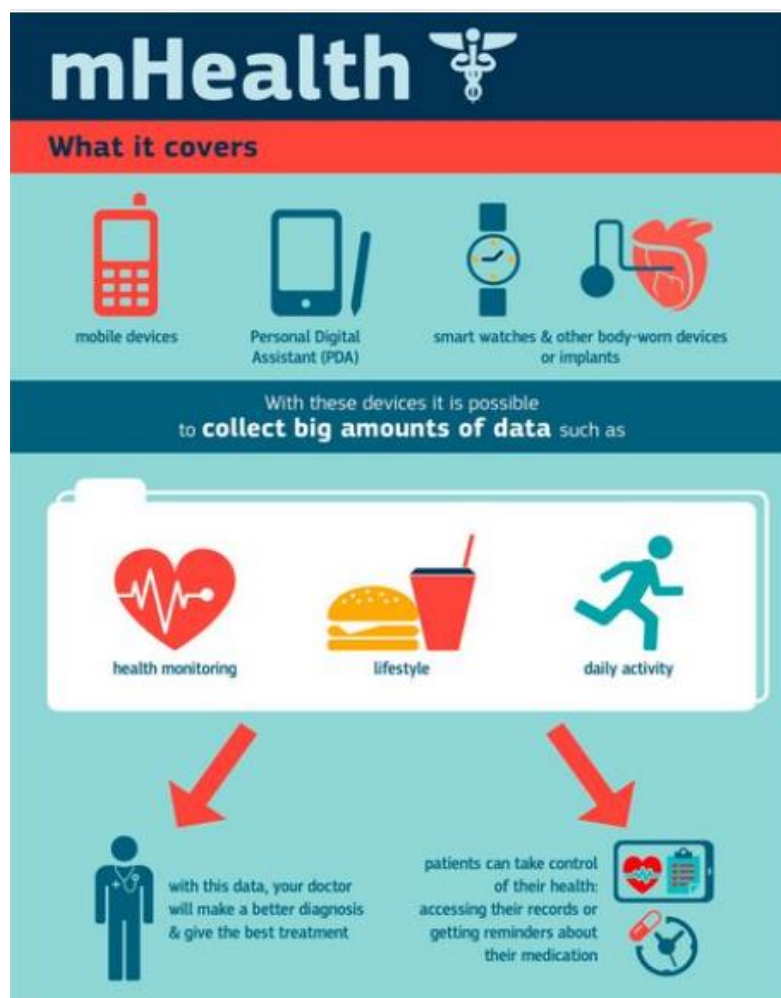

FIGURE 2. mHealth – what it covers (European commission 2020)

Mobile health applications refer to medical and public health practices and this concept is explained in more detail in Figure 2. These practices utilize, for example, mobile phones, laptops, and other wireless devices. The concept of mhealth also includes various wellness applications as well as smart watches. The concept also includes personalized reminders related to healthcare / wellness / medication via SMS and wireless applications in telemedicine. Healthcare mobile applications have a great potential to impact people's daily well-being through a variety of sensors and applications. Applications can enable the development of better evidence-based care practices. In addition, users get their own health information faster through the applications. (European commission 2014, 3.)

Digital health services are estimated to improve and balance people's health and lives. Mhealth services works as a mobile link between healthcare practitiones and clients, provide information and feedback how to improve own health related issues. At its best, mhealth can provide a lot of good for people's well-being in the future. However, there are still many open issues to be addressed, such as security and privacy, reflection on how applications can increase health instead of well-being, and how an aging population can take advantage of healthcare technology. In the future, the industry needs more research on standards and usability. (Musselwhite, Freeman & Marston 2017, 3.)

There already exist many mobile applications for mobile healthcare and wellbeing. Application users are accustomed to use different applications. If the application does not work for user, the user will will change to use another application. The application designer must therefore take user-oriented design into account in the application development work. Mhealth applications are popular today and the use is projected to grow a lot in the future. The information collected by devices and applications cannot yet be fully utilized. The wider use of this information gathered in the future will help in the development of health care. (Holopainen 2015.)

Development and different innovations in ehealt field increases all the time. Pioneers in the field certainly could not predict how fast the sector would develop and what all ehalth could allow and that ehealth services has become mainstream in many areas of healthcare. More advanced telecommunications infrastructure enables the development and utilization of higher-quality mobile digital services. Computers and mobile devices are beginning to reach the level where high-quality e-health services can be delivered. In the future, the distinction between a face-to-face meeting and a remote consultation will slowly begin to disappear, and it will no longer matter as much how the assessment of treatment takes place. (Nesbitt 2018, 11-12.)

3.2 User-centered design is collaboration between the users and the designers

In user-centered design, service users and designers interact with each other. Interaction is an ongoing process during which a service is developed, evaluated, and defined. It is important to consider the different users of the service. User centered design consists of taking into account usability requirements and accessibility requirements. Design for all meets this goal and is based on the idea that every user should be able to use the services extensively without customizations or special design. User-centricity takes into account different functionalities that help the user to use the service

as they wish. The service should be easy to learn, effective to use and, if necessary, provide feedback to the user on errors made by the user. (Voutilainen 2020, 103-104.)

The ICT sector is constantly evolving at a rapid pace and changes to technological solutions are often made. Users of technological solutions are not a unified group of people and often this group has a great need for workable and usable digital solutions. The solution to this challenge can be seen the design of user-centric services. The end user is closely involved in the process throughout the product development. User centered approach is devided into three steps which are an analysis and design phase, a development phase and a validation and evaluation phase. (Deuff & Coscuer 2013, 1.)

User centric design, accessibility and usability have much in common. Accessibility standards provide a good starting point for accessible digital services but it may not produce ideal usability for the customer. Understanding accessibility enables the development of a wide range of services. There is no need to sacrifice good ideas in planning. Good and achievable result can be created from them. Society relies on digital services and all people who use these services benefit from the accessible services. Accessibility standards are not equal and these standards should be applied as needed. (Lazar, Goldstein & Taylor 2015, 75-76.)

User-centered design can improve accessibility. Service design and design for all -model helps to understand the needs of end users. This enables the development of a clear, user-centered and accessible product. Accessibility is well advanced when the content of a website or application is in order, the written text is clear and the service / product is easy to find. (Övermark 2018.)

3.3   Accessibility emphasizes diversity

Accessibility concept means that as many different people as possible can use the digital service as easily as possible. The key theme is to take into account the needs and specificities of different users in the implementation of digital services and systems. By comparison, the accessibility of the physical world means, for example, the ease of movement in a buildings. There is a social level for taking accessibility into account; it guarantees equality between different users. Accessibility is also customer centricity, in which case the planning of digital services must take into account the diverse situations, physical and mental limitations and needs of different users. The design of the digital services to be accessible must therefore take into account the technical implementation, ease of use and clarity of the content. It is estimated that more than one million Finns need to use more accessible online services. The need for more accessible content can be influenced by, for example, the followings: visual impairments, hearing impairments, developmental impairments, learning difficulties, mental health problems, poor language skills and limited experience in using digital services. (Aluehallintovirasto 2021.)

Accessibility also means that the content of a website is accessible to all, the content is comprehensible and accessible to all, and that equality between all people is achieved. Attention to accessibility allows a wider user group to take advantage of a variety of features. At its simplest, the right choice of colors, the clarity of images and text, and the layout of content on a website can help the user to perceive the content better. There are many users in Finland who benefit from accessibility. 20% of

people need accessible services. A large part of this group is people with cognitive barriers, such as cerebrovascular disorders and memory disorders. In addition to this, accessible services are needed by, for example, the visually impaired, the deaf, people with motor challenges, the elderly, children and young people, and people with who have challenges wirh language. (Selovuo 2019, 13-15.)

Society's services are moving online. In short, this means digitalisation. The services emphasize independent information retrieval, self-service, and digital services must also be able to use and understand its operation. Digital services bring financial savings as well as the opportunity to use the services regardless of time and place. Alongside digitalisation, the ability to use electronic services will be emphasized in the future. Not all people are able to use services equally. (Selovuo 2019, 5.)

The Finnish Constitution law guarantees equal treatment of people. Accessibility is the realization of equality and it seeks to take into account in advance and guarantee the possibility for people with disabilities to use, for example, digital services and access to various buildings and facilities. Accessibility is one of the principles of the UN Convention on the rights of persons with disabilities. According to the agreement, the disabled person should have the right to access to the physical environment, transportation and information and communication technologies and systems. In addition, the European Parliament's directive on the accessibility of public sector websites and mobile applications (2016/2012 Accessibility Directive) entered into force on 22 December 2016. The aim of the directive is to promote accessibility of digital services for people with disabilities. (Voutilainen 2020, 108-109.)

3.4 The WCAG criteria are the basis for accessibility requirements

The digital service act (306/2019) obligates public authorities to comply with accessibility requirements. Law includes three mendatory requirements; the service and content must meet accessibility requirements (306/2019, 7 §), accessibility and its condition must be assessed in the accessibility report (306/2019, 9 §) and the service should include a feedback channel for submitting accessibility feedback (306/2019, 10 §). The law does not guarantee fully accessible content, but it allows services to be used on a variety of devices and technologies. The law applies extensively to the content and functionality of various websites and mobile applications. Public sector mobile applications must comply with the regulations from June 23 2021. (Aluehallintovirasto 2021.)
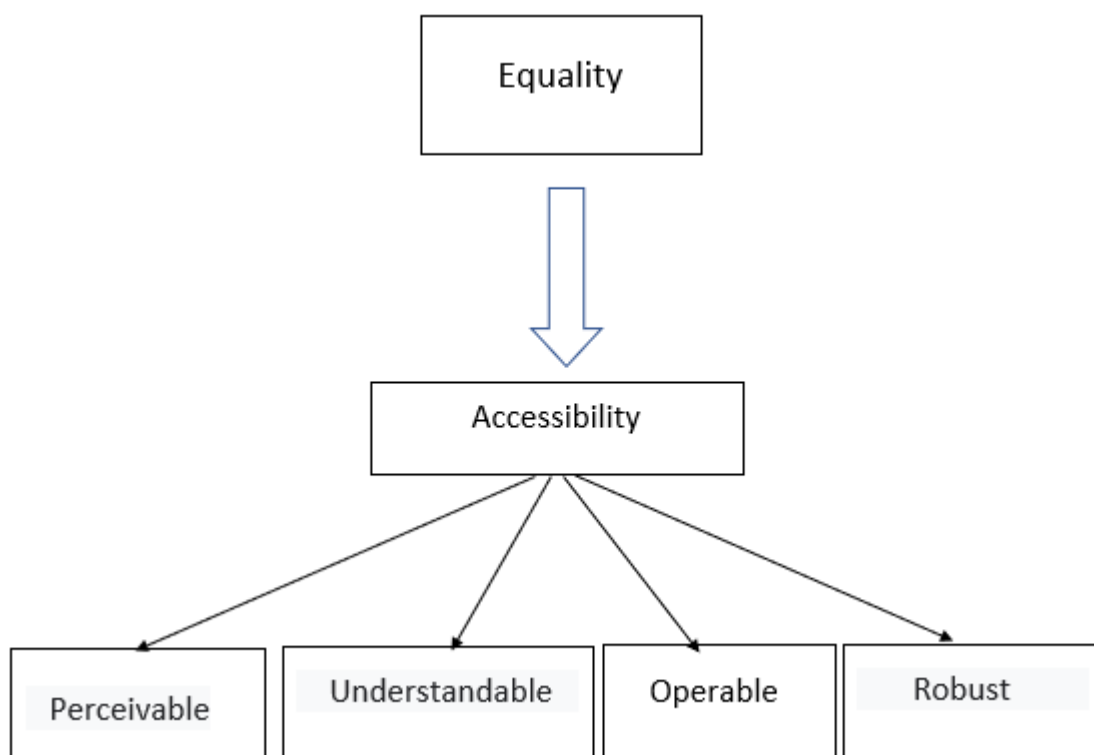
FIGURE 3. WCAG Accessibility factors (Voutilainen 2020, 110)

The Web Content Accessibility Guideline(WCAG) is a standard and core for accessible digital services. The WCAG standard is the result of many stakeholders and the instructions are quite clear to follow. Standard consists of four factors (Lazar 2015, 78). Digital accessibility includes four components, as shown in figure 3.

Perceivable means that parts of the digital service interface are made visible to the user. To meet the criterion, a textual equivalent for non-textual content should always be provided. Also, multimedia content should always be provided with subtitles or some other alternative. Content should be able to present in a variety of ways using assistive technologies without losing its relevance. Content should be easy to see and hear. Visibility refers to, for example, the clear use of colors, consideration of contrast, adequate text size, placement of text sections, and blank space on the site. For this criterion, alternative ways of presenting content should also be considered. For example, a blind user benefits from receiving subtitled information about what the image contains. **Understandable** means that the content information and the users interface must be logical and understandable. The text and information must be clear, comprehensible and informative. The functional use of the site or application must be logical, smooth, and predictable. Users should also be assisted to avoid error situations. All content should also be predictable and and all information should be presented in a manner that it is accessible to all users. **Operable** interface takes into account the controllability of the user interface component and navigation. All functionality must be available on the keyboard or other assistive tehcnologies. The content should be such that it does not cause seizures or physical reactions. Ease of content and navigation are also part of meeting this criterion. **Robust** digital service is able to utilize different kind of assistive technology. This factor takes into account

that the content of an application or website is technically accessible with various assistive technologies, excluding obsolete and unused technologies. (Voutilainen 2020, 108-109; Selovuo 2019, 69-91.)

User experience/UX and user interface/UI has a strong connection and the difference between is low. The user experience is more about the feeling that the product evokes. The feeling can be affected fox example by the product's visuality, clarity, ease of use. The user interface, on the other hand, refers t what the site or application looks like on a computer or on mobile phone screen. (Contrast 2016).

3.5   Different perspectives of usability and accessibility

International Organization of Standardization has defined usability as follows. " The extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency, and satisfaction, in a specified context of use" (Geisen & Bergström 2017, 3). Usability and accessibility share a lot in common and some sources sees accessibility as a subtype for usability and other sources sees usability as a subtype for accessibility. Both concepts has the idea of solving the same problem, but from a different perspective. For example, mobile application which is usable for normal user may not be accessible to a blind user. Product planning is not about making products just for people with disabilities. However, taking into account the needs of people with disabilities helps to design more accessible services. (Kjellberg 2019, 27.) Usability can be measured by different methods, but it is also ultimately a subjective experience. The experience is influenced, for example, by the characteristics of the user and the situation in which the use takes place. (Allanwood & Beare 2019, 54.)

FIGURE 4. Usability factors (modified from Nielsen 2012)

The usability of a mobile application is an important factor when thinking about product quality. In figure 4. usability is defined how easy a product is to use, how effective it is, how easy it is to learn to use, how error-free the product is, and how it satisfies the needs of users. In short, usability can be thought of as the functional sides of a product (Ye 2017). The usability of the product can be assessed by using the product in a real situation. If users complete the task quickly and effortlessly, the product can be classified as good. If the user does not know how to use the product, the fault is not in the user but in the usability of the product. Usability is an attribute that can be used to measure how easy a product is to use (Papunet 2020). Taking usability into account in digital services is an important factor. For example, if a company's website is bad or doesn't work, people will no longer use the pages. The same applies if a person cannot find what they want on a page or service. (Nielsen 2012.)
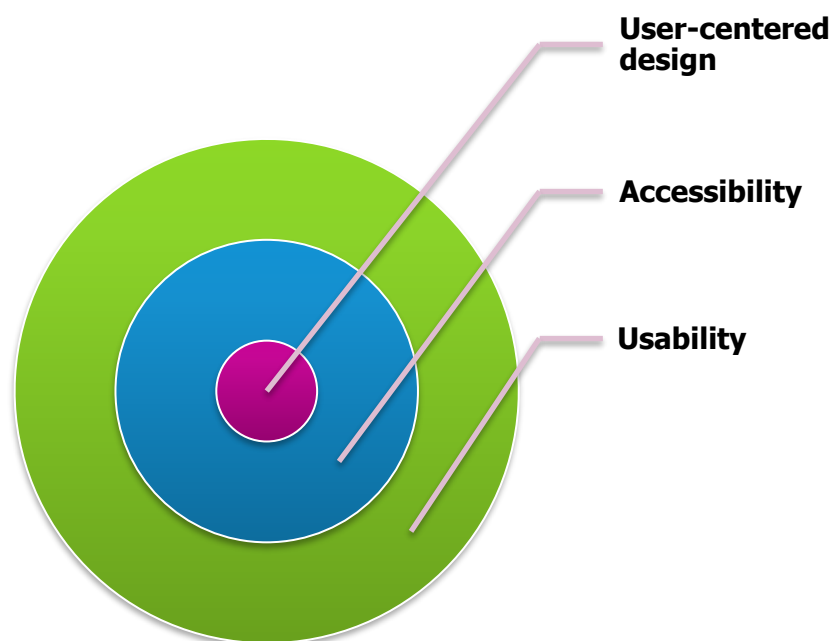
FIGURE 5. Adaptation of user centered design, accessibility and usability (modified from Nilsen 2012; Övermark 2018)

Adaptation of user-centered design, accessibility, and usability could be applied in a manner similar to Figure 5. Usability forms the outermost layer of the circle. In terms of usability, the user can consider, whether the application is functional and efficient, whether it is desired to be reused or whether it meets the user's needs. The next layer consists of the concept of accessibility. At this point, the user can consider whether the user is able to use the application despite limitations or whether there are barriers to use in the application. User-centered design can be summed up in the idea that services should be designed according to the design for all - model and it serves as a good basis for accessible and usable services.

The line between usability and accessibility is sometimes small. However, these concepts are closely intertwined. Usability answers the question of whether a service is efficient and effective, while accessibility answers the question of whether a service can be used on an equitable basis by everyone. (Koskela 2017.)

4 PURPOSE AND AIM OF THE THESIS

The client of this thesis is Finnish social security instituntion, Kela. Kela's organization and activities are described in more detail in section 2.1 of the thesis. The aim of this thesis is to produce information about the factors indicating the accessibility of mobile applications. The purpose is to get acquainted with the studies that have investigated the accessibility of mobile applications and to highlight the research results from these studies.

The research results can be utilized in the development of the Kanta-service mobile application. Kanta services are developing a mobile application. Accessibility of the mobile application is important for every citizen to be able to use the application independently and smoothly. Research questions in this thesis are:

- What factors in mobile applications increases accessibility for the user?
- What factors, according to the literature review, are related to the perceivable, understandable, operable and robust sides of mobile application?

5 METHODOLOGY AND ANALYSIS OF THE THESIS

The chapter introduces the study method, description of the literature search and data analysis. The chapter describes the process of literature seach process and a theory of thematic content analysis. Finally, the last section introduces the information about data search.

5.1 Narrative literature review

At the beginning of each study, the researcher should conduct a literature search related to previous studies. The literature review has a strong foundation in the research context. Literature review research method is based on process-like method. The study should be reproducible and based on current studies. The aim of the literature review is to develop a theoretical understanding of one's own field and to assess the validity of the theory. The method makes it possible to form an overall picture of a specific topic area. (Suhonen, Axelin & Stolt 2016, 7.)

Literature review includes different types of reviews. The review can be, for example, narrative literature review, systematic review or meta-analysis. The purpose of the narrative review is to describe and summarize the information related to the topic, its scope, amount and depth. The literature review reviews scientific articles. The process should be described and include information on the acquisition of the material and the synthesis of the material in tabular form. The literature review may have methodological shortcomings, for example, it does not take a position on the reliability of the material. Literature reviews assess the quality of original studies. However, evaluation often does not lead to the rejection of studies from the review. (Suhonen et al 2016, 8-9.)

Literature review begins with identifying a research problem. This gives direction to the whole study. It is a good idea to be clear and precise enough about the research question so that the researcher can process all the material he or she finds. After that the researcher performs a literature search and material selection. The level of the material selection process depends on the type of literature review, but the narrative review is a less systematic method. The purpose is to search for all studies that matches the research question. (Niela-Vilén & Hamari 2016, 23-30.)

Narrative literature review is flexible in its form of implementation. In addition, precise methods and rules do not define the implementation of the review and the material used can be extensive. The research questions also guides research much more flexibly than in more specific meta-analysis approach. (Salminen 2011, 6.)

This thesis utilized the methods of narrative literature review because it allows a broader description of the phenomeno. The work began with brainstorming a research question. After that, I did a data search in different databases to be able to create an image of how much information already exists on the topic. After compiling the material, I moved on to compile and describe the research results. For a narrative literature review, I gathered and searched different databases for the most recent and diverse information possible. The literature review's material was selected on the basis of its availability and suitability. In the procurement of the material, the entry and exclusion criteria also set their own conditions for the selected material.

5.2   Literature search process

The purpose of the literature review is to show the amount and quality of existing information on the topic. There are a lot of guidelines for making a literature review. The key is to make an accurate plan for information retrieval and document the information retrieval process. The purpose of this is to find all relevant information on the topic. In order to determine more specific criteria, the researcher should define inclusion and exclusion criteria for the studies. (Valkeapää 2016, 56.) Table 1 expresses the inclusion and exclusion criterias of the literature research.

TABLE 1. Inclusion and exclusion criterias for data collection of the thesis

Inclusion criterias	Exclusion criterias
A study or article discusses the accessibility of mobile health application	A study or article does not discuss the accessibility of mobile health applications
The study or article has been published between 2015-2021	The study or article was published before 2015
Finnish or English literature	Non-Finnish or English literature
Free literature	Paid literature
The study or article addresses the user's perspective on accessibility	The study or article does not address the user's perspective on accessibility
The title or abstract contains at least one of the following keywords: accessibility, mhealth, mobile health, mobile phone, smart-phone, mobile application, app, usability, user needs, self-management, self-care	The title or abstract does not include any of the following keywords: accessibility, mhealth, mobile health, mobile phone, smart-phone, mobile application, app, usability, user needs, self-management, self-care

The material for this literature review was collected from Pubmed, Sciencedirect, EBSCOhost(CINAHL complete) and Scholar Google databases. Access to these international databases was obtained through a license from Savonia University of Applied Sciences. These databases could be remotely accessed by logging into the Savonia University of Applied Sciences network with my own user IDs. During spring 2021, Savonia university of applied sciences informaticist provided guidance on the selection of the right databases and the use of databases. The informaticist guided the use of the right keywords. The keywords used were accessibility, mobile application, mobile app, mhealth, mobile health, mobile phone, smart phone, self-management, self-care, usability, user need and plural forms of words. All other digital accessibility material was rejected.

The material was selected from years between 2015-2021. The aim of the review was to use the latest researched data and therefore this was the limitation. The material or research text had to be fully available and free of charge. The language of the material had to be either Finnish or English. No other language options were accepted for the study. The studies had to address different factors of accessibility of mobile applications. The accessibility perspective had to be the user perspective and which features from the user perspective create or reduce the accessibility of mobile applications. Primarily, studies related to the accessibility of mobile applications used in healthcare were selected for the review, but studies on mobile applications in other fields were also accepted if the study dealt with the accessibility of the application from the users point of view. No other restrictions were made between the application user group. Kela offers services to everyone, in which case accessibility must be taken into account extensively without highlighting any specific user group. The publication also had to be a scientific study or an article.

TABLE 2. Study and article selection process

Database:	Results with limiters:	Included by title and abstract:	Included by full text:
Pubmed	88	5	3
EBSCOhost / Cinahl complete	38	3	2
Scholar Google	48	5	3
ScienceDirect	62	3	1

The last search of the Pubmed database was made on May 26, 2021. The keywords accessibility, mobile health, mhealth and app were used as keywords. The search was targeted to the title and abstract(Accessibility AND "mobile health" OR mhealth AND app). The search returned a total of 88 results at that time. Five results were taken for review on the basis of title and abstract, of which three results were accepted.

The last search of the EBSCOhost / Cinahl complete database was performed on May 26, 2021. The keywords accessibility, mobile health, mhealth and app were used as keywords. The search was targeted to the title and abstract (Accessibility AND (mhealth OR "mobile health") and app*). The search returned a total of 38 results at that time. Based on the title and abstract, 3 results were included in the review, of which 2 results were accepted.

The last search of the Scholar Google database was made on May 3, 2021. The terms accessibility and mobile applications were used as keywords. The search was targeted to the title (allintitle: Accessibility "mobile applications"). The search returned a total of 48 results at that time. Based on the title and abstract, 5 results were included in the review, of which 3 results were accepted.

The latest search of the ScienceDirect database was performed on June 1, 2021. The terms accessibility and mobile applications were used as keywords. The search was focused on the title and the abstract ("Accessibility" AND "mobile application"). The search returned a total of 62 results at that

time. Based on the title and abstract, 3 results were included in the review, of which 1 result was accepted.Nine articles were finally selected for the literature review. All articles were in English. No Finnish-language research or articles were found in the literature review.

Nine studies(N=9) were selected for the literature review. Results are presented in Table 3. Of the selected studies, five addressed the accessibility of mhealth applications. One study related to the mobile applications used in Brazil, and their accessibility, used in the banking, security, economy, and tourism industries. One study related to accessibility of mobile applications in the fields of social media, education, entertainment and the economy, and one study addressed at the accessibility of a mobile application used in education. One research was a literature review of mobile accessibility criterias. Studies that did not directly address the accessibility of mobile applications were excluded from this literature review.

The majority of the selected studies were reflecting healthcare mobile applications. Studies related to the accessibility of mobile applications in other industries have also been carefully considered. Mobile applications from other selected industries represent different industries and also provide insights from non-healthcare industries. Overall, it can be estimated that the mobile applications in the selected industries represent the entities that process people's private and confidential information. In addition, industries represent entities that may typically be represented in people's daily lives, such as industries related to banking, finance, or education.

TABLE 3. Characterictics of the selected researches(n=9)

Writer(s) and year	Article/research	Research method	Objective of the study	Results
Radcliffe et al. 2021	A Pilot Evaluation of Mhealth app Accessibility for Three Top-Rated Weight Management Apps by People with Disabilities	Validity study	Develop and test a prototype app accessibility testing protocol and inform recommendations for how to resolve common accessibility issues.	Application developers need to be aware of accessibility criteria. Developers need technical guidance on how to ensure the application's interface and design accessibility.
Zhou et al. 2020	Making Self-Management Mobile Health Apps Accessible to People With Disabilities: Qualitative Single-Subject Study	Qualitative Single-Subject Study	To identify an approach how to improve accessibility of Mhealth apps.	After adding the desired accessibility features, the performance of the users of the application improved. Users liked that the application could be customized.
Correia et al. 2019	A Roadmap Towards Mobile Applications with Accessibility for Visually Impaired users:	Literature review, observation-based analysis and user-centered evaluation	To propose guidelines for development of mobile application to ensure accessibility with usability.	The study provides guidance for designing more accessible mobile applications. The type of impairment causes

	Guideline and its Evaluation			different needs in order for the mobile application to be accessible.
Daihua et al. 2019	An Mhealth App for Users with Dexterity Impairments: Accessibility Study	Usability study method	To increase the usability by increasing the app´s accessibility	After redesigning the application, fewer touches were needed to complete the given task.
Ballantyne et al. 2018	Study of Accessibility guidelines of Mobile Applications	Systematic literature review	To provide a view of the current state of mobile accessibility	Application developers should be trained on accessibility reguirements. Many applications are accessible at the system level but not at the usage level.
Oliveira et al. 2018	Accessibility in Mobile Applications for Elderly Users: a Systematic Mapping	Systematic mapping	To characterize mobile application development issues concerning accessibility for elderly people	According to the study, the accessibility of mobile applications needs to be further investigated. There are still few guidelines for accessible mobile applications.
Daihua et al. 2015	Accessibility of mHealth Self-Care Apps for Individuals with Spina Bifida	Descriptive study	To explore the accessibility of iMHere app	Personalizing the application to meet the needs of the user can solve accessibility barriers.
Daihua et al. 2015	Accessibility Needs and Challenges of a Mhealth System for Patients with Dexterity Impairments	Descriptive and observational study	To explore and identify the accessibility needs and preferences	The needs of the users of the application differ. Personalized application can increase the accessibility of the application.
Serra et al. 2015	Accessibility Evaluation of E-Government Mobile Applications in Brazil	Case study	To discuss the methodological adaptations of WCAG 2.0 for the context of mobile application	The study emphasizes the importance of further research into the accessibility of mobile applications as well as the importance of more detailed mobile application accessibility guidelines.

5.3   Thematic data analysis

The material of this literature review was analyzed by thematic analysis. Thematic analysis is well suited for qualitative research. The aim is to extract from the material the most important topics and concepts for the research question. (Eskola & Suoranta 1998.) Different themes can be formed theoretically or content-based. In this thesis, the themes were based on theory. The analysis of the material was guided by my research questions as well as the WCAG standard and principles of accessibility. A more detailed description of the standard can be found in Chapter 3. My research questions in this thesis were as follows:

- What factors in mobile applications increase accessibility for user?

- What factors, according to the literature review, are related to the perceivable, understandable, operable and robust in mobile application?

After obtaining the research material, the material was carefully reviewed. The material was carefully read to obtain the widest possible overall picture. The analysis of the research material was based on four different principles of accessibility of the WCAG criteria. The main categories were found directly in the WCAG principles, which are: perceivable, understandable, operable and robust. The material was analyzed and themed according to four principles

The material was reviewed in such a way that, under each principle, the elements emphasizing accessibility that emerged from the literature were searched. I systematically grouped the emerging expressions and elements under each principle. Table 4 shows an example of the main categories and the results of the data.

TABLE 4. An example of the thematic data analysis

Perceivable	Operable	Understandable	Robust
Often the reading order of the text content is also based on a visually sensible order. Users of assistive devices may have challenges in understanding the information and texts. (Serra et al 2015)	Make sure that all the buttons and navigational features of the application are accessible. (Radcliffe, Lippincott, Anderson & Jones 2021)	Clear and understandable text. (Daihau, Parmanto, Dicianno & Pramana 2015)	The visual elements of the application must be correctly labelled in the application code. (Correia et al 2019)

Different color combinations and poor contrast make it difficult for the visually impaired to read the text. This should also be taken into account in situations where the mobile application is used in different lighting conditions. (Serra et al 2015)	Possible to enter values manually using the keyboard or voice input. (Radcliffe et al 2021)	Most of the errors are related to running the application. For example, the user may forget to save the information they have entered. The brief instructions provided by the application can help the user to operate the application correctly. (Daihau et al 2015)	Images and graphics should include alt text so that users using the screen reader and assistive technology can use the application smoothly. (Radcliffe et al 2021)
Poorly labelled images should not be used as links or buttons. (Serra et al 2015)	The clearly marked "next" and "back" buttons should be located in each input field and subpage. (Radcliffe et al 2021)	Avoid technical expressions and favor the user's native language. (Correia et al 2019)	Take advantage of describing images and figures in alt text so that users of the screen reader can understand them.(Correia et al 2019)

6 RESULTS OF THE LITERATURE RESEARCH

This section reviews the research findings of the literature review and provides answers to research questions. The research questions were as follows: What factors in mobile applications increases accessibility for user and what factors, according to the literature review, are related to the perceivable, understandable, operable and robust mobile application?

The data has been analyzed by using thematic analysis. The research results have been presented applying WCAG principles. The theory has been applied loosely to the presentation of research results. This solution was reached because the accessibility guidelines do not take a position on all the research results presented. Furthermore, the research results have not been forcibly placed under any accessibility component, but the analysis has been tried to utilize using the accessibility model.

6.1 Text size, images, and colors in perceivable mobile applications

According to the review, there are several factors that indicates the perceivability of the mobile application. Five of the studies selected for review highlight the impact of mobile application text size and style on perceivability. Studies show that the ability for a user to change the text size of an application increases the perceivability of the mobile application (Oliveira, Fioravanti, Fortes & Barbosa 2018). Resizing the text and font in the application to better suit for the user increases the usability and accessibility of the application (Zhou, Septono, Setiawan & Parmanto 2020; Ballantyne, Jha, Jacobsen, Hawker & El-Glaly 2018). The user of the mobile application should have ability to choose the most comfortable text size that seems appropriate for the user(Daihua, Parmanto & Dicianno 2019). The color and contrast of the text used in the application must be considered. Light colors combined with a light background color should be avoided. Contrast between text and background can increase the user experience of better readability of text. (Daihau, Parmanto, Dicianno & Pramana 2015.)

Six studies highlighted the effect of colors and contrast used in the application on the accessibility of the application. It is recommended to use high-contrast colors in the application (Correia, Penha, Macedo, Siebra & Anjos 2019; Oliveira et al 2018). Low contrast makes reading difficult, especially for users with low visioin. Good contrast also increases the perceivability of the application, for example in different lighting conditions. (Serra, Carvalho, Ferreira, Vaz & Freire 2015.) Consistent and thematic use of colors is perceived as a useful and accessible factor (Daihau et al. 2015). When designing an application, it is good to remember that the use of colors must not affect the use of the application (Correia et all 2019). For example, color-blind users may have challenges using the application. White background and dark text color is a good option (Zhou et al 2020). Users ability to personalize and customize the content (text and background color and text size) can increase accessibility (Daihua et al 2019 & 2015).

The perceivability of the application is reduced by content what is placed too tightly on the screen (Oliveira et al 2020). Text that is too narrow and buttons that are too close together are unwanted features. Perceivability is enhanced by the user's ability to adjust the application's subtitle spacing as

well as button size (Zhou et al 2020). Keeping the page as clear as possible can increase accessibility. Keeping the functions to a minimum helps the user to better understand what to do next in the application (Daihua et al 2015). All images, figures and graphics must include consistent alt-text and the text must be readable by a screen reader (Correia et al 2019). Alt text allows a user using a screen reader to read and interact, as well as obtain the necessary information from images if needed (Radcliffe et al 2021). All images used should be label correctly and images should not be used as links or buttons(Serra 2015). A feature that increased perceivability was vertical and horizontal detection of the position of the screen (Oliveira et al 2018).

The order of the text and its content has a great influence on the correct understanding of the context, especially when using a screen reader (Serra et al 2015). Illogically arranged text and text elements reduce the perceivability of the application. A person using the screen reader is completely dependent on the screen reader program being able to read the text elements in the correct and logical order. Otherwise, application is not accessible. (Ballantyne et al 2018.)

6.2   Increased operability with functional navigation

According to three selected studies, application navigation affects on application operability (Zhou et al 2020; Serra et al 2015; Radcliffe et al 2021). Application buttons as well as navigational elements should be made accessible (Radcliffe et al 2021). Several challenges related to application navigation are related problems with navigation. Page navigation should be structured so that content is accessible in different ways (Serra et al 2015). The unclear implementation of menus and submenus also affects the realization of accessibility (Oliveira et al 2018). Operability is increased by the search feature in the application (Correia et al 2019). The ability for the user to create and customize shortcuts for site navigation is important (Daihua et al 2019).

Unrecognizable and unclear buttons may confuse the user. Buttons should always be named so that the user understands the purpose of the button. (Ballantyne et al 2018.) Application links should be named in a way that the description clearly tells the user the purpose of the link (Serra et al 2015) and consistently located and named "back" and "next" buttons provides better navigation (Radcliffe et al 2021). The "Back" button is part of the universal design pattern and it should be placed in the upper left corner of the application or page. The "back" button should always return the user to the previous page (Correia et al 2019).

The small size of the buttons and icons makes it difficult for different user groups to use the application. In an application, large icons and buttons increase accessibility. (Daihua et al 2015.) Customizing the buttons and icons to meet the needs of the user's fingertip could be a good option. The application could specify the minimum size of buttons and icons used in the application according to the size of the user's fingertip (Dauhua et all 2019). The ambiguity of icons and symbols and small clicking space reduces accessibility (Oliveira et all 2018). The size of the object or button to be reached should correspond to the minimum contact size (Correia et al 2019). Keyboard customization with larger key sizes as well as preconfigured characters reduced the number of phone screen touches (Daihua et al 2019). Placing the buttons in the center of the application or screen can cause challenges for the user. Placing buttons on the edges of an application can make it easier to use the

application. Vertical placement of buttons on the screen and ability to choose handedness of buttons is desirable. (Zhou et al 2020.)

6.3 Clear content and predictable logic in understandable mobile application

According to research, an understandable application takes into account the language used in the application and its clarity. Unclear text and complexly expressed language are an obstacle to the realization of accessibility. (Oliveira et al 2018.) The word choices used in the application should be appropriate and clear (Daihua et al 2015) and the terminology used should be clear, avoid technical vocabulary, and be expressed in the user's own language (Correia et al 2019).

The intuitiveness of the mobile application and user guidance emerged in several studies. The user of the application may have challenges typing on the phone keypad. It is easier for the user that the application itself offers different options instead of the user having to write the answer. (Zhou et al 2020.) Application features such as autocorrect provides good user assistance and it also speed up text typing. The application could recognize the long breaks and to provide guidance as needed. If necessary, a separate pop-up window could ask if the user needs help or guidance to continue. (Correia et al 2019.) The application's instructive guidance, such as a short reminder or guidance as needed, helps the user to function properly in the application. Guided pop-up notifications can also make it easier for the user to work properly in the application. (Daihua et al 2015; Daihua et al 2019.) It should also be possible to hide and, if necessary, to show the login credentials of the application without having to shut down and restart the page or application (Radcliffe et al 2021).

Most of the mistakes a user makes are related to how the user should act in the application and how the actions should proceed. For example, the user may forget to save the required information. A short user-guided reminder speeds up operation and makes it easier for the user to operate in the application. (Daihua et al 2015.) Clarity of the guidance infomation provided is important (Oliveira et al. 2018). A scroll bar at the edge of the page notifies the user that the page continues. If the page has a lot of information, it may be a good idea to split the page into several separate pages. In this context, clear information using the up, down, right, and left arrows to divide information into several different pages is important indicator to make application more understandable. (Zhou et al 2020.)

A consistent and logical application interface is an important factor in increasing the comprehensibility of an mobile application. The logical progression of operations is important. Site navigation should be consistent and page-to-page navigation should take place as expected. (Correia et al 2019.) The elements used should remain the same on each page of the application. The inconsistent interface causes a lot of confusion for users. Consistency is important in terms of images, words, and layout. (Daihua et al 2015; Radcliffe et al 2021.) The application should be designed to be as consistent as possible in terms of themes, functions, and processes (Radcliffe 2021). It is not recommended to add any elements to the application just for aesthetic purposes. Elements should be directly related to the functions of the application. A page with different size elements and components is not recommended. (Correia et al 2019.)

6.4 Technical elements in robust mobile application

According to literature research, the most significant indicator of robustness is that the site or application is technically implemented so that the assistive technology is able to read and interpret the site or application correctly. Text and images should be described in such a way that the screen reader is able to interpret the element. (Correia et al 2019.) Developers should technically design implementations that allow the user to leverage a variety of assistive technologies that allow interaction with the application (Radcliffe et al. 2021).

All elements must be properly lebelled in the implementation of code (Correia et all 2019). All texts and button labels must be accessible by a screen reader. Unlabeled buttons cause confusion for the user if a screen reader does not recognize the button label. All types of users benefit from the ability to use the screen reader. For example, a user with a reading disability benefits from the ability to use a screen reader to read text aloud. If the application is implemented in a way that the screen reader is unable to interpret the texts, the application is inaccessible. (Ballantyne 2018.)

7   DISCUSSION

7.1   Reflection on the results

The purpose of this thesis was to find out in the form of a literature review which factors from the user's point of view affect the accessibility in mobile applications. This collected information can be used in the development of a mobile application designed by the thesis client organization, Kela. As a research method, the literature review worked well and through the method it was possible get answers to the research questions. The selected research method provided answers to the research problem. The material was comprehensive, but the research method could have also been different. For example, through a thematic interview, more user-oriented description of the topic could have been obtained.

Through digitalisation, society's services are becoming more digital. As Selovuo (2019, 13) states, digital services will change more in the future in a way where the customer himself has to take more responsibility. The services are more of a characteristic in that the customer himself searches for the required service and takes action there by itself. In this case, the customer is responsible for ensuring that the necessary action is taken correctly. A well-designed, customer-oriented and accessible-services supports the realization of this principle.

This literature review brought together the various factors of accessibility. The areas of accessibility were related to technical accessibility as well as cognitive accessibility. At its simplest, technical accessibility means that users can use an application using technical aids. Cognitive accessibility means, in a simplified way, a service or application that is fully understood. This involves, for example, the texts or the presentation of information in the form of an image or video. In order to clarify the results of the literature review, I will now summarize the most common factors that should be taken into account when designing the mobile applications. The summary of main results according to the literature review and Selovuo(2019) is presented in table 5. Table 5 also provides an answer to the research questions of the thesis.

TABLE 5. Factors to consider when evaluating application accessibility

Remember these features	Avoid these features
Sufficient font size and style	Avoid too bright and low contrast colors
Customizable font size	Content and text placed too tightly on the screen
Use clear colors that stands out from each other	Elements and buttons that are too close together
The contrast between colors is sufficient	Do not use the image as a link or button
Minimization and clarity of application functions	Avoid decentralized placement of text and content in the application

Include consistent alt-text in images, figures and graphics	Avoid placing different elements, links, or objects too close together
All links and buttons are informative and predictable	Buttons in the center of the application
Vertical and horizontal screen position detection	Unclear text and complex language
Text and content are consistently placed in the application	Do not use unnecessary elements, images and visual effects
Provide structured and accessible page navigation with search function	
Name the buttons and links clearly("back" and "next" buttons)	
Prefer large icons, buttons, and other elements	
Allow the user to personalize the application	
Place buttons on the edge of the application	
Intuitivines of the application(autocorrect, ready-made answer options)	
Instructive application guidance and pop-up notifications	
Consistent and logical application interface(site navigation, logial progress of operations, images, word, layout)	
Assistive technology is compatible with the application.	
All elements must be properly lebelled in the implementation of code	

Based on the literature review, table 5 provides some good examples that are good to consider when designing an accessible mobile application. Based on the literature review, noteworthy features emerged. However, the review did not always provide a detailed example of how each detail in use should be technically implemented. Kari Selovuo's Saavutettavuusopas(2019) publication has been used to support this literature conclusion

The adequate size, style and ability to change the size of the text used to suit the application emerged in the literature review (Oliveira et al 2018; Zhou et al 2020; Ballantyne et al 2018; Daihua et all 2019). According to Zhou et al(2020) the text should be as large as possible and bold as

needed. According to Selovuo, visually impaired people in particular benefit from the large size of the text and letters. Visually impaired people also benefit from other features, such as images, symbols, and sensibly located elements. The guide does not comment on the text size of the mobile application. However, the guidance is that the size of the text should never be reduced unnecessarily (Selovuo 2019, 110). The user's ability to change the text size to suit itself was highlighted in the literature review. In a web browser, this possibility exists, but not typically in all mobile applications.

The contrast of the text and the use of colors in the application emerged in the review. Factors related to color usage and contrast should be considered in the application because some users will not be able to detect colors at all or the color vision will be different in some other way. Problems related to color vision are common (Selovuo 2019, 106). The colors used should be clearly distinguishable, the contrast between the colors is good and the significance of any matter has not been indicated by color. Contrast and color choices have an effect on the perceivability of the application and its attention increases the accessibility of the application, for example, under different lighting conditions, according to Serra et al(2015). According to Daihua(2015), personalizing the application can solve many accessibility challenges. In this case, the user of the application has the opportunity to influence the content, colors or size of the text.

Cognitive difficulties reduces a person's ability to learn new things. This group greatly benefits from consideration of accessibility and therefore content should always be designed clearly. A single clear guideline cannot be developed because cognitive limitations are often different and each user benefits from different things (Selovuo 2019,116). In general, the content of the application should be clear and its functions simple. This will help the user to figure out what to do next in the application(Daihua et al 2015). Buttons and links should always be named descriptively and their operation should be predictable (Ballantyne et al 2018). In addition, buttons should be placed at the edges of the application (Daihua et al 2019). According to Selovuo (2019, 116), clear and concise content, supporting the text with images and grouping the text sections into logical entities make it easier to understand the content. Logically designed application interface and site navigation support the accessibility of the application (Correia et a l2019). A mobile application that works logically and predictably facilitates the activities of users with cognitive difficulties. A logically functioning application is sure to please all users.

In addition to color, images also play a huge role in communication. Visually impaired users cannot see images. Images can be subtitled, allowing a screen reader to tell you what's in the image. Images without alt text tell the blind user nothing. The alt text should be a short and clear description of what the image contains. The more information the image contains, the more important is the description. The decorative image does not need to be subtitled, bu then the image must contain an empty alt attribute. (Selovuo 2019, 35.) The description in alt text description should be sufficient for the user to be able to imagine the image. Too long description, on the other hand, is not desirable. (Correia et al 2019.) A visually impaired user operates the application with a screen reader. All content must be such that it can be interpreted, if necessary, by assistive technologies.

The user may have a disability that restricts the use of the application. For example, tremors, involuntary movements, a missing limb, or challenges in precision tasks can cause challenges. In this

case, there may be challenges in using the application. (Selovuo 2019, 114.) Too small touch targer size can complicate application use (Correia et al 2019). Buttons and icons that change according to the size of your fingertip could also make the application easier to use (Daihua et al 2019). According to Selovuo (2019,114), the operation of the touch screen must be taken into account in the design of the application, so that different elements can be easily touched with a finger.

The hints, tips, and action examples provided by the application support the user's actions. The user can sometimes end up in a dead end or the operating is otherwise slow. Selovuo (2019) provides a suggestion that the user could be provided with images or tips in the application if necessary. The same theme also emerges in the literature review. Assisting the user in writing, for example, various instructions and pop-up tips can certainly speed up and facilitate the user's action. For example, the user's activity could be facilitated by the application providing ready-made response options, if possible. This is also supported by the research of Zhou(2020) and partners. The application could also monitor the user and, if necessary, assist the user in adding the necessary information. Intuition certainly has its place and can support the smoother operation of the user.

The client of this thesis is Kela. The purpose of the thesis was to highlight the factors influencing accessibility in mobile application, which should be taken into account in the development work of the Kanta mobile application. The development work of the accessible mobile application has a clear connection with Kela's strategic goals, which are presented in more detail in Figure 1. User-centered and accessible services support the goal of developing the customer experience. Accessible mobile application allows each customer and user to check with the Kanta mobile application smoothly whether, for example, the necessary healthcare texts or records are available. In addition, the strategy highlights the development of digital services. Kela's customers are all Finnish citizens. This group is made up of people with very different qualities and skills. The big challenge is how to create digital services accessible to all willing users. In the development of an accessible application or service, more customer or user focus should be taken into account. It is also good to keep a wide range of experts in different fields involved in the planning and implementation process.

Usability, accessibility and user-centered design have a lot in common and more precisely these concepts are opened in the theoretical part of the thesis in chapter 3. The design of user-centric services should be the basis for all design and development work now and in the future. When services are digitized, technology must not be the one that directly determinates what a service is made of. Users' experiences should be able to be used more widely in all development work. Alongside customer-centricity, accessibility must be taken into account. Without consideration for accessibility, a large proportion of users will not benefit from the services made possible by digitalisation. When a service is accessible, every user will be better able to benefit from a well-designed and usable digital service.

7.2   Validity and ethics of the study

For the completion of the thesis, it is good to draw up a precise schedule, according to which it is possible to proceed precisely. Changes may occur along the way, and the work will not proceed as planned. However, it is not worth rushing to ruin a good job. Staying on schedule and making choices based on what the schedule allows is, I think, essential to getting the job done. Doing this thesis started with getting a topic idea for my work place. The topic of the thesis was specified and a supervisor was appointed for the work. We had discussions with my supervisor about the goals set for the work. In this way, we created a common view that the thesis also meets the client's needs.

As the topic and research questions became clearer, I booked an appointment with informaticist at the Savonia University of Applied Sciences, who knew how to guide me in using different databases. Using databases is a demanding step and that is why I feel that personal guidance was important. When searching for information, each database works a little differently. Relevant material may not be found in the review if the author does not know how to use the database correctly. This phase of the thesis was personally challenging for myself. Searching for material is often a long process. The right keywords can sometimes take a long time to come up with. The search strategy should be well planned and you should not immediately disappoint if the first database searches do not yield the desired results. (Lehtiö & Johansson 2016, 36.)

In this literature review, the data search was carried out in several databases. This made it possible to collect the widest possible material on the subject under investigation. The number of search re-sults was quite high, and search had to be limited so that the search terms can be found in both the title and the abstract. This may have had an impact on the fact that relevant information on the re-search may have been excluded from the literature review. The correct selection of search terms and keywords may have influenced the outcome of the data search. Terms and keywords were specified in the early stages together with the Savonia UAS informaticist. The literature review data consisted of studies published between 2015 and 2021. The aim was to include the most recent studies in the thesis, in which case previous relevant information is not included in this thesis. The data search produced a total of 9 studies. The number of results was moderate. The studies dealt with the accessibility of mobile applications and revealed factors highlighting accessibility from the user's point of view. The data search process produced relevant, although unfortunately minor, re-sults for my literature review.

The literature review consisted of original studies. The selected material was written in English. There were some professional terms and concepts in the material that were unfamiliar to myself. The material was carefully studied to avoid misunderstandings. In some parts the English-language material has been challenging to understand. This is a good point to take into account when inter-preting the results of the thesis. I tried my best to deal with the English-language material. I did this thesis as an individual project. Doing a thesis alone gave me more freedom in terms of schedules. Another student would have been a good addition to this thesis. With another student, I could have reflected on the material more broadly and had discussions in situations where my own understand-ing is not always enough.

For this literature review, I did not need to ask for research permission. Permissions are usually related to situations where sensitive material is handled in some way. My own material is based on studies that have already been completed. Ethics for this thesis means how closely I have followed the literature review process, also marking the citations correctly is a base for good ethics. Copyright must be respected as it is part of a good research tradition. In my thesis, I have followed the ethical guidelines of the research and cited in accordance with the reporting guidelines of Savonia University of Applied Sciences, if the information was researched by another author.

Professionally, doing this thesis has taught me a lot. I consider next this topic based on the generic competences of masters degree in digital health. Generic competences are: **learning competence, ethical competence, working communisty competence, innovation competence and international competence**. Doing this thesis has been a huge learning experience. My own professionalism has grown and I have gainednew knowledge of the digitalisation of healthcare. For the purpose of my thesis, I have become acquainted with the making of a literature review, which is a working method of compiling the researched information. Through this process, my **learning competence**s have strengthened a lot. **Ethical competencies** are reflected, for example, in the research part of the thesis, so that I have tried my best to act throughout the process in accordance with the ethical principles of the research. My **working community competences** have also evolved. This process has arisen in collaboration with the thesis client organization and the supervisors of the thesis. The process has required a goal-oriented study approach and it has a strong link to **innovation competencies**. The thesis strengthened my research skills. Although there were several uncertain moments along the way, I received a lot of support and guidance from my instructors throughout the process. My thesis is work-oriented and emphasizes user-orientation. **International competences** have been strengthened because during the process I delved into international articles and through this I have gained the confidence to work and produce text in English as well. This will give me the courage to work in international contexts the future.

8 CONCLUSIONS

The purpose of this thesis was to gather information in the form of a literature review on what factors influence the user experience of the accessibility of a mobile application. For the review, I was able to collect a sufficiently large amount of material, and on the basis of the material, I was able to answer my research questions moderately well. A broader view of the user experience could have been gained by interviewing users. In addition to this, the views of application developers on accessibility could have brought a more different perspective to this thesis. Accessibility is a topical issue at the moment. Mobile applications has to be accessible from June 23, 2021. The thesis is topical and hopefully gives even a small direction to what should be taken into account in the application. The limitation of my thesis is that it does not fully correspond to how each factor should be implemented in the application.

This literature review pointed that, in the case of mobile applications, accessibility means elements related to the application's interface, content, and cognitive accessibility. The fact that the user interface of the application works technically smoothly does not guarantee that the user will get all the information he or she needs about the application. Attention should also be paid to linguistic and cognitive accessibility, such as how things are expressed in text format or what font and style is used in the text. The review showed that accessibility also consists in part of very clear factors that need to be taken into account. The logical order of the content, the use of atl texts, the ability to use a screen reader in application, and the consideration of colors and fonts make the application much more accessible.

Accessibility can seem difficult to comprehend if you don't need support or help in everyday life. However, considering accessibility can have a positive impact on the daily lives of many people. It enables the individual to function equally in society. In this case, anyone has the opportunity to manage their own affairs electronically. User centricity emphasizes where and how the application is used and what kind of user groups the application can have. In this case, good ideas do not have to be wasted. Accessibility should not be understood as an obstacle, but as an enabler of equality. Some of the accessibility criteria are easy to assess and the fulfillment of the criteria can be assessed objectively. Such a criterion may be, for example, the use of atl texts. However, criteria that affect subjective experience may be more challenging to implement. For example, users can interpret the information and text used in an application in many different ways. In the accessibility of applications, both technical and cognitive accessibility are important issues to consider.

The accessibility of mobile applications is still a little researched topic. There are still much to be explored and clarified on this subject, and I believe that if this literature review had been taken place in a few years' time, the results could have been more precise and detailed. There are lot to be explore in this area. In my opinion, a good topic for further research in mobile accessibility is still related to considering the user's perspectives. Older people benefit from the accessible services. A large number of services are changing digitally at an accelerating pace and if these services are not designed to be used by older people, a large number of people will be completely excluded from these services. The same idea also strongly applies to other user groups.

REFERENCES

Allanwood, Gavin & Beare, Peter 2019. User experience design. A practical introduction. London: Bloomsbury Visual Arts 2019.

Aluehallintovirasto 2021. Digipalvelulain vaatimukset. https://www.saavutettavuusvaatimukset.fi/digipalvelulain-vaatimukset/. Accessed 13.3.2021.

Aluehallintovirasto 2021. Kenelle saavutettavuus on tärkeää? https://www.saavutettavuusvaatimukset.fi/yleista-saavutettavuudesta/kenelle-saavutettavuus-on-tarkeaa/. Accessed 13.3.2021.

Aluehallintovirasto 2021. Siirtymäajat. https://www.saavutettavuusvaatimukset.fi/digipalvelulain-vaatimukset/siirtymaajat/. Accessed 13.3.2021.

Aluehallintovirasto 2021. Yleistä saavutettavuudesta. https://www.saavutettavuusvaatimukset.fi/yleista-saavutettavuudesta/. Accessed 13.3.2021.

Ballantyne, Mars, Jha, Arcit, Jacobsen, Anna, Hawker, J. Scot & EL-Glaly, Yasmine N 2018. Study of Accessibility Guidelines of Mobile Applications. https://doi.org/10.1145/3282894.3282921. Https://www.researchgate.net/profile/Yasmine-Elglaly/publication/329494003_Study_of_Accessibility_Guidelines_of_Mobile_Applications/links/5c23a560a6fdccfc706b0b6b/Study-of-Accessibility-Guidelines-of-Mobile-Applications.pdf. Accessed 15.6.2021.

Contrast 2016. UX-design ja UI-design: Mitä eroa niillä on? https://contrast.fi/ux-design-ja-ui-design-mita-eroa-niilla-on/ Accessed 6.4.2021.

Correia, Walter F.M, Penha, Marcelo, Macedo, Jefté A., Siebra, Clauirton A. & Anjos, Marcelo E. 2019. A roadmap towards mobile applications with accessibility for visually impaired users: guideline and its evaluation. DOI: https://doi.org/10.23972/det2019iss19pp87-111. https://www.ufrgs.br/det/index.php/det/article/view/625. Accessed 3.6.2021.

Daihua, Yu, Parmanto, Bambang & Dicianno, Brad 2019. An mHealth App for Users with Dexterity Impairments: Accessibility Study. DOI: 10.2196/mhealth.9931. Https://pubmed-ncbi-nlm-nih-gov.ezproxy.savonia.fi/30622096/. Accessed 1.6.2021.

Daihua X., Yu, Parmanto, Bambang, Dicianno, Brad E. & Pramana, Gede 2015. Accessibility of mHealth Self-Care Apps for Individuals with Spina Bifida. Journal article-research. Https://web-b-ebscohost-com.ezproxy.savonia.fi/ehost/detail/detail?vid=5&sid=7a5f0a58-afa1-4c59-98dd-ba0098057c29%40pdc-v-sessmgr02&bdata=JkF1dGhUeXBlPWlwLHNoaWImbGFuZz1maSZzaXRlPWVob3N0LWxpdmU%3d#AN=109793691&db=ccm. Accessed 22.4.2021.

Daihua X., Yu, Parmanto, Bambang, Dicianno, Brad E, Watzlaf, Valerie J & Seelman, Katherine D 2015. Accessibility needs and challenges of a mHealth system for patients with dexterity impairment. DOI: 10.3109/17483107.2015.1063171. Https://web-b-ebscohost-com.ezproxy.savonia.fi/ehost/detail/detail?vid=3&sid=7a5f0a58-afa1-4c59-98dd-ba0098057c29%40pdc-v-sess-

mgr02&bdata=JkF1dGhUeXBlPWl-
wLHNoaWImbGFuZz1maSZzaXRlPWVob3N0LWxpdmU%3d#db=ccm&AN=119997068 Accessed
21.4.2021.

Deuff, Dominique & Cosquer, Mathilde 2013. User-Centered Agile Method. E-book.
Https://ebookcentral-proquest-com.ezproxy.savonia.fi/lib/savoniafi/reader.action?docID=1187167.
Accessed 12.5.2021.

Digital service act 306/2019. https://www.finlex.fi/fi/laki/alkup/2019/20190306. Accessed
8.10.2021.

Eskola, Jari & Suoranta, Juha 1998. Johdatus laadulliseen tutkimukseen. E-book. Ellibs online library.
https://www.ellibslibrary.com/reader/9789517685047. Accessed 5.10.2021.

European commission 2014. VIHREÄ KIRJA terveysalan mobiilisovelluksista ("mHealth"). PDF file.
Published 10.4.2014. https://ec.europa.eu/transparency/documents-register/de-
tail?ref=COM(2014)219&lang=fi. Accessed 25.8.2021

Geisen, Emily & Bergstrom, Jennifer, Romano 2017. Usability testing for survey research. Cam-
bridge, Massachusetts : Morgan Kaufmann 2017. https://ebookcentral-proquest-com.ezproxy.savo-
nia.fi/lib/savoniafi/reader.action?docID=4807038 Accessed 10.5.2021.

Holopainen, Arto 2015. Lääketieteellinen aikakauskirja duodecim. Mobiiliteknologia ja terveyssovel-
lukset, mitä ne ovat? https://www.duodecimlehti.fi/duo12334. Accessed 14.3.2021

Kanta 2021. What are Kanta services? Updated 3.3.2021. Webpage. Https://www.kanta.fi/mita-
kanta-palvelut-ovat. Accessed 25.1.20211

Kela 2020. Kela provides service to customers in many different ways. Updated 9.9.2020
https://www.kela.fi/web/en/operations-kelas-services. Accessed 13.3.2021

Kela 2020. Our strategy. Updated 18.2.2020. https://www.kela.fi/web/en/operations-strategy. Ac-
cessed 13.3.2021

Kjellber, Elfriede 2019. Sähköisen asiointipalvelun saavutettavuus ja käyttäjäkokemus ikäihmisten
näkökulmasta. Master's thesis. Degree programme in communication science. University of Vaasa.
https://core.ac.uk/download/pdf/270104475.pdf. Accessed 10.5.2021.

Koskela, Johanna 2017. Saavutettavuus, siis mitä? Blog by Celia. 22.1.2017. https://www.ce-
lia.fi/Blogi/saavutettavuus-siis-mita/ Accessed 9.9.2021.

Lazar, Jonathan, Goldstein, Daniel & Taylor Anne 2015. Ensuring Digital Accessibility through Pro-
cess and Policy. Amsterdam, Netherlands : Morgan Kaufmann 2015

Lehtiö, Leeni & Johansson Elise 2016. Järjestelmällinen tiedonhaku hoitotieteessä. In Stolt, Minna,
Axelin, Anna & Suhonen Riitta(Eds.) Kirjallisuuskatsaus hoitotieteessa. Turku: Juvenes print.

Martin-Khan, Melinda, Freeman, Shannon, Dam, Kevin & Betkus Georgia 2017. The Evolution on
telehealth. In Marston, Hannah R., Freeman, Shannon & Musselwhite Charled(Eds.) Mobile e-

health. Cham, Switzerland : Springer, 174. https://ebookcentral-proquest-com.ezproxy.savonia.fi/lib/savoniafi/reader.action?docID=5178279&ppg=1. Accessed 23.4.2021.

Musselwhite, Charles, Freeman, Shannon & Marston, Hanna R. 2017. An Introduction to the Potential for Mobile eHealth Revolution to Impact on Hard to Reach, Marginalised and Excluded Groups. In Marston, Hannah R. et al. Mobile e-health. Cham, Switzerland : Springer. https://ebookcentral-proquest-com.ezproxy.savonia.fi/lib/savoniafi/reader.action?docID=5178279&ppg=1 Accessed 26.4.2021.

Mobiili saavutettavuus.fi s.e. Mistä on kyse? https://mobiilisaavutettavuus.fi/mista-on-kyse. Website. Accessed 23.4.2021.

Nesbitt, Thomas S. 2018. History of telehealth. In Rheuban, Karen, Schulder & Krupinski, Elizabeth A.(Eds.) Understanging telehealth. New York : McGraw-Hill Education [2018], 11-12.

Niela-Vilén, Hannakaisa & Hamari Lotta 2016. Kirjallisuuskatsauksen vaiheet. In Stolt, Minna, Axelin, Anna & Suhonen Riitta(Eds.) Kirjallisuuskatsaus hoitotieteessa. Turku: Juvenes print.

Nielsen, Jakob 2012. Usability 101: Introduction to Usability. Blog by Norman Nielsen group. 01.03.2012. https://www.nngroup.com/articles/usability-101-introduction-to-usability/ Accessed 26.4.2021.

Nurmi, Jarkko 2021. Omakanta mobiilisovellus. E-mail message. 06.04.2021. Recipient: Pekka Heikkinen.

Oliveira, Camila, Dias, Fioravanti, Maria, Lydia, Fortes, Renata, Pontin, De Mattos & Barbosa, Ellen, Francine 2018. Accessibility in mobile applications for elderly users: a systematic mapping. DOI: 10.1109/FIE.2018.8659017. Https://ieeexplore.ieee.org/abstract/document/8659017. Accessed 3.6.2021.

Papunet 2020. Mitä on käytettävyys? https://papunet.net/saavutettavuus/mita-on-kaytettavyys. Accessed 6.4.2021.

Radcliffe, Erin, Lippincott, Ben & Jones, Mike 2021. A Pilot Evaluation of mHealth App Accessibility for Three Top-Rated Weight Management Apps by People with Disabilities. DOI: 10.3390/ijerph18073669. Https://pubmed-ncbi-nlm-nih-gov.ezproxy.savonia.fi/33915917/. Accessed 30.4.2021.

Salminen, Ari 2011. Mikä kirjallisuuskatsaus? Johdatus kirjallisuuskatsauksen tyyppeihin ja hallintotieteellisiin sovelluksiin. Vaasan yliopiston julkaisuja. Https://www.univaasa.fi/materiaali/pdf/isbn_978-952-476-349-3.pdf. Accessed 25.1.2021

Selovuo, Kari 2019. Saavutettavuusopas. Helsinki: Euraprint.

Setiawan, I Made Agus, Zhou, Leming, Alfiksi, Zakiya, Saptono, Andi, Fairman, Andrea, Dicianno, Brad, Edward & PArmanto Bambang 2019. An Adaptive Mobile Health System to Support Self-Management for Persons With Chronic Conditions and Disabilities: Usability and Feasibility Studies. https://formative.jmir.org/2019/2/e12982. Accessed 21.4.2021.

Serra, Leandro, Coelho, Carvalho, Lucas, Pedroso, Ferreira, Lucas, Pereira, Vaz, Jorge, Belimar, Silva & Freire, Andre, Pimenta 2015. Accessibility Evaluation of E-Government Mobile Applications in Brazil. https://doi.org/10.1016/j.procs.2015.09.279. Https://www-sciencedirect-com.ezproxy.savonia.fi/science/article/pii/S1877050915031257. Accessed 1.6.2021.

Tuomi, Jouni & Sarajärvi, Anneli 2018. Laadullinen tutkimus ja sisällönanalyysi. Savonia finna online service. https://savonia.finna.fi/Record/savonia.994529356406248. Accessed 15.6.2021-

Vilkka, Hanna 2007. Tutki ja kehitä. Helsinki: Kustannusyhtiö Tammi.

Voutillainen, Tomi 2020. Digitaalisten palveluiden säätely. Helsinki : Alma Talent.

WHO 2019. Recommendations on digital interventions for health system strengthening. https://apps.who.int/iris/bitstream/handle/10665/311941/9789241550505-eng.pdf?ua=1 Accessed 14.3.2021.

Ye, Summer. 2017.T he Ultimate Guide – Difference Between Usability and User Experience. https://www.mockplus.com/blog/post/difference-between-usability-and-user-experience. Accessed 6.4.2021

Zhou, Leming, Saptono, Andi, Setiawan, I Made Agus & Parmanto, Bambang 2020. Making Self-Management Mobile Health Apps Accessible to People With Disabilities: Qualitative Single-Subject Study. DOI: 10.2196/15060. Https://pubmed-ncbi-nlm-nih-gov.ezproxy.savonia.fi/31899453/ Accessed 26.4.2021.

Övermark, Timo 2018. Käyttäjälähtöinen suunnittelu parantaa saavutettavuutta. Blog by Papunet. 31.8.2018. https://papunet.net/saavutettavuus/blogi/kayttajalahtoinen-suunnittelu-parantaa-saavutettavuutta. Accessed 12.5.2021.