

Master's Programme in Computer, Communication and Information Sciences

Implementing and maintaining continuous accessibility in e-commerce development

Single-case study of a company with in-house development of digital B2C sales channels

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Abstract

In an increasingly digitalised world, where services are progressively moving online and physical service points are being reduced, it is crucial to ensure that digital services are simple and satisfying to use for everyone, regardless of their individual needs and abilities. To promote equality in digital services and improve accessibility, new regulations will soon take effect in the European Union, requiring organisations with consumer-facing e-commerce to comply with accessibility standards. According to existing research, to support the implementation of accessible digital services, accessibility must be considered early and continuously throughout the project life cycle. This underscores the need for accessibility expertise and the establishment of practices that support accessibility in e-commerce development.

The objective of this thesis was to examine accessibility practices, key supporting factors, and the challenges faced by digital practitioners in e-commerce development. A single-case study was conducted on a Nordic transportation company actively developing B2C digital sales channels. The study involved seven semi-structured interviews with employees in various roles to explore the company's approach to accessibility, role-specific responsibilities, perceptions of key accessibility-supporting factors, and the challenges encountered.

The study identified seven essential accessibility-related practices and key factors facilitating continuous accessibility implementation. Additionally, various challenges, from balancing diverse user needs in a single solution to understanding the user needs behind accessibility requirements, were observed. Based on the study results, the thesis presents practical implications that aim to guide organisations in enhancing accessibility in their e-commerce channels, emphasizing practices such as integrating accessibility into continuous development, regularly collaborating with accessibility experts and users with disabilities, and fostering organisation-wide commitment to accessibility. To conclude, this research provides insights into the perceived benefits of the identified accessibility practices and presents common challenges organisations may encounter in improving accessibility in their digital sales channels.

Keywords digital accessibility, accessibility implementation, B2C E-commerce

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Tiivistelmä

Digitalisaation kiihtyessä ja palvelujen siirtyessä kasvavissa määrin verkkoon samalla kun fyysisiä palvelupisteitä vähennetään, on tärkeää varmistaa, että digitaaliset palvelut ovat yksinkertaisia ja miellyttäviä käyttää kaikille, riippumatta yksilöiden erilaisista ominaisuuksista. Edistääkseen tasa-arvoa digitaalisissa palveluissa ja parantaakseen digitaalista saavutettavuutta, Euroopan unionissa on astumassa voimaan uusia säädöksiä, jotka velvoittavat kuluttajille suunnattuja verkkokauppoja noudattamaan saavutettavuusvaatimuksia. Aikaisemman tutkimuksen perusteella saavutettavuuden toteuttamista digitaalisissa palveluissa tukee saavutettavuuden huomioiminen jo varhaisessa vaiheessa ja jatkuvasti koko projektin elinkaaren ajan. Tämä korostaa saavutettavuusosaamisen ja saavutettavuutta tukevien käytäntöjen tarvetta digitaalisia palveluita kehitettäessä.

Tässä työssä toteutettiin tapaustutkimus, jossa tutkittiin yksittäistä pohjoismaista liikennealan yritystä, joka kehittää kuluttajille suunnattuja digitaalisia myyntikanaviaan. Tutkimuksessa suoritettiin eri rooleissa työskentelevien työntekijöiden kanssa seitsemän semistrukturoitua haastattelua, joiden avulla tarkasteltiin yrityksen saavutettavuuslähestymistapaa, rooleihin liittyviä vastuita ja koettuja haasteita sekä näkemyksiä saavutettavuutta tukevista avaintekijöistä.

Tutkimus tunnisti seitsemän olennaista saavutettavuuteen liittyvää käytäntöä ja avaintekijää, jotka edistävät jatkuvaa saavutettavuuden toteuttamista. Lisäksi havaittiin erilaisia haasteita, kuten erilaisten käyttäjätarpeiden huomioiminen yhdessä ratkaisussa sekä saavutettavuusvaatimusten taustalla olevien käyttäjätarpeiden ymmärtäminen. Työ esittelee tulosten perusteella muodostettuja käytännön suosituksia, jotka pyrkivät ohjaamaan organisaatioita parantamaan saavutettavuutta digitaalisissa myyntikanavissaan, korostaen käytäntöjä kuten saavutettavuuden integroimista jatkuvaan kehitykseen, säännöllistä yhteistyötä saavutettavuusasiantuntijoiden ja käyttäjien kanssa sekä organisaation laajaa sitoutumista saavutettavuuteen. Tämä tutkimus tarjoaa näkemyksiä tunnistettujen saavutettavuuskäytäntöjen hyödyistä ja esittelee yleisiä haasteita, joita organisaatiot voivat kohdata parantaessaan saavutettavuutta digitaalisissa myyntikanavissaan.

Avainsanat digitaalinen saavutettavuus, saavutettavuuden kehitys, B2C-verkko-kaupat

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Preface and acknowledgements

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Helsinki, 04.07.2024
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Symbols and abbreviations

Abbreviations

B2C	Business-to-consumer
WCAG	Web Content Accessibility Guidelines
W3C	World Wide Web Consortium
UX	User Experience
CX	Customer Experience
QA	Quality Assurance

1 Introduction

Tasks that used to require physical on-site presence from customers, such as shopping for groceries, buying new clothes, or signing a new electricity contract, can now be performed online through e-commerce. Therefore, e-commerce holds significant potential, particularly for people with disabilities who may encounter challenges accessing traditional physical stores. However, this potential is currently not being met as revealed by Eficode (2022) and Acosta-Vargas *et al.* (2022) who conducted accessibility evaluations on the largest European and Global online stores. The evaluations revealed that even the largest and most well-known online stores have significant accessibility issues which make it difficult, or even impossible, for some people with disabilities to browse or make purchases from online stores (Acosta-Vargas *et al.*, 2022; Eficode, 2022).

The World Wide Web Consortium (W3C) defines digital accessibility, or web accessibility, as designing digital content in an inclusive manner, taking people with disabilities into consideration (W3C, 2024a). The ISO/IEC 30071-1 (2019) standard for developing accessible ICT products and services further splits accessibility experience into three levels that build upon each other, starting from technical accessibility where the applicable accessibility guidelines and requirements are being met and the system can be used by people with diverse characteristics and assistive technologies. The next level goes beyond the technical requirements and ensures that the system is effective and efficient to use by people with disabilities, and the third, highest, level corresponds to people with disabilities finding satisfaction in using the system.

To help organisations and individuals develop accessible content, The W3C Web Accessibility Initiative (WAI) has created standards, strategies, and other support materials (WAI, 2024a). One of the most well-known of them is the widely used Web Content Accessibility Guidelines (WCAG) international standard. The WCAG organises the guidelines around four key principles of accessibility, meaning that web content must be perceivable, operable, understandable, and robust for people with disabilities and assistive technologies. Under each of the principles, a set of guidelines and their testable success criteria are presented in three conformance levels: A, AA, and AAA; level A being the lowest and level AAA being the highest (WAI, 2023). In addition, content that is designed for people with disabilities by WCAG 2.0 has also been studied to bring benefits and increase user satisfaction for nondisabled people of all ages, especially mobile device users (Schmutz, Sonderegger and Sauer, 2018, p. 706).

Nevertheless, having guidelines and support materials is only part of the solution; these guidelines must also be implemented effectively by organisations and digital practitioners to develop accessible digital systems. To promote the adoption of accessibility in digital systems and ensure equal opportunities for all to participate in society, The European Accessibility Act (EU Directive 2019/882) was enacted in 2019. The act was implemented in Finland through the Digital Services Act (306/2019), mostly focusing on the digital products and services provided to consumers by the public sector. However, amendments have been made to the Digital Services Act expanding the accessibility requirements to include new services and actors, one of them being B2C e-commerce provided by both the public and the private sector beginning in June 2025. The Digital Services Act (306/2019) includes three central requirements; the web content must conform to the level A and level AA criteria of the WCAG version 2.1, the service must provide an accessibility statement presenting the current state of accessibility and known accessibility issues on the digital channel, and the service must provide a channel for users to give feedback on the accessibility of the service (Regional State Administrative Agency, 2024c). Considering the current state of accessibility in consumer-facing e-commerce, the act's expansion implies that there will be an increasing demand for organisations to ensure their current and new online stores will adhere to the accessibility requirements. This, in turn, will require accessibility expertise from organisations and digital practitioners that develop and maintain consumer-facing electronic commerce.

Instead of a goal-oriented approach to digital accessibility where accessibility is tested and ensured at the end of a project, researchers advocate a process-oriented approach where accessibility is considered from the beginning and throughout the development lifecycle in different phases (Luján-Mora and Masri, 2012; Horton and Sloan, 2014; Dowden and Dowden, 2019; Paiva, Freire and de Mattos Fortes, 2021; Bi *et al.*, 2022). Leaving accessibility testing to the end of the project has been said to lead to more costs and greater complexity than considering accessibility since the beginning (Luján-Mora and Masri, 2012, p. 5). Furthermore, as the testing happens only at the end of the project, the remaining time and budget at that stage, as well as any technical constraints may significantly impact how well accessibility can be improved at the end of the project (Horton and Sloan, 2014, p. 107). Therefore, these findings imply that organisations and their employees involved in developing e-commerce solutions will have to start taking on new responsibilities and integrate accessibility-related practices and tools into their current processes.

In recent years, some accessibility evaluation studies have been made on consumer-facing e-commerce websites and the studies have highlighted the common accessibility issues from the users' perspective as well as the

accessibility conformance levels of the websites (Acosta-Vargas *et al.*, 2022; Eficode, 2022). Also, research has been conducted on the common practices and faced challenges in software projects and agile software development processes, but the focus has been mainly on analysing specific roles in the development teams or organisations and software projects on a more general level (Leitner, Strauss and Stummer, 2016; Bai, Mork and Stray, 2017, 2018; Velleman, Nahuis and van der Geest, 2017; Vollenwyder, Opwis and Brühlmann, 2020; Bi *et al.*, 2022). However, there is a contextual research gap on how e-commerce development teams have organised and incorporated accessibility practices in their development processes and what kind of challenges or issues are present in the e-commerce context when implementing and maintaining digital accessibility. Naturally, some software elements and development processes are universal between e-commerce development and software development in general, but there are also unique characteristics in e-commerce projects that cannot be found in other common software or website projects. Aspects, such as efficient navigation and search functionality, large quantities of products and additional services to display, simple yet engaging purchase paths, and operational checkout and payment flow, are commonly found specifically in e-commerce and not in other software products.

This thesis aims to investigate this research gap through a case study of an organisation that actively develops two of its e-commerce channels and where accessibility conformance has been mandatory since 2019 when the Digital Services Act (306/2019) initially came into effect. In the case study, employees working in various roles are interviewed and their accessibility-related roles and practices, collaboration with internal and external stakeholders, and encountered challenges when working with accessibility are investigated.

The research questions for the thesis are as follows:

1. What practices and key factors can be established to achieve and maintain continuous accessibility in e-commerce development?
2. What common challenges do digital practitioners face when implementing and ensuring accessibility?

The thesis concentrates on the practices that support continuous accessibility, instead of focusing on the technical implementation of transforming an inaccessible e-commerce solution into an accessibility-compliant version. As accessibility conformance for e-commerce will be enforced by law from 2025, organisations developing B2C e-commerce will have to start focusing on accessibility, and the question anymore will not be why to do that, but instead, how to achieve that. Moreover, it is not enough to make the digital service

accessible once and then forget about it, instead, organisations must learn how to maintain the level of accessibility as digital solutions are being continuously developed and new content and features are introduced.

This thesis is structured as follows. Chapter 2 presents the theoretical background of digital accessibility, and earlier research on the implications of accessibility implementation to organisations and digital practitioners and how accessibility can be incorporated into the software development lifecycle. Furthermore, the chapter presents common challenges faced by organisations and practitioners when adopting accessibility into the organisation and implementing it into the developed digital services. Chapter 3 presents the research methodology and approach of this study, and Chapter 4 introduces the results of the empirical study. Finally, Chapter 5 summarises the research findings by presenting answers to the research questions, discussing practical implications, and presenting the limitations of the study and recommendations for future research.

2 Literature review

2.1 Digital accessibility in the e-commerce context

The recent accessibility evaluations of top global e-commerce websites reveal that users with disabilities face numerous amounts of issues and barriers that affect their user experience when conducting online shopping. The most common accessibility issues faced by users include issues such as poor colour contrast, lack of meaningful link texts, insufficient text alternatives for non-text content, lack of keyboard support, and poor user experience with assistive technology (Acosta-Vargas *et al.*, 2022, p. 17; Eficode, 2022, p. 76). Regarding the WCAG accessibility conformance level, approximately half of the 50 e-commerce sites evaluated in the study by Acosta-Vargas *et al.* (2022) were discovered to be level AA conformant. The evaluation conducted by Eficode (2022) did not rank the websites along WCAG conformance levels but created their own accessibility grading scale, where 0 is not accessible at all and 5 is very accessible. The average score of the 20 evaluated e-commerce websites was determined to be 2.7 out of 5. Additionally, a survey conducted by Brownlow and Williams (2020) analysed the online shopping experience of people with disabilities in the UK. According to the survey, the most common issues that make online shopping difficult for people with difficulties involve crowded pages with too much content, captcha tests, poor navigation, and link information, filling in forms, and poor colour contrast and text layout. The study found that 69% of online shoppers with disabilities stated that they click away from a site with accessibility barriers. While the accessibility of the evaluated e-commerce websites might have already improved by now, based on these results it is safe to assume that accessibility conformance remains a problematic area for many consumer-facing online stores worldwide.

As the European Accessibility Act requires all consumer-facing e-commerce services, apart from the services provided by microenterprises¹, to comply with accessibility requirements after June of 2025, companies must learn how to consider people with disabilities throughout different phases of the customer journey and customer activities. Vollenwyder *et al.* (2023, p. 11) state that complying with the WCAG requirements gives a good foundation for accessibility as it entails the most important technical aspects. However, it does not automatically ensure the service is fully accessible to people with disabilities. Complying with the accessibility requirements ensures that the

¹ As stated by The Regional State Administrative Agency (2024b) “The Act does not apply to micro-enterprises. A micro-enterprise refers to enterprises with fewer than 10 employees, whose annual turnover does not exceed EUR 2 million or whose annual balance sheet total does not exceed EUR 2 million.”.

service is technically accessible, but according to various definitions, such as the one defined by The Regional State Administrative Agency (2024a), digital accessibility goes beyond only technical accessibility. In addition to technical accessibility, digital accessibility can be seen as consisting of two other areas, the ease of use and the clarity and comprehensibility of the content. Therefore, Vollenwyder *et al.* (2023) recommend the use of user-centred and participatory design methods, in addition to conforming to the accessibility requirements, to make the digital service easy for all users to use and understand, and achieve the most accessible solution.

For organisations developing B2C e-commerce, amendments to the European Accessibility Act will introduce motivation to start implementing more accessible services to comply with the accessibility requirements. However, avoiding potential fines is not the only benefit organisations can gain from implementing accessible digital services. Previous studies have investigated the reasons why businesses should concentrate on the implementation of accessible digital services and have identified different factors influencing their adoption and implementation (Yesilada *et al.*, 2012; Leitner, Strauss and Stummer, 2016; Velleman, Nahuis and van der Geest, 2017; Mäkipää and Vartiainen, 2023). In a case study conducted by Leitner, Strauss, and Stummer (2016, p. 253), organisation's motivations to implement web accessibility standards were studied and the results showed three primary motives for organisations to incorporate web accessibility in their digital solutions: economic, social, and technical motivations.

According to the World Health Organisation (WHO, 2023), an estimated 1.3 billion people, in other words, 16% of the global population, are living with a significant disability. Moreover, Eurostat (2023) reported that 27% of people aged 16 years and over living in the EU have some form of disability. The reported numbers reveal that there is a significant customer base for businesses that can make their services accessible to people with disabilities. When a digital service is accessible, people with disabilities will more likely have a better user experience when using the service, increasing satisfaction, enjoyment, and customer loyalty towards the service or a product (Horton and Sloan, 2014, p. 106). Furthermore, 75% of the respondents with disabilities in the survey, conducted by Brownlow and Williams (2020), agreed that accessibility was seen as a more important factor than price when making spending decisions in an online shop. Additionally, according to the W3C Web Accessibility Initiative (WAI, 2024b), by following the accessibility guidelines, businesses make their systems easier to use for users with disabilities as well as elderly users. Therefore, the ongoing demographic change, with the rising number of elderly individuals utilising digital services, serves as an additional economic rationale for implementing web accessibility (Leitner, Strauss and Stummer, 2016, p. 253).

The social motivators include factors, such as ethical behaviour, equality, and social responsibility (Leitner, Strauss and Stummer, 2016, p. 253). A study of over 300 digital practitioners conducted by Yesilada *et al.* (2012, p. 6) found “being inclusive” to be the most commonly mentioned motivation for digital practitioners to embrace web accessibility, meaning that social motivators are in an important position for adopting and implementing accessibility. Furthermore, intrinsic motivations can be seen as highly important, as forcing people to embrace accessibility practices, without explaining and demonstrating the benefits accessibility offers to all, does not commit people to accessibility adoption and implementation (Yesilada *et al.*, 2012, pp. 8–9). A systematic literature review conducted by Mäkipää and Vartiainen (2023) concentrated on analysing the intrinsic and extrinsic motivators for web practitioners to implement accessibility. They discovered that the most common intrinsic motivators included personal drive, recognition of universal benefits, and the awareness that the user base consists of individuals with different disabilities who should be provided with a working solution.

In addition to accessibility implementation being driven by social and economic motivators, various benefits of accessible services from the technical perspective have also been studied to influence the adoption and implementation of digital accessibility. According to Leitner, Strauss and Stummer (2016, p. 254), improving accessibility also increases usability, clarity and simplicity, download speed, and overall website quality. Furthermore, Velleman, Nahuis and van der Geest (2017) conducted a study where they interviewed the experiences of key stakeholders from municipalities that had recently started adopting and implementing digital accessibility in their digital services. The interviewed stakeholders highlighted the benefits of accessible websites from the viewpoint of digital practitioners, which included technical benefits, such as the website being more mobile-friendly, better code quality leading to less expensive website management, a faster website, and a better ranking in search engines.

Brownlow and Williams (2020), the researchers behind the accessibility survey in the UK, stated that due to a lack of improvement in the survey results compared to earlier years, making all services, not only the ones provided by the public sector, follow accessibility requirements by law seems to be the only solution that is left to improve the situation. On the one hand, it would force organisations to comply with the accessibility requirements under the threat of a fine, but on the other hand, forcing the accessibility requirements might shift the focus of organisations to merely reach the minimum technical requirements set by the law, instead of focusing on how to create a better user experience for people with disabilities. When focusing on only complying with minimum standards, the user’s perspective is often missed (Steen-

Hansen and Fagernes, 2016, p. 439). Furthermore, the mere minimum conformance with web accessibility standards alone has been found to not necessarily lead to improved usability and user experience for people with disabilities (Vollenwyder *et al.*, 2023, p. 10). Then again, legislation on accessibility has been found to positively impact the accessibility adoption and implementation process, especially in convincing other organisational stakeholders of its importance and placing accessibility on the list of priorities (Velleman, Nahuis and van der Geest, 2017, p. 185).

2.2 Building the environment for successful accessibility adoption and implementation

This chapter presents various key activities and practices from prior research and literature on adopting and implementing accessibility in the organisation to ensure the development of accessible digital products and services. The activities and practices are categorised under seven broader recommendations that organisations can follow to integrate accessibility better into their organisation and the developed digital systems. The overview of the recommendations and specific activities and practices can be seen in Table 1 in Appendix A.

Analyse the status of accessibility and identify the requirements

The first step for adopting and implementing accessibility within the organisation and into the developed digital systems starts with analysing the accessibility status of the current developed digital systems, if there are any yet, and identifying the relevant accessibility requirements (Dowden and Dowden, 2019, chap. 4; ISO/IEC 30071-1:2019). Researchers advocate for this to happen as early on in the project life cycle as possible to improve the quality and usability of the final product as well as reduce expensive rework later in the project if accessibility has not been considered since the beginning (Abuaddous, Zalisham and Basir, 2016; Steen-Hansen and Fagernes, 2016; Dowden and Dowden, 2019). When accessibility is initially adopted in the organisation, Dowden and Dowden (2019) and Eficode (2022) propose that the first step is to determine, through an accessibility expert evaluation, the accessibility status of the current system to understand the extent of the upcoming changes. The ISO/IEC 30071-1:2019 standard for implementing accessible digital systems also states that the adoption of accessibility should begin with the discovery of the accessibility requirements that apply to the organisation and the digital systems that it develops.

On top of discovering the state of accessibility in the current systems and the applicable accessibility requirements, Horton and Quesenbery (2014) advocate for analysing the current organisational resources for accessibility

implementation, such as attitudes, knowledge levels, and technical skills towards accessibility implementation. Different capability maturity models can be utilised to assess and improve the current knowledge levels, processes and practices regarding a certain capability. One such example regarding accessibility is the Accessibility Maturity Model provided by the Web Accessibility Initiative (WAI). The accessibility maturity model enables assessing the organisational accessibility maturity through seven different dimensions: communications, knowledge and skills, support, ICT development lifecycle, personnel, procurement, and culture (W3C, 2024b). A spreadsheet template is provided for organisations to track and monitor the maturity of each dimension either during the initial adoption phase or throughout the project life cycle. However, the study by Auer *et al.* (2023), that analysed and compared the different existing accessibility maturity models, found a lack of empirical foundation and evaluation of the existing accessibility maturity models, meaning that there is a lack of evidence on the manageability and effectiveness of the models in practice.

Establish an accessibility culture and ensure organisational commitment

Horton and Quesenbery (2014) highlight that organisational commitment to accessibility ensures that accessibility is considered not only when it is convenient, but it is always viewed as a priority. Furthermore, Dowden and Dowden (2019, chap. 3) state that business stakeholders hold significant influence in promoting accessibility, given their roles as decision-makers regarding timelines, requirements, and budgets. Moreover, they have the chance to lead by example through their actions. The study by Velleman, Nahuis and van der Geest (2017), which presents factors explaining the adoption and implementation processes for digital accessibility, found managerial commitment and decisions to have a big impact on accessibility adoption and implementation. They also found that non-management stakeholders have a big impact on the commitment of the managers, as the interviewed managers who received advice or pressure from the non-management stakeholders on accessibility, gave higher priority to accessibility implementation.

For establishing a successful accessibility culture and ensuring that the whole organisation is committed to accessibility implementation, Eficode (2022) recommends accessibility and inclusion to be included in the business strategy and company values. Furthermore, they state that a common target level for accessibility and user experience should be selected and communicated effectively within the organisation to ensure that all the employees prioritise accessibility in their work. To further foster the accessibility culture within the company, Steen-Hansen and Fagernes (2016) advise that enough time is

set aside for employees to discuss and share knowledge about accessibility with each other.

Build internal accessibility expertise

As stated by Horton and Quesenbery (2014, p. 194-195), accessibility inclusion and implementation for an organisation's digital systems is not a single event or a one-person job, instead, it requires everyone to share responsibility, authority, and accountability continuously throughout the system life cycle. Building internal accessibility expertise within the organisation can be viewed as consisting of two key activities. First, identifying all the relevant stakeholders in accessibility implementation and maintenance within the organisation and clearly communicating their responsibilities (Horton and Sloan, 2014; ISO/IEC 30071-1:2019; Eficode, 2022). Steen-Hansen and Fagernes (2016) and Bi *et al.* (2022) advise to ensure at this point that the organisation possesses team members with high competence, expertise, and motivation towards accessibility implementation. In case the organisation lacks the required resources and looks to hire new team members, Horton and Sloan (2014) propose including accessibility as a job requirement in recruiting and communicating all the accessibility-related tasks in the responsibilities of the role that is recruited.

The second step in building internal accessibility expertise can be seen as providing the employees with enough training and support so that they can fulfil their specified responsibilities. The researchers advocate for organisations to fill the skill and knowledge gaps by providing accessibility training, whether through self-study and online courses, or workshops facilitated by accessibility experts (Horton and Quesenbery, 2014; Abuaddous, Zalisham and Basir, 2016; Eficode, 2022). Furthermore, Steen-Hansen and Fagernes (2016) highlight that letting the development team observe first-hand how users with different disabilities use the websites and other IT solutions can increase their motivation towards accessibility implementation and deepen their knowledge and understanding of different disabilities and how the users with disabilities experience digital systems.

Utilise external accessibility expertise

In addition to building accessibility expertise within the organisation, the accessibility literature also highlights the value of using external accessibility expertise for developing accessible digital solutions (Horton and Quesenbery, 2014; Horton and Sloan, 2014; Dowden and Dowden, 2019; Fathauer and Rao, 2019). The external accessibility expertise found in the literature often includes external accessibility auditors, accessibility

specialists and consultants, and people with disabilities who can provide insights and guidance through their personal experience.

As the accessibility of a digital product or system is not something that can be accomplished once and then forgotten about, Dowden and Dowden (2019) propose arranging regular accessibility audits by external auditors to ensure that any new developments or system updates have not degraded the accessibility of the organisation's digital systems. Horton and Sloan (2014) emphasize that a common issue for organisations in utilising external accessibility expertise is to bring accessibility consultants as 'accessibility cops' to look for and report on any issues and compliance violations. They state that through that role, the consultants often have a very limited positive impact on increasing awareness and improving the processes for accessibility implementation. Instead, they advocate for establishing partnerships with accessibility experts early in the project, to ensure that they are seen as partners instead of compliance officers. Furthermore, Horton and Sloan (2014) and Fathauer and Rao (2019) state that accessibility experts and specialists are important channels for the organisation to understand the accessibility requirements and user needs in their own context of use and give specific recommendations on how to improve the internal processes and practices for building better accessible digital services. Another accessibility expert group discussed in the literature are people with various disabilities, who should be involved in the product development process to build better accessible products (Horton and Quesenbery, 2014; Horton and Sloan, 2014). Chapter 2.4 will present more details on how and when people with disabilities should be involved in the development process and the benefits it can bring.

Maintain accessibility documentation

Regarding accessibility documentation, the Digital Services Act (306/2019) has certain requirements for documentation, stating that organisations that fall under the act must provide accessibility statements for each of their digital channel presenting the current state of accessibility and known accessibility issues in the digital channel. In addition, the ISO/IEC 30071-1:2019 standard that guides on implementation and development of an organisational accessibility policy for developing accessible digital systems, advocates for the creation and maintenance of at least three key accessibility documents throughout the system life cycle. The first is the organisational ICT policy that should be documented for internal use. The ICT policy document should include how accessibility has been considered in the organisation's broader ICT policies, procedures, activities and standards, and present the accessibility goals for the organisation's digital systems. The second accessibility document is the public accessibility statement, required also by the Digital Services Act (306/2019), for each digital system that the organisation develops

for public use. The third document is an internal actively updated accessibility log for each system where the accessibility requirements and decisions regarding accessibility should be documented throughout the system's life cycle to support the development and maintenance of the systems.

Embed accessibility into the organisation's systems and tools

Horton and Sloan (2014) argue that to integrate accessibility successfully into product development processes and change the way how an organisation approaches accessibility, it is essential to establish an accessibility infrastructure. They state that accessibility should be integrated into both broader strategic aspects, such as organisational policies and content strategies, as well as more specific systems and tools, such as code repositories, style guides, and content development tools (Horton and Sloan, 2014, pp. 110–111). Content development tools and systems that promote and ensure accessible content production limit the risk of creating inaccessible content and the struggles content creators face. Code repositories and style guides that have accessibility integrated into them can ease the workload and speed up the work processes of designers and developers. Moreover, Shah (2023) argues that a well-established Design System acts as a central resource for both designers and developers. By incorporating WCAG 2.1 directly into these systems, accessibility becomes a core component of the design process, rather than being considered an afterthought.

In addition to the systems developed and used internally within the organisation, it is also crucial to assess the accessibility support of the third-party integrations used by the organisation to implement and develop the digital systems (Ng, 2017; Dowden and Dowden, 2019). Dowden and Dowden (2019, chap. 4) state that researching the accessibility support, capabilities, and limitations of every third-party tool or element used with or in the developed digital system is necessary. When faced with a third-party component or tool that lacks accessibility support, it should either be replaced, or alternative operation modes or partial conformance must be considered for the part of the digital system that depends on that specific third-party integration.

2.3 Integrating accessibility into the development process

This chapter introduces how prior research has approached integrating accessibility implementation and testing into the development process. The chapter presents both established methodologies and process models as well as more general best practices development teams can utilise to integrate accessibility practices and disability inclusion into their work processes.

Alongside building the environment in the organisation where digital accessibility is seen as a priority, one of the key components for ensuring digital accessibility of the provided digital service in the long term is to integrate accessibility-related practices, such as accessibility evaluation and testing, into the development process (Luján-Mora and Masri, 2012; Horton and Sloan, 2014; Sanchez-Gordon, Sánchez-Gordón and Luján-Mora, 2016). While accessibility testing methods can and should be utilised in the final testing phase before deploying the software to ensure that the final solution conforms to the accessibility requirements, researchers advocate for the testing and other accessibility practices to be incorporated into the whole development process throughout the project life cycle (Horton and Quesenbery, 2014, p. 193; Horton and Sloan, 2014; Steen-Hansen and Fagernes, 2016; Bai, Stray and Mork, 2019, p. 11; Paiva, Freire and de Mattos Fortes, 2021, p. 14; Bi *et al.*, 2022, p. 19). Especially for digital services such as online stores, where good customer experience is the key to success, usability and accessibility should be considered at every stage from planning and design to development and maintenance (Eficode, 2022, p. 80).

A systematic literature review of accessibility in software development processes conducted by Paiva, Freire and de Mattos Fortes (2021) revealed a growth in studies concentrating on process improvement to establish better accessibility of the developed digital system or product. To achieve better accessibility, the development teams should have a process-oriented view of accessibility development, use a user-centred design approach and involve users with disabilities in different stages of the development process (Paiva, Freire and de Mattos Fortes, 2021, p. 14). The authors also highlight the importance of accessibility incorporation into agile methodologies, stating that the utilisation of agile methods is an increasingly growing trend in web and mobile application development, especially among startups and smaller companies.

2.3.1 Methodologies and process models for accessibility development

The existing literature contains various methodologies and software process models for creating accessible software, such as the disability-aware software engineering process model by Nganji and Nggada (2011) and the adapted SCRUM methodology by Romero-Chacón *et al.* (2019). The focus on accessibility varies between the different models, some of them focusing more on the initial phases of software projects, and how different disabilities can be considered already during requirements elicitation and feasibility studies, while other models concentrate on incorporating accessibility testing and evaluation methods in later phases, during the development and testing.

One of the process models that focus on considering various users with disabilities as early as possible in the project is the disability-aware software engineering process model presented by Nganji and Nggada (2011). The paper also introduces a user-sensitive inclusive design method which is stated by the authors to ensure that the developed software is both accessible and usable for people with disabilities. Instead of presenting in detail how accessibility testing and evaluation can be integrated into the process, the main focus of the process model is on concentrating on accessibility already from the moment the need or relevance for the system is explored and analysed. The model emphasises that the different user groups and their needs must be considered, potentially with external accessibility expertise, throughout the project in every phase, such as when the system requirements are analysed, technologies are selected, and designs are proposed. However, as no empirical research on the application of the process model was presented in the paper, its practical effectiveness and potential challenges are difficult to evaluate.

While the research conducted by Nganji and Nggada (2011) did not mention the Web Content Accessibility Guidelines and concentrated more on the awareness of users with disabilities in each phase of the development process, more recent methodologies and process models focus also on complying with the WCAG criteria and have specified activities for ensuring the compliance with the WCAG accessibility requirements. One such example is the adapted SCRUM methodology, presented by Romero-Chacón *et al.* (2019) that according to the authors guarantees compliance with the WCAG 2.0 principles. The methodology implemented by the authors follows standard SCRUM practices, such as sprints and daily meetings, integrated with new accessibility-ensuring practices. In addition to time estimation and effort estimation for user stories, the methodology adds a new phase called ‘identification of accessibility tasks’ to sprint planning. The new phase includes adding different accessibility-related tasks, such as developer accessibility tests and accessibility corrections, with their respective time estimations to the user stories. The methodology also added new phases to sprints to be conducted after the development phase, called ‘accessibility testing’, ‘accessibility fixes’, and ‘accessibility checks’.

The accessibility testing process defined in the adapted SCRUM methodology follows the Website Accessibility Conformance Evaluation Methodology (WCAG-EM) created by the Web Accessibility Initiative (WAI) as a supporting resource for the Web Content Accessibility Guidelines (Romero-Chacón *et al.*, 2020). The WCAG-EM contains five phases that guide the procedure of testing accessibility for a website or an application or a more specific part of it. The five phases contain defining the scope of the evaluation, exploring the digital channel or functionality to be tested, selecting a representative

sample when it is not possible to evaluate the whole system, evaluating the selected sample, and finally reporting the findings for internal use (WAI, 2020). The paper concludes that the adapted SCRUM methodology was utilised successfully for the development of a web platform in Costa Rica (Romero-Chacón *et al.*, 2020, p. 112). However, the authors note that regular usability and accessibility validations with visually impaired individuals were conducted throughout development. Therefore, it can be argued that utilising the presented methodology alone in another context might not achieve the same success as presented in the paper, without also conducting regular usability and accessibility evaluations.

Another accessibility process model utilising the WCAG-Evaluation Methodology is presented by Campoverde-Molina, Luján-Mora and Valverde (2021). They present a process model for continuous web accessibility testing, which consists of the adaptation of the Deming cycle, the WCAG-EM methodology, and Total Quality Management (TQM). The iterative process model consists of four key steps – plan, do, check, and act – that are derived from the Deming cycle, which is a methodology designed for organisations for continuous improvement. The first, Plan, phase includes determining the current situation of the evaluated digital system and defining the accessibility requirements it should fulfil, to create an action plan and a solution plan for the system. The next, Do, phase consists of following the action plan and fixing the identified issues. The third, Check, phase consists of collecting and measuring the results of the fixes. The final, Act, phase includes documenting the solution to prevent the problems from reoccurring. The feasibility of the process model in practice was verified through a case study, which revealed that the accessibility of the analysed website was improved by 75% after the first iteration.

In addition to the other presented process models, Sanchez-Gordon, Sánchez-Gordón and Luján-Mora (2016) also present an engineering development process where accessibility-related activities have been included in the phases of project initiation, analysis, design, construction, testing, and delivery. The paper presents that already in the project initiation phase, the development team should select the accessibility evaluation methods and testing tools, such as disability simulators, assistive technologies, and automatic accessibility evaluation tools, to be utilised throughout the project. The software analysis phase contains accessibility-related tasks such as arranging for the development team members the possibility to observe how users with disabilities interact with software products and ensuring that the requirements specifications include also accessibility requirements. In the software design phase, the design architecture as well as the software components and interfaces must be evaluated against the specified accessibility requirements. As recognised by the authors of the paper, the presented development

process and the list of accessibility-related tasks are not exhaustive and they have not yet been empirically validated (Sanchez-Gordon, Sánchez-Gordón and Luján-Mora, 2016, p. 246).

To conclude, while there are different methodologies and software process models for developing accessible software, some of them have not been empirically validated at all and others through single case studies. Therefore, transforming the existing development processes to strictly follow any of the presented process models might not be feasible for development teams as their benefits and potential challenges in different contexts and industries have not yet been fully discovered. However, the presented models and methodologies lay a good foundation for development teams on which direction to go for developing accessible software and how the different phases can include the consideration of accessibility and users with different characteristics. Furthermore, it is good to notice that most of the process models and methodologies presented in accessibility literature follow agile iterative processes, instead of more traditional development methodologies where each phase must be fully completed before moving on to the next one and making changes later on in the development process is difficult.

2.3.2 Utilisation of agile software development practices

Instead of defining complete development processes where each phase of the process has readily defined activities and tasks for incorporating accessibility, some studies present more general guidelines and practices for integrating accessibility into the existing software development process that the development team may already have in place. One such source is the ISO/IEC 30071-1:2019 standard that provides guidance for ensuring the accessibility of information and communications technology (ICT) systems, emphasizing inclusivity for diverse user groups, including individuals with disabilities and older users. It addresses organisational and developmental aspects, offering guidelines for building and maintaining accessible digital products and services, applicable to all types of organisations and software development methodologies.

The ISO/IEC 30071-1:2019 standard presents eight activities that should be incorporated into the software development life cycle and followed throughout the development and life of a digital system. The list of activities includes activities such as specifying the widest range of potential users, specifying user accessibility needs, and ensuring communication about accessibility both internally and externally. For each activity, the standard provides further instructions on what aspects to consider and how to incorporate them into the relevant phases of the development process.

While the guidance provided by the ISO/IEC 30071-1:2019 standard applies to all software development methodologies, the existing literature and research on managing accessibility emphasizes the importance of practices often found in more agile than traditional software development methods. As an example, Luján-Mora and Masri (2012, p. 4) state that accessibility testing and assurance must be continuous throughout the development life cycle for the issues to be detected early and resolved as soon as possible, avoiding expensive reworks if the testing of the final product or service only happens at the very end as done in traditional software development, such as the waterfall method. Furthermore, Romero-Chacón *et al.* (2019, p. 113) argue that the accessibility and usability validation processes happen too late in the traditional waterfall methodology. Utilising agile methodologies allows the early detection of accessibility and usability issues, and the smaller iterative development cycles ensure that the teams can gather knowledge around accessibility steadily throughout the project.

In their research, Luján-Mora and Masri (2012) introduce their approach to how agile methods can be used to achieve web accessibility and how web accessibility is related to the key values of the Agile Manifesto. The Agile Manifesto contains four key values: working software over comprehensive documentation, customer collaboration over contract negotiation, and responding to change over following a plan. For each key value, Luján-Mora and Masri (2012) present how they should be managed to promote the inclusion of accessibility throughout development. For instance, they state that cooperation between designers and developers as well as frequent interaction between developers and end-users should be prioritised, the satisfaction of the customers should be evaluated through frequent accessibility testing with users, and accessibility testing should be conducted continuously already since the beginning of the project for the early detection of accessibility issues. In their paper, Bi *et al.* (2022) present recommendations for implementing accessibility and the recommendations include various main principles of agile software development, such as self-organising teams and frequent face-to-face communication with customers and end-users throughout the project life cycle.

On the other hand, Pellegrini *et al.* (2020) discuss how some common practices of agile methods may affect negatively the development of accessibility if not enough attention is paid to disability inclusion. For example, the practice of starting with the construction of the minimum viable product (MVP) and improving it later in further iterations combined with the lack of knowledge about accessibility and how to implement it has been seen to deprioritize accessibility requirements in agile software projects. They also state that even though following agile principles and methods offers a good foundation for the implementation of accessible digital systems, specific

attention to users with disabilities and accessibility still needs to be paid for the successful implementation of accessible software. For example, when constructing user stories and specifying the ‘definition of done’ that tells the developer when the task can be defined as complete, various user characteristics and accessibility requirements specific to that user story must be defined.

2.3.3 The role of accessibility experts in the development process

Regarding the development team composition and responsibilities, studies have been conducted on the role of specific accessibility experts in the development process. Some studies highlight building accessibility expertise within different roles while utilising little or no external accessibility specialists (Horton and Sloan, 2014). Others advocate for the frequent use of external accessibility expertise throughout the development process (Steen-Hansen and Fagernes, 2016). Additionally, some researchers support the idea of permanently integrating an accessibility specialist into the development team and process (Fathauer and Rao, 2019).

Horton and Sloan (2014, p. 111) recommend building accessibility expertise into each role of the product development team, as every team member must commit to ensuring an accessible user experience. In smaller teams, some people might hold the responsibilities of multiple roles, and in larger teams, some roles might have multiple team members working in the same role. Additionally, having responsibilities for different roles does not mean that accessibility is divided into multiple parts, rather, accessibility should be treated as a holistic and shared process across the whole project team (Horton and Sloan, 2014, p. 110).

In their paper, Fathauer and Rao (2019) present the findings of their study where they designed and developed an accessible software system, integrating an accessibility specialist in their agile development team. They present several benefits of integrating an accessibility specialist in the agile development process, one of them being their know-how to evaluate accessibility beyond the visual checks and automatic tools through utilising different screen readers and carrying out accessibility tests that require manual identification of issues and potential pitfalls. Also, they found that whenever the project team faced an accessibility-related issue, discussions with the accessibility specialist revealed other ways to achieve the end goal, making the final solution more maintainable, accessible, and user-friendly. Furthermore, the accessibility specialist was able to shift the project team's focus from merely achieving conformance with the technical criteria of the accessibility guidelines to going beyond the technical level and truly concentrating on supporting the use of the service for people with disabilities (Fathauer and Rao, 2019,

p. 8). They state the accessibility specialist integrated into the development process was working on multiple projects simultaneously, which significantly reduced the costs of adding the new member to the development team.

Steen-Hansen and Fagernes (2016) also share their thoughts on involving accessibility experts within the development team, stating that especially when accessibility is initially adopted into the organisation and the knowledge and know-how around accessibility have not yet been formed, using an external accessibility expert can provide both time and cost benefits. They state that having an expert on the team, especially at the beginning of a project, can help put in place working accessibility practices, teach and arrange training on disabilities and accessibility implementation for team members, and ensure that the team members can focus on their own areas of expertise. As a result, accessibility knowledge and know-how is spread around the organisation and the need for the accessibility expert over time decreases (Steen-Hansen and Fagernes, 2016, pp. 443–444). Another approach is introduced by Abuaddous, Zalisham and Basir (2016, p. 179), who recommend creating a new web accessibility position in the organisation. The accessibility specialist role could be nearly anyone from the organisation, from a web developer to a project manager, who takes accessibility training courses and participates in workshops. The selected accessibility specialist can then drive the accessibility initiatives forward in the organisation and facilitate interactions between management, development teams and customers to positively impact the development of accessible solutions.

Regardless of the extent of the role of the specific accessibility specialist in the development process, the studies still advocate for the whole development team to learn and understand how to work with inclusivity and accessibility instead of leaving that as the sole responsibility of the single role (Horton and Quesenbery, 2014; Horton and Sloan, 2014; Velleman, Nahuis and van der Geest, 2017; Bi *et al.*, 2022). As Steen-Hansen and Fagernes (2016) stated, without proper communication and the organisation arranging enough time for the accessibility specialist to share their knowledge, the benefits of having the accessibility specialist will be left very short. Therefore, whether integrating a specific accessibility specialist into the development team or not, ensuring frequent and effective communication and knowledge sharing is crucial for successful accessibility implementation.

2.4 Selecting the appropriate accessibility evaluation and testing methods

This chapter introduces different accessibility evaluation and testing methods that can be used to guide and test the accessibility of a design component, early prototype, or the full working solution. This chapter also presents the

findings of prior research on the ideal combination of different testing methods to include in the software development process.

The ISO/IEC 30071-1:2019 standard for developing accessible user interfaces presents five categories of different accessibility testing methods: manual conformity testing, automated conformity testing, assistive technologies, cognitive walkthroughs, and accessibility testing with diverse users. The various accessibility evaluation and testing methods that can be used depend on the state of the design or system. Some of the methods can be used on early prototypes or design proposals, such as automated tools or WCAG guidelines. However, some methods require the implementation of the system before they can be properly utilised, such as cognitive walkthroughs or accessibility testing with users.

Manual conformity testing involves an internal evaluator or external auditor manually inspecting and evaluating the digital solution using various guidelines and checklists to ensure it meets the appropriate accessibility requirements. An example of a common guideline used in manual conformity testing is the WCAG standard, which covers both technical and usable accessibility (Bai, Mork and Stray, 2017). However, as stated by Vollenwyder *et al.* (2023, p. 11), conformance to web accessibility standards should only be seen as the first step towards creating inclusive user experiences. The experiment conducted by Vollenwyder *et al.* (2023) revealed that only 10% of the recorded experiences by users with visual impairments were classified as related to web accessibility. The results suggest that by strictly following only checklist-based accessibility testing methods, such as WCAG 2.0, a large portion of the user experience for individuals with disabilities is missed.

Automated conformity testing consists of automated testing tools including online or local applications and software that can be used to analyse the conformance of a website, or smaller parts of it, against specified accessibility guidelines (Abascal, Arrue and Valencia, 2019). The automated tools can quickly help developers and other team members to discover slight problems with for example color contrasts, HTML page structure and semantics, or keyboard navigation (Mudunuri and Thatikonda, 2023, p. 41). In a study of different accessibility testing methods software teams prefer, an automated testing tool, called SiteImprove, which operates automatically and displays the accessibility issues to the tester was perceived as remarkably easy to learn and the most useful testing method in the study (Bai, Stray and Mork, 2019, p. 10).

However, a significant limitation of automated accessibility testing tools is that they cannot detect all accessibility issues (Abascal, Arrue and Valencia, 2019, p. 499). For example, the automated tools concentrate on validating

the found elements against the desired criteria but they are unable to identify whether the websites are missing any elements that could be crucial for users with disabilities, or whether the pages have inconsistencies in the structural organisation or keyboard tabbing order (Fathauer and Rao, 2019, p. 2). Moreover, it was discovered that when evaluating the accessibility of e-commerce websites, the automated testing tool struggled to find accessibility issues related to the WCAG “understandable” principle that is responsible for ensuring that the content and the operation of the interface are understandable for the user (Acosta-Vargas *et al.*, 2022). Furthermore, Pellegrini *et al.* (2020, p. 278) argue that while automated testing can speed up the testing process and reduce the effort required for repetitive tasks, it still contains broad limitations. They state that automated testing tools cannot test usability-related aspects, they are directed towards testing websites and not mobile applications, and they cannot be integrated with development environments that allow continuous integration and deployment.

Cognitive walkthroughs consist of an expert tester assuming the perspective of various target user groups and completing typical user tasks in the system to be tested (ISO/IEC 30071-1:2019). As stated by the ISO/IEC 30071-1:2019 standard, cognitive walkthroughs can be combined with the use of assistive technologies, such as screen readers that users with visual impairments can use. Testing with assistive technologies ensures that the digital system can be used with various combinations of assistive technologies and that the developed system supports the accessibility features of different browsers and platforms. Steen-Hansen and Fagernes (2016) emphasize the importance of testing with a large variety of different assistive technologies as often as possible as there are differences in how different assistive technologies operate. However, they also remind that there are vast differences in different browsing strategies and how different users use digital systems, meaning that while testing with assistive technologies can be beneficial, it should not replace testing with real users.

While there are numerous accessibility testing and evaluation methods, and research has been conducted on the benefits and challenges of each approach, studies have also been conducted on what testing methods to select and how to incorporate the testing methods in each phase of iterative software development (Bai, Mork and Stray, 2017; Stray *et al.*, 2019). Based on their evaluation and cost-benefit analysis of accessibility testing in agile software development, Bai, Mork and Stray (2017) present an optimal combination of different accessibility evaluation methods with the best ratio of low costs and a high accessibility issue discoverability. In the study, they discovered that the combination of a simulation kit with reduced vision, WCAG, and a screen reader helped discover a large number of accessibility issues with moderately low costs. Additionally, using automated checkers was

proven to also discover a high number of accessibility issues while having low resource and knowledge requirements to use them. Finally, utilising personas and conducting walkthroughs was shown to have great issue discovery, but with the drawback that it requires high knowledge about different disabilities and how the different users use the system.

Based on these results, Bai, Mork and Stray (2017, p. 9) presents the idea of an “agile accessibility spiral” which illustrates how the findings can be utilised to incorporate accessibility testing successfully and efficiently in an agile development process. Firstly, being the testing methods that were found to discover a high number of issues with low effort and cost, simulation kits with reduced vision and automated checkers were proposed to be utilised by designers and developers as early and as often as possible in the development cycle. The Cambridge Simulation Glasses, which simulate reduced vision, were proven to be especially useful, as they not only helped designers and developers to discover the most accessibility errors but also helped the designers and developers to experience first-hand how the discovered issues and errors affect the use of the digital products for users with reduced vision. The results of a case study conducted by Stray *et al.* (2019) support the combination of automatic testing tools and the use of simulation glasses to ensure effective identification of accessibility issues. Using the glasses is platform-independent, it was observed to discover accessibility issues that the automatic tools were not able to discover, and they can be used in every phase of software design and development (Stray *et al.*, 2019, p. 97). Furthermore, instead of focusing on small parts of software at a time, the glasses enabled the tester to have an overview of the entire product.

However, according to some researchers, using disability simulations also raises some ethical concerns (Silverman, Gwinn and Van Boven, 2015; Nario-Redmond, Gospodinov and Cobb, 2017). The use of disability simulations has shown unintended negative outcomes, including the perception of individuals with disabilities as less capable, and the limitation of brief simulations accurately representing the lived experiences of people with disabilities (Silverman, Gwinn and Van Boven, 2015). Nario-Redmond, Gospodinov and Cobb (2017) recommends that instead of pretending to be blind or have visual impairments, practitioners should evaluate the accessibility of digital products through the tools and software utilised by users with visual impairments. Furthermore, if the objective is to discover how people perceive accessibility issues, the practitioners should communicate directly with people with disabilities.

In the accessibility spiral presented by Bai, Mork and Stray (2017), the third testing method to be used is the WCAG Walkthrough. The study found that digital practitioners seem to agree that WCAG guidelines are somewhat

difficult and laborious to work with, emphasizing the need for also other accessibility testing methods. The findings of a later study of different accessibility testing methods conducted by Bai, Stray and Mork (2019) reveal that software team members viewed the WCAG Walkthrough method as a useful accessibility testing method, yet hard to use and not satisfying to work with.

Screen readers were placed as the fourth testing method as they discovered the highest amount of critical errors, but as it requires a stable version of the code to be utilised, it should be used only after the other testing methods to assure the accessibility of the final result. The study by Bai, Mork and Stray (2017) found that the screen reader testing method identified the highest amount of critical accessibility issues. They labelled the knowledge requirement of screen reader testing as a “medium”-level, as operating the screen readers requires some practice and learning. However, the results of a later study conducted by Bai, Stray and Mork (2019) found that screen readers were found to be very useful in finding accessibility issues, but more surprisingly, easy to learn and easy to use. However, they stated that they might have influenced the results by handing the practitioners written instructions on how to use the screen readers before the tests.

Lastly, persona testing represents the final stage in the accessibility spiral, recommended for less frequent use due to its demand for extensive expertise and resources. Nevertheless, when conducted by a project team with adequate experience and understanding, persona testing remains a valuable method for effectively uncovering accessibility issues. Nganji and Nggada (2011) support the idea of using persona testing to reduce the high costs that could be involved with accessibility testing with users and developing the potential prototypes for the testing sessions. They advocate for consultation with disabled people and disability experts for creating the personas to ensure the awareness of the user needs of people with different disabilities.

The effectiveness and perceptions towards accessibility testing with users were not analysed in the evaluation of the different accessibility testing methods conducted by Bai, Mork and Stray (2017); Bai, Stray and Mork (2019); or Stray *et al.* (2019). However, according to Abascal, Arrue and Valencia (2019, pp. 481–482), data recorded and observed from accessibility testing sessions with users with disabilities give the most reliable results for ensuring and improving accessibility. On the other hand, an exploratory study conducted by Aizpurua *et al.* (2014) with 11 legally blind users highlighted issues with accessibility testing with users as an accurate method for accessibility evaluation. The study found that accessibility testing with users can introduce potential biases that need to be managed. For example, the specific needs and problems of the participants may not represent those of all users with similar disabilities. Additionally, the accessibility findings from the testing sessions

are heavily dependent on the evaluator's expertise in accessibility. Aizpurua *et al.* (2014, p. 4) emphasize that accessibility testing with users for accessibility evaluation can be improved by having informal sessions with the evaluator and the user, where the user can freely navigate the website and is encouraged to report any issues that they face.

Vollenwyder *et al.* (2023) propose that users with disabilities should be included already in user research before the development of a project has been started, design drafts should be verified by users before they are assigned to developers, and accessibility testing sessions with users should be arranged soon after the first implementation has been published. However, while accessibility testing with users is widely recognised as an accessibility evaluation method that can greatly improve the usability and accessibility of digital services and products, there is a lack of literature guiding how, when, and how often to incorporate the testing sessions within an iterative software development process after the initial implementation has been published.

2.5 Digital accessibility implementation challenges in organisations

Implementing digital accessibility and integrating accessibility into the processes and operations of an organisation has been studied to pose numerous challenges. This chapter explores the different challenges presented in the literature and presents them under seven broader themes. The full table of the themes and challenges can be found in Table 2 in Appendix B. The presented challenges are gathered from numerous studies, where the researchers have conducted surveys, interviews, and evaluations for digital practitioners working on software projects to unveil the challenges they have faced regarding accessibility work. In addition, relevant research reviewing existing accessibility literature on implementation challenges was utilised.

Organisational and management challenges

Research by Bi *et al.* (2022), which gathered data from 15 interviews and 365 survey responses from various countries to investigate how digital practitioners perceive accessibility development and design in practice, revealed challenges in organisational and management practices. The study found that the lack of executive sponsorship and management commitment causes challenges in organisations for adopting and sustaining accessibility efforts. Furthermore, organisational culture factors and the size of the organisation were found to affect the implementation of accessibility, as smaller organisations were found to lack the necessary resources and support, while larger organisations were found to lack comprehensive accessibility evaluation. Additionally, Inal *et al.* (2020), who collected data from 167 UX professionals in

Nordic countries via an online survey, and Bai, Mork and Stray (2018), who surveyed 89 members of agile software projects, highlight the lack of management support as a challenge in digital accessibility implementation. Furthermore, Inal *et al.* (2020, p. 10) note that as the top challenges mentioned by the digital practitioners included budget and time constraints as well as lack of training, the issues arise from lack of management support as those aspects are the managers' responsibilities. Horton and Sloan (2014) state that a significant challenge in adopting and implementing accessibility within an organisation is overcoming the perceptions about the difficulty, complexity, effort, and cost required to achieve accessibility in their digital systems. These perceptions about the complexity and costs of accessibility implementation could play a role in the lack of executive sponsorship and managerial commitment towards accessibility implementation.

Skills and knowledge gaps around accessibility

Another significant area of concern, related to management support, is the skills and knowledge gaps regarding digital accessibility within the organisation and the development team. Bi *et al.* (2022) found that many organisations suffer from the lack of necessary skills and knowledge related to accessibility in the development teams. Additionally, also lack of project management competence and lack of teamwork were observed as challenges for incorporating accessibility in practice. Inal *et al.* (2020) present that time constraints and lack of training were the most reported answers for the challenges in ensuring digital accessibility. Furthermore, in their paper about web accessibility challenges, Abuaddous, Zalisham and Basir (2016) argue that untrained IT teams cause challenges for accessibility implementation and emphasize the need for more comprehensive accessibility training and increased awareness among developers and other stakeholders.

Content management challenges

Leitner, Strauss and Stummer (2016) present considerations and challenges in accessibility implementation through an exploratory case study and interviews of people working on software projects in private sector organisations. The interviews revealed difficulties related to content management, especially in software projects with a high frequency of people changing the content on the websites. They state that in content design and creation, even though the employees would obtain knowledge and awareness of accessibility, human errors and negligence are difficult to check or monitor which increases the risk of having inaccessible content on the websites. Furthermore, the study revealed issues with content management systems that do not support the creation of accessible content, which leads to either implementing a

new content management system or adapting the existing system with both options leading to increased costs and the need for further employee training.

Process and planning challenges

In their study, Bai, Mork and Stray (2018) found the lack of integrated processes and routines for practising universal design to be a major barrier to accessibility implementation in organisations. Additionally, the research conducted by Bi *et al.* (2022) presents the lack of a complete set of accessibility practices as a challenge to accessibility implementation. Furthermore, they present issues such as unclear project planning and scope, unclear requirements, and the lack of customer role and presence in the software process as common challenges faced in accessibility work. Leitner, Strauss and Stummer (2016) present that implementing and integrating accessibility to already existing digital solutions is difficult and expensive, and Horton and Sloan (2014, p. 108) argue that changing current practices to the ones that support accessibility is often seen as a too overwhelming process for the development teams.

Design and development challenges

The study by Inal *et al.* (2020, p. 8) revealed that among UX professionals, time and cost constraints are one of the most common challenges in creating an accessible system for people with disabilities. In addition to time and cost constraints, Abuaddous, Zalisham and Basir (2016) present also a lack of awareness and motivation towards accessibility as a major challenge for designing and developing accessible software. Moreover, Mudunuri and Thatikonda (2023) present two major challenges faced by developers and designers, one of them being the lack of awareness about accessibility and techniques. They state that the lack of awareness about accessibility guidelines and techniques to develop accessible software often might unintentionally result in inaccessible solutions. The other challenge faced by both designers and developers is designing and developing solutions that utilise innovative and visually appealing design elements while still maintaining inclusivity in the final solution.

Challenges regarding accessibility standards and guidelines

Even though the Web Content Accessibility Guidelines (WCAG) is a widely used web standard for creating accessible content, various studies reveal that the guidelines are difficult to use even for web professionals. Abuaddous, Zalisham and Basir (2016, p. 178) list multiple challenges regarding standards and guidelines, such as ambiguity and incompleteness of the WCAG 2.0, meaning that some of the criteria leave room for interpretation and

complying with all the requirements in WCAG 2.0 still does not guarantee that the digital system is accessible for all. They also present that according to prior research, the guidelines are difficult to navigate and following the guidelines can slow down the accessibility evaluation process remarkably. These results were supported by the findings of Bai, Stray and Mork (2019) who conducted an evaluation, with a sample of 54 people working in various software teams, of different accessibility testing methods and tools. The results showed that even though the participants viewed the WCAG walkthrough as a useful method for evaluating accessibility, it was seen as difficult to use and not satisfying to work with.

Challenges in accessibility evaluation and testing

Challenges related to accessibility evaluation methods and testing tools were gathered from two case studies conducted by Bai, Mork and Stray (2017), as well as an evaluation of accessibility tools by Bai, Stray and Mork (2019). The studies revealed challenges related to automatic accessibility checkers and persona-based testing. The automated accessibility checkers were able to find many accessibility issues on the evaluated web pages but none of the issues were considered critical or cognitive, and the automated checkers could successfully be used only for static pages and not the more complex pages (Bai, Mork and Stray, 2017, p. 6). They found that automated checkers were not able to identify any fundamental accessibility problems, instead, they revealed mainly minor issues such as colour contrast problems. Moreover, according to Fathauer and Rao (2019, p. 2), the automatic accessibility tools are only able to identify issues with interface elements that are present or are required, but they are not able to identify for example missing information or semantic inconsistencies. Furthermore, Abuaddous, Zalisham and Basir (2016, p. 178) argue that automated tools can give inaccurate results that vary from tool to tool and the results can be difficult to analyse, especially by developers with less experience around accessibility.

Abuaddous, Zalisham and Basir (2016) also reveal common challenges with accessibility testing with users, stating that they require a lot of expertise and conducting accessibility testing with users is more time-consuming than the other accessibility testing methods. Furthermore, they state that planning the testing sessions and finding users that match certain required characteristics can be difficult. Alongside automated tools and accessibility testing with users, Bai, Stray and Mork (2019) reveal one more challenging accessibility evaluation method; persona-based testing. While the study participants found persona-based testing to be useful, it was seen as too subjective, open to interpretation, and difficult to work with.

3 Research Methodology

This chapter introduces the selected research approach, how the literature review and the empirical research were conducted, and how the collected data was analysed. Also, a brief introduction to the case study company is presented. Figure 1 presents an overview of the research approach, containing key steps in developing the literature review and conducting the case study.

3.1 Research Approach

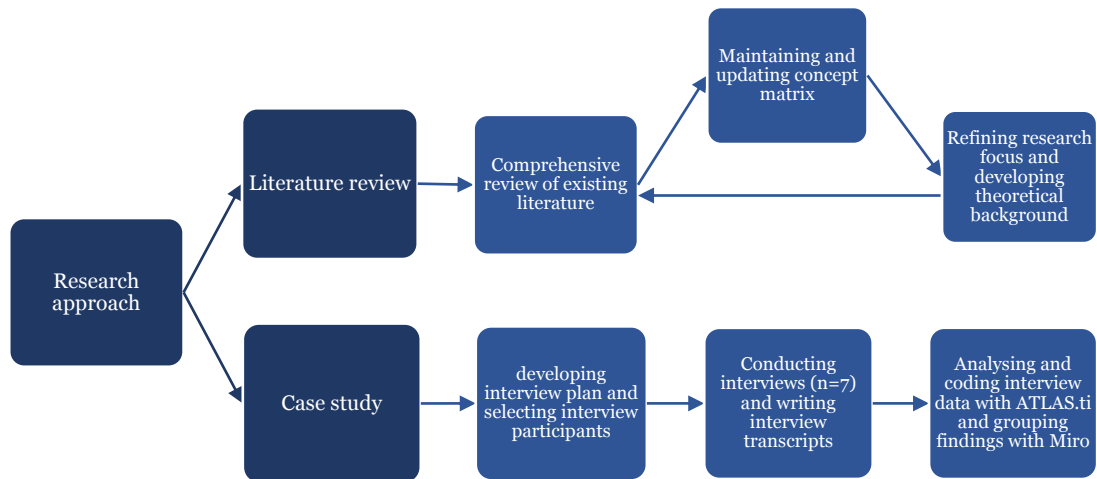


Figure 1: An overview of the research approach.

To investigate the accessibility approach and practices, as well as common challenges related to accessibility implementation within an organisation and the practitioners in various roles, conducting a case study was seen as the most suitable approach. The case study approach was selected because it allows for a detailed and in-depth data collection of a bounded system, in this study, a single representative case company (Creswell and Poth, 2016, p. 73). According to Hancock, Ockleford and Windridge (2007, pp. 11-12), case study approaches have received criticism because the case being studied might not accurately represent similar cases, making it difficult to generalize the results. However, they state that this criticism ignores the primary purpose of case study research, which is to provide a detailed contextual description of a specific case. Therefore, by transparently presenting the context and the findings of the case study, while still ensuring the anonymity of the interview participants, this study aims to allow the reader to assess the suitability of the study to their own contexts, as guided by Hancock, Ockleford and Windridge (2007).

As the objective was to gather insights about accessibility implementation in an organisation developing e-commerce, and not all organisations are considering accessibility yet, a purposive sampling strategy was selected for choosing the case company. For selecting a case study company for the research, two main criteria were set:

1. The company has an actively developed and maintained e-commerce channel selling products or services to consumers.
2. Accessibility statement(s) provided by the company show that their e-commerce channel(s) conform to the accessibility requirements set by The European Accessibility Act (EU Directive 2019/882).

Following the two main criteria, a Nordic transportation company with two actively developed and maintained consumer-facing e-commerce channels (website and mobile application) and a demonstrated history of adhering to accessibility requirements was selected as the case study company.

For the data collection in the case study, qualitative research methods were seen as more appropriate than quantitative methods as the objective was to gather in-depth insights into the practices, perceptions, and challenges experienced by different roles within the organisation. Hancock, Ockleford and Windridge (2007, p. 6) support this choice, stating that qualitative research is ideal when a systematic, yet flexible research approach is required, and the objective is to gather data that cannot be expressed numerically.

While literature and prior research exist on accessibility implementation and commonly faced challenges in a more general software development context, there is a scarcity of research on accessibility implementation and common challenges specifically in the e-commerce development context. Therefore, semi-structured interviews were selected as the data collection method for this qualitative study to build upon the findings from prior research and allow for the emergence of new concepts through the case study. Seaman (1999, p. 562) states that semi-structured interviews enable researchers to use a mixture of specific and open-ended questions, which helps uncover expected information but also allows for the discovery of unexpected insights. The specific questions help gather responses that may support or challenge prior research and earlier findings from the literature, while the open-ended questions allow participants to share insights that may not have been anticipated based on earlier related research. Thus, using the semi-structured interviews enabled the collection of insights that could be compared to prior research and literature on accessibility implementation and challenges in a broader context, but the open-ended questions ensured that the participants

were able to share insights specific to their own work and allowed flexibility to ask follow-up questions from the interviewees.

For this study, a systematic combining approach was utilised for theory development, which is the recommended approach for theory development from a single case study by Dubois and Gadde (2002, p. 553). In a systematic combining approach, the literature review and the empirical study are conducted in parallel, allowing for an iterative process where insights from the literature review and the case study can complement one another. A thorough review of existing literature on accessibility implementation in organisations was conducted before the empirical study to gain a solid foundation on the topic and develop the interview plans. However, the approach allowed for further improving the understanding and theoretical perspective of the topic during and after the empirical research which helped in categorizing and prioritizing the findings from the case study as well as aligning the literature review with the empirical research to ensure coherence of the research. As Hancock, Ockleford, and Windridge (2007) suggest, qualitative research often requires the refinement and reformulation of research questions as the study progresses, which was also a key aspect of this study. Refining the research questions throughout the study ensured that the literature review and research focus aligned with the emerging insights and findings from the case study.

3.2 Literature review

Before focusing on the empirical research including the case study and semi-structured interviews, a comprehensive search and review of existing literature was conducted to gain a deeper understanding of the topic of implementing accessibility, the different practices and responsibilities related to accessibility implementation, and the commonly faced challenges by practitioners and organisations when adopting or implementing accessibility into their digital solutions. The findings of prior literature and related research material enabled the forming of a firm foundation for the literature review as well as for the interview plans for the semi-structured interviews.

The collection of literature and prior research on the topic was primarily conducted utilising Google Scholar and Aalto-Primo, which allowed extensive coverage of scholarly literature from various academic resources. In addition to the academic resources, materials from the W3C Web Accessibility Initiative (WAI), which develops and maintains accessibility-related standards and guidelines, such as the Web Content Accessibility Guidelines (WCAG), were also incorporated into the literature review process.

Due to the scarcity of literature and earlier research specifically on the topic of accessibility implementation in the e-commerce context, the search

keywords included also broader terms and identified synonyms. For the term “accessibility”, synonyms such as “digital accessibility”, “web accessibility”, “inclusive development”, and “inclusive design” were utilised. To find earlier research, especially from the viewpoint of digital practitioners and organisations, the earlier keywords were matched with search terms, such as “design process”, “development process”, “software development”, and “organisation OR organization”. Additionally, to identify e-commerce-specific accessibility issues and practices, synonyms for e-commerce included “online store”, “online shopping”, and “digital commerce”.

After finding a relevant article related to the topic of the research, a reference management tool, Zotero, was utilised to ensure that the articles were quick and easy to find when writing the literature review. Instead of an author-centric literature review where findings and materials are presented one after another, Webster and Watson (2002, p. 16) state that literature reviews should follow a concept-centric approach to synthesize the literature. Therefore, to support a concept-centric approach, a concept matrix was developed as recommended by Webster and Watson (2002). The concept matrix was formed in an online spreadsheet where the relevant concepts and themes regarding accessibility implementation in an organisation and e-commerce context were outlined. After reading an article, the key ideas discussed in the articles were recorded under the corresponding categories in the matrix. These categories included concepts, such as "Roles and responsibilities of different stakeholders " and "Accessibility testing tools and evaluation methods". The concept matrix was utilised when constructing the literature review, enabling a comprehensive examination and comparison of the findings by different authors on specific concepts.

3.3 Case Study Background

The case study examines a Nordic transportation company that develops and maintains its online ticketing system in-house, which includes both a web-based version and a mobile application. Since 2019, the company's e-commerce solutions have been required to comply with accessibility requirements mandated by law and during the same year, the company renewed both of its consumer-facing digital sales channels, focusing on incorporating accessibility into the channels from the beginning.

Dedicated development teams are assigned to each channel, consisting of both internal employees and external consultants. The development team of the web channel includes a product owner, UX designers, developers, and QA specialists. The mobile application development team consists of a product owner, a UX designer, developers, and a QA specialist. The development teams embrace agile practices, utilising Kanban, iterative development

processes, and daily meetings with their channel development team. Additionally, a team of content designers work closely with the development teams to design and develop content for both of the digital channels.

Working in the transportation industry, the company also has existing initiatives in place for improving physical accessibility, such as collaborations with various disability organisations, which are led mostly by the company's service quality specialist. Regarding digital channels and digital accessibility, the company's design lead is responsible for defining the accessibility strategy and supporting the digital channels in the accessibility work. Furthermore, both digital channels are supported by the customer experience (CX) team which focuses on planning and conceptualizing the customer experience and sharing the insights with the rest of the organisation.

3.4 Semi-structured interviews

3.4.1 Participant selection

The participants for the semi-structured interviews were recognised after a discussion with a key stakeholder from the case study company. During the discussion, the focus and objectives of the empirical research were presented, and the potential roles associated with implementing accessibility were outlined. After the discussion, the case study company selected the participants for the interview study, ensuring that enough interviewees were selected to get a comprehensive view of the accessibility implementation in the organisation from the viewpoint of various roles but limiting the number of participants to minimize the disruptions to the company's operations caused by conducting the interviews.

In total, seven participants were interviewed. The participants all worked in different roles in the organisation and had differing responsibilities related to implementing and ensuring accessibility in the company's digital channels. The participants in question were the design lead, head of CX and service design, service quality specialist, content designer, UX designer, developer, and QA specialist. In addition, the head of CX and service design had worked as a product owner of both of the company's digital sales channels early on when the channels were renewed and accessibility was considered initially, providing insights from the perspective of the product owner as well as the adoption phase of accessibility in the organisation's digital services. The UX designer, developer and QA specialist were all from the mobile application development team, enabling a good overview and in-depth inspection of how accessibility is managed within one channel. However, this also introduced the disadvantage that less first-hand insights could be gathered from the web channel development team.

The interview participants were contacted by email and the objective of the thesis and the interview process and practicalities were presented. Additionally, a privacy information and consent form were sent as an attachment to the participants. The participants were informed that the interviews were recorded to form the transcriptions for the data analysis phase, after which the recordings were to be immediately deleted.

3.4.2 Conducting the interviews

Before conducting the interviews, interview plans were written. As all the participants worked in different roles, the interview plan was slightly modified based on the participant and their responsibility areas. Most of the questions were the same in all of the interview plans but some of them had follow-up questions regarding the participant's area of expertise. Appendix C presents the interview plan that was used for interviewing the development team members (UX designer, developer, QA specialist).

The semi-structured interviews were conducted online during the workdays to cause as little disruption for the participants. The interviews were held in either Microsoft Teams or Google Meet and they were conducted in Finnish or English, depending on the preference of the interviewees. Before starting the interviews, the participants were one more time informed that the interviews would be recorded, their identities and responses would be kept anonymous in the final thesis, and they were given the option to decline to answer any questions that would make them feel uncomfortable.

Considering that the number of potential interviewees was very limited as all of them had to be from the same case company and be involved with accessibility implementation, no separate pilot interviews were conducted. A 90-minute time slot was scheduled for the first interview, to ensure that there was enough time to go through the interview plan. As the first interview remained under 60 minutes, 60-minute time slots were scheduled with the remaining participants. As instructed by Adams (2015, p. 499) the interview plan was reassessed after the first interview, and slight modifications, such as reordering of the questions and addition of new questions that could unveil important information in upcoming interviews, were made.

3.4.3 data analysis and coding

After the interviews were conducted, the transcriptions were formed, and the interview recordings were deleted. The transcription documents were downloaded to ATLAS.ti, a data management tool that supports analysing and coding qualitative data. The data analysis process for each transcript started with

reading through the transcript once to get an overview of the interview transcript before starting the coding process. For the coding process, an inductive approach was utilised, and the initial codes were generated based on significant statements, sentences, or concepts presented within the transcripts. The inductive approach was selected as it allows the findings to emerge from the data without the restraints of an established framework or existing theory shaping the code structure (Thomas, 2006, p. 238). As the objective of conducting the semi-structured interviews was to collect data for the specified questions but also to gather insights on unforeseen concepts, the inductive approach was seen as the most suitable option.

To ensure consistency and reliability in coding, the initial codes were continuously monitored and modified as new concepts and themes emerged from the interview data. Codes were applied to sentences or a group of sentences that represented a specific idea or a topic presented by the interviewees. Throughout the coding process, care was taken to maintain a balance between specificity and generality, ensuring that codes were both precise and applicable across different interviews. Following the initial coding phase, codes with similar meanings were merged, and broad codes were subdivided into more specific sub-codes to aid the analysis process.

After the coding of all transcripts was completed, the next step involved organising the coded segments into meaningful clusters or categories. Using ATLAS.ti, code groups were created to align with the research questions, allowing for the systematic grouping of relevant codes under each research question. To further synthesize and interpret the findings, insights and quotes from the transcripts were imported to Miro, a digital whiteboard platform, that allowed the visual representation of the research findings and grouping of similar insights. This process enabled the creation of coherent categories and sub-themes, which formed the basis for presenting the research findings in a structured and logical manner.

4 Results

This chapter presents the results of the semi-structured interviews conducted with the employees of the case company. In Section 4.1, the company's approach to managing accessibility and accessibility-related practices will be presented. Section 4.2 introduces the challenges faced by the company and the interview participants when implementing and ensuring accessibility in the company's digital sales channels.

4.1 Accessibility approach and established practices

4.1.1 Defining the accessibility strategy and target level

The renewed digital sales channels, including the website and the mobile application, were launched in 2019 and both channels were required to follow the accessibility requirements by law already from the initial launch. The interviewed head of CX and service design was the product owner of both channels during the first years, and they stated that from the beginning, the objective regarding accessibility was to comply with the critical requirements and ensure that new developments do not deteriorate the accessibility level. Therefore, from the beginning, it was important to integrate accessibility testing and monitoring into the development process, which will be discussed in further detail in section 4.1.3.

In the company, one of the responsibilities of the design lead is planning and internally communicating the current accessibility strategy of the digital channels. The accessibility strategy includes plans and decisions regarding the two digital channels on managing accessibility in the long term, what level of accessibility the development teams should aim for, how to consider updates and changes in the accessibility requirements, and how to approach the already identified problematic areas. The channel development teams are then responsible for following the set accessibility strategy and ensuring that their channel fulfils the accessibility requirements.

The design lead discussed being involved recently in updating the digital channel strategy to meet the upcoming changes and new legal requirements regarding digital accessibility, which will take effect in the summer of 2025. As part of the strategy, they recognised the importance of an external accessibility audit to assess the current accessibility levels in the digital channels and pinpoint areas for improvement. The design lead emphasised that even though they have a good internal understanding of the level of accessibility in their digital sales channels, it is necessary to receive an unbiased external audit to assess the current level of accessibility.

The overall accessibility design approach was mentioned from the beginning to follow a single design strategy, meaning that the website and the mobile application are designed in a way that the same solution works for everyone, eliminating the need to create separate accessible versions of the entire solutions for people with diverse characteristics. However, occasionally some problematic areas or functionalities are identified, and the channel development teams, with the support of the design lead, must decide on the appropriate approach to address the issue. On an identified accessibility issue one of the digital channels currently faces, the design lead commented that strategic planning is ongoing on whether to develop the current functionality further and improve its accessibility for all or to provide an alternative version where the customer with accessibility needs can perform the same task through another way.

The design lead described the minimum target level for accessibility in the company's consumer-facing digital sales channels with the following words:

“Our absolute minimum in the development is to meet the WCAG AA level, but we have set the target level in a way that we gladly go higher than that when it is natural, and we can easily go beyond that.”

The Design Lead explained that they intentionally set the target level at WCAG level AA instead of AAA. They noted that aiming for AAA can sometimes alter the average user experience, and in some cases, even make it worse. They believe that trying to achieve the level AAA would sometimes require too many compromises for other user groups, so they choose not to pursue it as a base level. On this topic, the head of CX and service design shared a practical example from multiple years ago, where the colour for a primary call-to-action button was initially designed to be red as it had the most colour contrast, thus being the most accessible option. However, after considering that some customers might associate the red colour with a warning or error signal, the final colour of the button was changed to another colour with slightly less contrast but still complying with the accessibility requirements and fitting better with the brand colours. The interviewee highlighted this as an example of how, especially during the first few years, it required some practising for the whole company to balance between being accessible enough and striving to be the most accessible.

4.1.2 Organisational commitment to accessibility

All seven of the interview participants mentioned the business strategy and company values that support and prioritise accessibility work, play a key role in the company's success in implementing accessible digital services. One of

the participants emphasized that the successful accessibility implementation “really culminates to the values a lot, on what are the company’s values”. The interview participants stated that customer experience, and thereby accessibility, is seen as extremely important within the company and it is the reason that enables the company and its employees to work to improve both physical and digital accessibility in the company’s offerings.

“I think the company really cares about the customers and is really aware of its responsibility that mobility is like a human right and you cannot deprive of anyone’s right to be able to travel independently. So we have the awareness and we actually put in time and effort into it.” – UX designer

The QA specialist also described that accessibility is seen as a very important topic company-wide and an area that the company wants to put effort into. Additionally, they mentioned that the attitude towards accessibility in their channel development team is very good and the entire team views it as an important topic. In addition to the importance of the development team viewing accessibility as a priority, the developer mentioned that having already the upper management prioritize accessibility is crucial as it ensures sufficient time for ensuring accessibility during development.

“In my opinion, they [company values] are something that can really have a big impact on improving accessibility. We operate according to those shared values, and it helps to ensure that nobody goes off on their own against the common rules.” – Service quality specialist

The head of CX and service design described that the company-wide focus on accessibility comes through the company’s strategy to improve the overall customer experience. The design lead described that the focus on improving the customer experience for everyone, including people with disabilities and older people, also serves as a growth strategy. The ageing population has both the time to travel and the desire to purchase tickets well in advance, meaning that the digital channels must be easy to use and understand.

4.1.3 Accessibility integrated into the development process

When creating new functionalities or content for the digital channels, the development teams utilise Kanban. A ticket is created for each new development task, and its status is visualized on the Kanban board. The typical workflow for new development begins with the channel product owner maintaining and prioritising backlog items. Once the next development task is selected, the UX designer designs a layout with placeholder content. This placeholder content is then replaced and refined by the content designers. The task then moves to the development phase, where the developer follows the layout

and instructions provided by the UX designer. Finally, the task enters the testing phase, where the QA specialist ensures the quality and operability of the new component or functionality.

While no current product owners were interviewed, the other interviewees mentioned some responsibilities that product owners have for accessibility to be integrated into the development process. Firstly, product owners must ensure that their development team has the required knowledge and know-how to develop accessible solutions. Product owners are also responsible for prioritizing the development tasks and bug fixes and considering the effects of accessibility on these decisions. For the development tasks, the QA specialist stated that “The product owner is responsible for the term ‘accessibility’ to be mentioned early in the tasks”. Furthermore, the product owner, together with the UX designer, is responsible for including accessibility in the acceptance criteria of the tasks.

UX Design

When the development team starts developing a new functionality or a component, the task often begins with the UX design and implementing the design layout for the developers to follow. Most of the interviewees mentioned UX designers have a big responsibility to ensure that the final solution is accessible by including accessibility considerations as early as possible in the design process. The UX designer stated that the approach to accessibility in the design phase is to bake accessibility into the reusable components by having a design system that has pre-defined numerous accessibility-related considerations, such as brand colour contrasts, recommended typefaces to use, and touch target sizes.

“We don't have a lot of issues and we pre-define a lot of things. I think that's why in companies these days people drive the component library a lot. If you don't have a component library, I guess every single time if you start from scratch when you need something new, then the likelihood of making a mistake is quite high.” – UX designer

By having a design system where accessibility has been considered carefully, the UX designer can create new designs by utilising the existing components and ensure, without the need to manually go through the Web Content Accessibility Guidelines, the use of automated checkers, or a screen reader, that the design is accessible. However, when introducing completely new components that cannot be created by utilising the existing design system, the UX designer mentioned that they use a Figma accessibility plugin and potentially also other alternative accessibility tools found online to ensure accessibility. Furthermore, for new components where the behaviour of screen readers has

not yet been defined, screen readers are utilised already in the design phase to inform the developers and QA specialists how the new component or functionality should be implemented to work for screen reader users.

Content Design

When creating the design layouts that developers utilise to implement the designs, the UX designers fill the content with placeholder texts and the content designers then replace the content with the final UX copy. When creating the UX copy, the content designer implements both the visible content and the content to be read by screen readers. According to the content designer, there are no specific content guidelines or tools utilised for writing easy-to-understand content. Instead, often the readable and easy-to-understand content comes naturally through earlier work experience or discussions with other content design team members. They stated that the goal is to ensure that the text is concise, informative, and uses consistent terms across all digital and physical channels to avoid any confusion for the customers. Additionally, the content must also align with the company's tone of voice.

In addition to writing content for the website and the mobile application, the interviewed content designer is also responsible for writing newsletters. For both the website and the mobile application, content is created through the same Content Management System. According to the content designer, writing accessible content for the website and mobile application is usually straightforward as the “colours and elements” are pretty much handed to them, and their accessibility attributes have been already pre-defined. For the content on the website, the company utilises a tool that automatically monitors the website and reports to the web development team and the content team for basic accessibility issues and spelling mistakes. For the mobile application, no such monitoring tool came forth in the interviews. For writing the newsletters, no specific accessibility testing tools or guidelines are used, but sometimes when there are uncertainties for example with link colours in light and dark modes, an arbitrary online colour contrast checker is utilised to confirm the accessibility.

Development

After the designer has finished creating the design layout for a new development task, the ticket moves forward in the Kanban board for the developers. The interviewed mobile developer recognised that developers have a big responsibility for following the design specifications and making the solution accessible. The interviewed developer highlighted that having large amounts of their own custom native code created by the developers greatly improves the developer experience when implementing accessibility in a new feature.

“Through the native code, we can easily redefine the focus order or add a certain kind of order and organise it in our own way. And for managing the focus order when moving from one screen to another also has custom implementations, which are really easy to use and greatly aid our work.”

- Developer

The developer explained that sometimes when implementing a new feature, alternative operation modes can be set for screen reader users if the default solution does not completely support screen readers. One such instance currently exists in the mobile application, and the feature that was found to be difficult to make accessible has an alternative simplified solution that works but does not work as extensively as for the users without screen readers. The design lead and the mobile development team had identified the accessibility issue and informed the users about the issue through the accessibility statement, and plans are currently being made on how to assess the issue in future iterations.

Already in the implementation phase, the developer stated that they conduct screen reader testing with a single mobile device to ensure that the new implementation operates with the screen reader according to the design specifications and that there are no obvious issues with accessibility. By having screen reader testing already in this phase, the developers can recognise and fix accessibility issues more quickly and reduce the work for the QA specialist who performs more extensive screen reader testing before the new implementation goes live. According to the developer, the screen reader testing conducted by the developers does not have a clearly defined process, rather, it is usually case-specific in what aspects are assessed.

Testing

After the developer has finished implementing the new task, the ticket moves to the testing phase where the QA specialist of the team conducts more thorough functional testing to ensure quality and locate any existing issues. The QA specialist described their screen reader testing process as “very light and easy” and while the testing itself can be laborious, the process is still quite simple. The screen reader testing conducted in the mobile application channel is performed on the default screen readers, VoiceOver and TalkBack, of two devices running iOS and Android operating systems. According to the QA specialist, the reason for conducting screen reader testing with both VoiceOver and TalkBack is that the different screen readers sometimes operate differently, and it is important to ensure that both screen readers work correctly as they are the most used screen readers for mobile users.

When bigger changes are made that affect the purchase path of the customers, the QA specialist commented that manually testing the basic purchase path is often enough, rather than testing the purchase path with all different customer types, as it often works the same way for all customer types and there would simply be not enough time to test through every single scenario with all the different customer types. While the screen reader testing is the main focus of the accessibility testing conducted by the QA specialists, they were also described as capable of recognising other accessibility issues as well, such as issues related to cognitive accessibility.

4.1.4 Self-organising and collaborative development teams

The interviewees highlighted the importance of frequent communication and collaboration of the development team when working with accessibility. The head of CX and service design highlighted that it has been a big advantage that the development teams have worked very independently and in an agile manner, being able to make decisions by themselves. Regarding the ways of working and the use of tools to evaluate and monitor accessibility, the participant stated that it has been a conscious decision to not define any particular tools or ways of working for the development teams and rather let the development teams and individuals decide the tools and practices they find enjoyable and best to use for themselves. The interviewed developer shared similar insights when describing how the process of accessibility testing has evolved within their development team: “It has come through our team, and in general also, we don't have directives from above dictating how something should be done.”

The interview participants stated that there are no specific meeting or communication channels, for example in the organisation's internal communication tools, or regular meetings arranged specifically for asking accessibility-related questions or for other related discussions. Instead, the interviewed development team members stated that any accessibility-related questions or issues can be raised during daily meetings with the channel development team or by contacting the relevant body through the company's communication channels. The service quality specialist highlighted that there is a low threshold to contact anyone in the organisation, despite the organisation being large.

Furthermore, besides meetings, the interviewees mentioned that they utilise a lot of the expertise within the development teams. When faced with any questions or issues regarding accessibility implementation or evaluation, the interview participants mentioned first trying to find the answers from Google or by benchmarking other solutions, and if they cannot find the answer through that, they turn to their colleagues and team members. For example,

the design lead and the UX designer brought up that when faced with questions about accessibility or screen readers, they often contact the QA specialist who is very knowledgeable and eager to help others on these topics. Additionally, the content designer stated that they have very good connections to the development teams so they can at any time send them a message whether they notice any accessibility issues or have any related questions.

When planning and designing new components or functionalities, the interviewed developer mentioned that a lot of collaboration and discussions happen within the team, and they can make decisions in a very agile way if some issues or problems arise that have not been discovered before. Similarly, the QA Specialist pointed out that new features are always brainstormed collectively with the channel's product owner, designer, and developers to ensure that diverse viewpoints are considered and to guarantee the highest quality in the outcome. They also emphasized the importance of discussing the accessibility-related aspects within the team with various roles, especially as most, if not all, have accumulated some knowledge on accessibility through the years and can spot potential issues or problem areas within their domain of expertise. The developer also mentioned that occasionally some accessibility-related issues that had gone unnoticed during the initial planning and design, are discovered during the development or testing phase. However, the developer did not view this as an issue, on the contrary, they viewed this as a natural part of the agile development process, highlighting that “as the whole development process is so agile anyway, I think it makes sense that it happens sometimes.”

4.1.5 Frequent collaboration and communication with customers

The organisation frequently collaborates with customers and collects large amounts of customer feedback regarding the physical service as well as the digital sales channels. The design lead stated that in the development of the company's digital services, practically all the larger user groups that have organised advocacy groups, such as the Federation of the Visually Impaired and the Pensioner's Federation, are considered. The service quality specialist remarked that as the number of physical service points is being reduced and the customers are increasingly directed towards digital sales channels for purchasing tickets, lots of collaboration is done especially with pensioners. They pointed out that pensioners can be a bit wary of the promotion of digital services and the self-service model in ticket sales, and it is important that they are being listened to for improving both the physical and digital services.

The collaboration with customers is usually conducted through accessibility testing sessions with various user groups where either the physical service or the digital channels are being tested with real customers. According to the

design lead, the accessibility testing sessions with users are usually facilitated and joined by at least one digital channel designer and one concept designer. In addition, sometimes the design lead and a person working in the company as a customer researcher join the accessibility testing sessions with users. The design lead gave an example of an accessibility testing session with users from the Pensioner's Federation, where they wanted to understand the whole customer purchase path on the website sales channel and identify problematic areas for the ageing population. The design lead mentioned that they have also conducted lighter testing in the vehicles where they have identified people who have bought a pensioner's ticket and asked kindly whether they would have time to try and share comments on a developed prototype. From these accessibility testing sessions with pensioners, the design lead shared various positive highlights: "The sessions have been incredibly rewarding because these people have time, they enjoy talking, they like to help, and they know that we are trying to improve their experience, so those moments are usually very pleasant."

Additionally, the company has created a co-development group with another transportation organisation to improve physical and digital accessibility in the transportation domain. The co-development group acts as a channel for the companies to listen and communicate with the representatives of different disability organisations, acquire users for accessibility testing sessions, and enable direct communication with the users and the company representatives who drive accessibility initiatives forward in their companies. The service quality specialist commented on the motivations for starting the co-development group: "The idea originated from the desire to move more towards involving customers more in our service development, not just experts from the various federations, but also our service users, in this development of accessibility."

In addition to accessibility testing with users, another way to consider the needs and expectations of the users has been to actively gather and listen to customer feedback. The design lead mentioned that accessibility feedback on digital channels from customers usually comes through three different channels: feedback through customer support, feedback directly from the federations, and the accessibility feedback system located on the website. The feedback to customer support is processed in a monthly meeting with the customer support representative, design lead, and the channel product owners. The feedback received directly from the federations is directed to the service quality specialist who then directs the feedback to the correct internal stakeholders. The service quality specialist concluded that this kind of feedback is not that common, maybe every other month some feedback is received directly from the federations. The design lead praised the feedback received directly from the federations, describing them as well-reasoned and highly

valuable. Finally, the feedback that is received directly through the accessibility feedback mechanism on the website is managed by the channel product owner who is responsible for going through the feedback, prioritizing it and making the required changes.

4.1.6 Full ownership and control of accessibility implementation

The head of CX and service design mentioned two important decisions the company made already before the initial launch of the current digital sales channels. First, the company decided to build accessibility knowledge in-house for the current employees, instead of recruiting separate accessibility specialists within the development teams or outsourcing the accessibility planning and implementation outside the development teams. Second, the company decided to make accessibility a shared responsibility within the company and the development teams, instead of being the sole responsibility of a single role or person in the organisation. The participant stated that at first, accessibility implementation and testing were planned to be the sole responsibility of the developers, but after further consideration, it was seen as more beneficial and less risky to make accessibility more holistically the whole responsibility of the different roles in the development teams and share the responsibilities within the teams.

To have full ownership of accessibility implementation, the staff has needed training and independent learning to incorporate the accessibility mindset and proper accessibility practices within their work processes. The interview participants stated that the company does not have any regularly scheduled accessibility training sessions in place, instead, the majority of their accessibility knowledge has mostly come through independent learning and from hearing the accessibility audit reports. In the company, the design lead and the channel product owners are responsible for ensuring that the channel development team members have all the required knowledge and know-how to ensure accessibility of the individual development tasks and the entire system.

“Training sessions have been organised as needed. So, the practice was already in place before me in this company, and now it has been continued in a way that the situation is somewhat assessed according to whether there have been any bigger changes or new employees. Then, with a low threshold, some kind of customized training session is arranged for that purpose.” – Design lead

The head of CX and service design stated that two bigger accessibility trainings have been arranged for all the people working on the digital channels, and some smaller team-specific training sessions have been arranged more

frequently throughout the years. They highlighted the benefit that by training internal employees on accessibility and managing it internally within the company, they have not needed to utilise external accessibility partners as often later on, as the employees have acquired lots of knowledge on the topic through the years and are eager to share their expertise within the community. The participant mentioned that the development teams consist of in-house employees and external consultants, but the leadership responsibilities always lie with the team members from their company, and it is their responsibility to ensure that accessibility is considered within the development teams. In addition, the head of CX and service design added: “It's better to take matters into your own hands because it's not only an opportunity for the company but also for the individual to acquire new workplace skills”. The design lead added that in-house development of the company's digital services enables being in control and improving the services a lot more easily than if the development was outsourced. Moreover, they emphasized that “having the development happen internally gives us very good tools to work with these issues and to be reactive when we notice that something is not working or needs to be changed.”

4.1.7 Utilisation of external accessibility expertise

Despite focusing on having full ownership and control of accessibility implementation within the company, the company has still utilised, and continues to utilise, external accessibility expertise to develop the digital channels as well as to train and educate the staff. The external accessibility expertise utilised by the company can be divided into three groups: the company's accessibility partners, federations and associations of different disabilities, and accessibility auditors. The head of CX and service design stated that when digital accessibility was initially adopted within the organisation, it started with discussions with the company's accessibility partners to understand the relevant requirements for the company's digital channels. The participant stated that the company had existing accessibility partners that they had utilised earlier on when working with physical accessibility, and they decided to utilise the same experts to help them organise around digital accessibility as well. One of the participants shared experiences from a training session conducted by the company's accessibility partner for the company employees:

“It was really good, and even though the technical work and requirements themselves are familiar, it brought a whole different perspective, especially in terms of testing and how to simulate the situation using our own digital devices. It helps to get into the right mindset to resonate with customers who have challenges or disabilities.”

In addition to accessibility partners, the company utilises the expertise of the various federations for improving and assuring the accessibility of their digital channels. Regular meetings are held where representatives from these federations, who both represent specific disability groups and are often knowledgeable about implementing accessibility in digital services, can directly express their concerns and share their expertise with the company. In addition, the interviews revealed that collaboration also extends beyond the meetings, as sometimes the federations can be directly contacted for feedback on certain issues. On this topic, the design lead shared a recent example where they directly contacted their contact person at the Federation of the Visually Impaired to ask their opinion on whether the colour contrasts were good enough for a new design proposition and if there were any issues with using a specific colour as a background.

According to the design lead, accessibility audits, where an external accessibility auditor evaluates the accessibility of the company's digital sales channels and reports the findings to the company, are arranged regularly. The audits have typically occurred approximately every other year, based on how big changes to the customer experience have been made in the digital channels. The head of CX and service design mentioned that in the beginning, before and after the initial launch of the website and mobile application, accessibility audits were done more actively than currently, as accessibility was less familiar for the development teams back then and the audits gave both assurance that the channels were complying to the accessibility requirements but also good insights and tips for the development teams concerning accessibility implementation and monitoring. The participants stated that after an accessibility audit is performed, often the whole channel development team is invited to hear the final audit report and key findings.

The interview participants highlighted the importance of accessibility audits in their development of accessibility knowledge and know-how through the years. The head of CX and service design highlighted that hearing the audit reports has been a great way for the development teams to improve their knowledge around the topic and to ask directly from the experts on how to do something in their own work context.

“Especially the audits have been very practical and rewarding. There are concrete findings that ‘this issue needs fixing’ and suggestions on how to fix it. So, both the development teams and I have gained expertise on what types of things are good to consider.” – Design lead

The QA specialist and the developer shared similar insights in their interviews, describing the audits, and especially the sessions where the final reports are presented by the auditors, as “fruitful” and giving “very practical

suggestions on what to fix and where to pay attention”. The content designer also emphasized the usefulness of a recent accessibility audit and the final session where the results were presented and discussed.

“It was really eye-opening to see how the test subject, using a screen reader, reads our website, especially since those UX texts also have separate descriptions for the screen reader. Through that, it really became clear how someone using such a device experiences the website.”

– Content designer

4.2 Challenges related to ensuring and implementing accessibility

4.2.1 Challenges in UX Design

In the interviews, challenges regarding UX design in the company’s digital channels were mainly mentioned by the UX designer and the design lead. The challenges regarding UX design are categorized under three main themes that are presented below.

Balancing the user needs in a single design strategy

The interviewed UX designer discussed the challenges encountered in designing accessible mobile applications, particularly in balancing the need for a fast and visually appealing user experience with accessibility considerations. They highlighted the dilemma of accommodating all users with and without specific accessibility needs in the same application and the difficulty of presenting the content efficiently and maintaining the accessibility of the design as the application evolves.

“The mobile application layout is very spaced, things are huge, and we use pretty big fonts compared to many other apps. And that's actually right in the beginning a conscious decision from an accessibility perspective. But then when the app develops and there are more and more features then how can we kind of maintain that level of accessibility.” – UX designer

The participant also evaluated the possibility of implementing different User Interface modes to cater to diverse user needs in the future:

“I don't know if that could be the future that we could have a standard scale stuff for everybody else. And then could we have a mode called ‘accessibility mode’ so that people can kind of get what they want, something that is like more optimized for their own real needs? But then again, that's a question of resources.”

Presenting additional services

Related to the challenge of balancing the user needs in a constantly evolving application, the interview participants also stated that presenting additional services on digital sales channels can cause issues. The design lead commented that as a designer, it would be easier to have fewer additional services and different options to display for the customer, as having too much content to display makes it difficult to keep the user experience lean. The design lead proposed automation as a possible solution to tackle the problem in the near future:

“We need to find ways to simplify it with the help of automation so that not all options are necessarily visible to everyone, but to identify the individual customer's needs and to serve them better individually.”

In addition to the challenge of how to be able to present all the provided services and options for the user, the interviewed UX designer brought up another related issue, the presentation order of additional services and the core essential features. The participant described a concrete example of a situation in the application where certain additional related services are promoted to customers, and the decision has to be made if the additional services are presented before or after the more essential core features. For example, a blind screen reader user could benefit from an additional service that provides food and drinks directly to their seat during travelling, which would support the viewpoint of promoting the service and prioritizing its presentation order in the application to ensure that the user is aware of the service. However, some users might find it laborious, or annoying, to close all the upsell service promotions if all they want to do is simply perform the most essential core task if they know that they do not want anything else at all. The UX designer described this as “constant balancing between different user needs which is always not very easy”.

Keeping the purchase path and customer journey simple

The design lead discussed the challenges of designing a good user experience for everyone in the digital sales context and keeping the purchase path simple:

“In our business, as we are selling tickets, the customer must know how to use the calendar, choose their passenger type from various options, and select possible additional services. Then there are also different ticket types and discount types. When all these factors are taken into account, it can become quite complex.”

Additionally, the design lead mentioned the complexity of making changes or cancelling the order through the digital channels after the purchase has been made. Especially if the order has included any additional services as well, it can become complicated and include different rules on when the changes or cancellations must be done and in which channels can the actions be taken. According to the design lead, these things cause challenges firstly on how to implement them in the digital channels, but also how to effectively communicate and present them to every customer, including those with accessibility needs.

4.2.2 Challenges in development and implementation

Challenges concerning development and technical implementation were discussed in the interviews, revealing problematic aspects regarding accessibility, such as limited resources, features that are challenging to make accessible, and inaccessible third-party integrations. The interviewed developer commented that the more complicated accessibility-related tasks are often implemented by developers with more experience in accessibility or who have earlier worked with similar tasks. That is due to time resources, as some complicated functionalities may require so much thinking on how to make it work for different users, and having earlier experience related to specific functionality or similar situations can reduce the required time to develop it. The developer also highlighted the difficulty of conveying visual information effectively through auditory means and the importance of finding a balance between providing comprehensive descriptions for screen reader users without overwhelming users with excessive information.

One concrete example of a challenging functionality, shared by the design lead and the developer, is map-based services and making them accessible to screen reader users. Since map-based services rely heavily on visual information and often require specific interaction modes, accommodating users with diverse accessibility needs can be challenging. Thus, the design lead commented that making their seat map, for selecting the seats, accessible has proven to be a difficult task for the company. Currently, as the functionality does not work for screen reader users, they are offered a working, albeit very simplified, alternative solution for the functionality.

In addition, the design lead highlighted one more problematic area in the digital service context: third-party integrations beyond the company's control. They shared an example of an issue that they have recently received accessibility feedback on: "This week we received feedback from a customer on the payment services of a certain bank, which currently do not work as well for blind users as the services of other banks." As the company offers the

possibility for customers to pay with the problematic third-party payment method but cannot directly resolve these issues by themselves, they stated that they have reached out to the bank regarding the issue, and fixes are expected soon.

4.2.3 Challenges in accessibility testing

The challenges regarding accessibility testing that were found from the interviews were mainly related to screen reader testing, but also insights were gained on some of the challenges related to the planning of accessibility testing sessions with users.

Screen reader testing

The interview participants mentioned two major challenges regarding screen reader testing: the first being that they find screen reader testing to be very time-consuming, and the second being the differences in how various screen readers operate. The QA specialist emphasized that after learning how to use the screen readers, their use is straightforward, and the process of screen reader testing is pretty simple. The interviewed developer shared similar insights by stating that the use of screen readers does not cause any challenges and that using them feels very natural. However, the participants highlighted that the challenge in screen reader testing is that it can be very time-consuming and labour-intensive. They have to carefully balance between conducting thorough accessibility testing and introducing new features at a steady pace. The head of CX and service design also highlighted this challenge, noting that since the beginning, the target level for quality inside the company has been so high that sometimes even extra work has been done to ensure complete accessibility, slowing down the rate of development. As a result, the development teams and team members have needed to find the correct level of thoroughness in accessibility assurance and testing while still ensuring a high enough rate of new development. The QA specialist commented on experiencing this challenge, especially during busy periods:

"The difficulty is that it's [screen reader testing] quite time-consuming, especially when there's a busier situation and new functionality needs to be released. If there's still testing to be done, there may not always be enough time to test it as thoroughly as I would desire. However, we still try to ensure it's done well enough."

The Design Lead shared that especially before releasing a new version, it is often required to manually test the whole service and the purchase paths, which can be a "massive task" and slow down the testing phase remarkably. The participant also shared another potential testing-related issue, related to

the orientation of the mobile application. Currently, the application works only in portrait mode, but the accessibility requirements define that mobile applications should also support landscape mode. The participant reflected that if the landscape mode is introduced into the mobile application at some point, it means that the amount of screen reader testing will increase remarkably, as the application needs to be tested in both portrait mode and landscape mode to ensure it works correctly in both operating modes.

Regarding the devices and screen readers used by the development teams, the interviews revealed limitations and challenges related to screen readers for mobile devices. The interviewed developer mentioned using a single mobile device for screen reader testing and the QA specialist stated using often two of the most common mobile screen readers, TalkBack (Android) and VoiceOver (iOS). The QA Specialist mentioned that the challenge is that some features or components in the mobile application work differently with different screen readers. Therefore, the most used screen readers are utilised during testing and ensured that the component or functionality under test is working with both screen readers. The Developer added that the different mobile manufacturers, that use the Android operating system, have their own implementations for screen readers which makes testing even more difficult, and the possibility of some customer, who uses a more uncommon device and screen reader, experiencing accessibility issues rises. Additionally, the developer mentioned that for mobile screen reader testing, it is not that easy to use different simulators or emulators, rather, the actual devices are required for testing. However, due to time limitations, the development team cannot test with all the different devices and screen readers and must rely on the application working correctly with the rest of the screen readers, if the two of the most used screen readers pass the tests. The development teams are actively collecting and listening for feedback, so they can quickly react and fix the issues if feedback regarding screen readers is received from customers.

Accessibility testing with users

On top of the challenges regarding screen reader testing, the interviews revealed two challenges related to accessibility testing with users. The Service quality specialist stated that facilitating and conducting the accessibility testing sessions does not pose any specific issues, instead, the challenges are caused by limited time constraints and resources when planning the testing sessions.

“I would name time constraints and cost-effectiveness as concrete challenges. When we need to be cost-effective, we have to think accordingly about what makes sense. Can we give up something extra? We have to

think carefully about what we want and what is actually important, and focus on that so that we don't then increase the organisational costs.”

– Service quality specialist

Additionally, one of the development team members mentioned that they have not yet been present in the accessibility testing sessions, but they would view the first-hand insights as very beneficial. They discussed that the reason for not being present in the sessions could be due to the language barrier between the interview participant and the users. Often the testing sessions are hosted in the native language of the users, and as the interview participant does not speak their native language, the insights and results are delivered to them second-hand through the facilitators of the testing sessions.

4.2.4 Challenges in content design

The content designer mentioned a similar challenge as mentioned by the designers, which is the excessive amount of information to display while keeping the content easy to find and understand. In addition, the service quality specialist highlighted that a lot of information about the physical accessibility of the services that are offered through the website and the mobile application is presented in the digital channels, but they are of little use if the customers cannot find the information in the digital channels. Therefore, an existing challenge is how to make the digital channels even more clear and easier for the user to find the information they need. What further complicates presenting the information is that elements that could be used to effectively present the information were regarded as problematic regarding accessibility. The content designer mentioned trying to limit the use of elements that they understood to be difficult for screen reader users to use:

“I've understood that at least some of those dropdown elements or those folding list types are a bit challenging [for screen reader users]. So, when there's a lot of information, it's sometimes difficult to present them compactly without that.”

The content designer shared also another challenge, which is that sometimes new products or services that the company develops can be difficult to use or understand which may limit the potential user group. They mentioned, that, “sometimes we start with a kind of MVP version and the product may be usable, but it may also exclude some users because it's a bit complicated to use.” Then, if the products or services in themselves are difficult to use or understand, clearly presenting and introducing them in the digital channels is also difficult.

4.2.5 Challenges in communication and documentation of accessibility efforts

The head of CX and service design shared that at the beginning of the development of the current digital channels, one of the biggest challenges was that a lot of information remained siloed within their own channels, and physical accessibility and digital accessibility in the different channels were managed separately. They state that currently accessibility is handled more holistically, with better communication between different channels. However, interview participants still mentioned some issues related to holistic understanding and documentation of current accessibility efforts within the company.

The head of CX and service design emphasized the need for an even more holistic understanding within the company of how collaboration with organisations and partners is handled, and how the different roles and teams are involved in accessibility work. They stated that as the company continuously changes and evolves, it would be important to have clearly defined specifications and responsibilities for each role regarding accessibility implementation and maintenance to ensure that accessibility remains at the required level in the future.

When asked about whether there are any areas or aspects that still have room for improvement in accessibility work within the company, the service quality specialist highlighted accessibility documentation and a clear future vision as improvement areas for the company. However, they noted that documenting how the company handles both physical and digital accessibility is a very complex matter, as it involves multiple directives, various users and disability types, and different user needs and requirements.

“But this is one area where there is room for improvement so that we can also document what is currently being done, what is being implemented, and what is not being implemented. And I would still say that, that vision of what we want to achieve in terms of physical and digital accessibility by, say, 2028, is perhaps one area where there is room for improvement.”

– Service quality specialist

4.2.6 Challenges in understanding accessibility requirements and user needs

The interviews revealed various challenges concerning the understanding of accessibility requirements and user needs within the organisation. The head of CX and service design stated that since the renewal of the digital sales channels, "Perhaps the most difficult part has been fully understanding the distinction between critical and non-critical requirements." They mentioned

that in some parts, the WCAG requirements are quite unclear and subjective, for which they have utilised their accessibility partners to understand them in the context of their own digital channels better.

One specific challenge discussed in multiple interviews was the requirement for landscape orientation in mobile applications, as mandated by WCAG. The company's mobile application does not support the landscape orientation mode yet and the design lead stated that introducing the landscape mode to the application will most likely be a major project. The interviews revealed numerous questions and potential problem areas regarding the landscape orientation mode. One of the members of the development team shared that it would help them to understand the real user needs behind the requirement, and to understand the context of when and why a person would need landscape mode for the mobile application. The participants also expressed their concerns towards landscape mode in the mobile application, stating that introducing the landscape mode would require a remarkable effort in design, development, and testing as every new functionality and component would need to be designed, developed and tested for both orientation modes.

Furthermore, interview participants expressed some difficulties in comprehending in practice how customers with disabilities use the system. The developer shared that even though they have learned to operate the screen readers and check that their implementation works correctly on the technical level, it is difficult to understand how customers with screen readers experience and use the system. The content designer shared similar challenges, sharing that sometimes it is difficult to understand what elements should be hidden from screen readers and under what circumstances. The development team members stated that they had not been directly involved in accessibility testing sessions with users but mentioned that being able to see how the users perceive and use the system could provide valuable first-hand insights.

5 Discussion

This chapter provides a comprehensive discussion of the findings from the study. Section 5.1 presents the answers to the research questions found through the empirical study, how the findings compare to existing literature, and discusses what new was found from the study. Section 5.2 offers practical implications from this research study for organisations and digital practitioners to enhance digital accessibility in their consumer-facing e-commerce channels. Section 5.3 addresses the limitations of the study and Section 5.4 provides recommendations for future research based on identified gaps and the findings of the study.

5.1 Answers to research questions

5.1.1 Practices and key factors for achieving and managing continuous accessibility

Through the single case study and semi-structured interviews, several practices and key factors were recognised that support and drive the accessibility implementation forward within the organisation and the consumer-facing digital channels.

The first of the identified practices is **establishing the accessibility strategy for the digital channels and defining the minimum target level for accessibility implementation**. The accessibility strategy for the digital channels was stated to include longer-term plans for accessibility management, planning how to respond to upcoming changes in the legal requirements around accessibility, assessing the need and extent for accessibility partnerships, and determining how to approach the already identified problem areas around accessibility in the digital channels. While for example, the ISO/IEC 30071-1:2019 standard for developing accessible user interfaces presents a checklist for assessing the organisation's ICT accessibility policy, there is a lack of prior research about establishing an accessibility strategy for the company and its digital channels and how to manage them effectively in practice. Planning and setting the accessibility strategy was stated to be the responsibility of the design lead of the company, and having some form of strategic planning in place for future development was said to ensure that accessibility is managed in a more long-term and systematic manner, instead of handling it feature by feature.

Additionally, the company had set in place a company-wide policy for the minimum accessibility level for any new and existing features and components in the digital channels. The report by Eficode (2022) recommends

setting a target for a “good level of accessibility and overall user experience” on a company level but does not specify how that should be done in practice. The case company had defined the minimum target level to be WCAG 2.1 level AA conformance. While the WCAG 2.1 level AA conformance as a minimum accessibility target level sets a clear target level for the development team members to aim for and ensure that the solution complies with the legal requirements, Vollenwyder *et al.* (2023, p. 11) argue that mere conformance to web accessibility standards should be seen only as the first step towards inclusive user experiences. Therefore, the development organisation as well as the development teams needs to ensure that also other user-centred activities, such as involving users with disabilities in user research activities are conducted together alongside reaching the minimum conformance level to improve the user experience for all users.

The second key factor that supports accessibility implementation was recognised as the **organisational commitment to accessibility**. The interview participants highlighted that both physical and digital accessibility is seen as a very important topic throughout the organisation. The company’s business strategy and values emphasise the focus on customer experience which, according to the interview participants, ensures that all employees operate according to the same shared values and enough resources are set aside for the development team to ensure accessibility during development. This finding aligns with prior research, which has also recognised organisation-wide commitment to accessibility, from top-level managers to development team members, as crucial for successful accessibility implementation (Horton and Quesenbery, 2014; Velleman, Nahuis and van der Geest, 2017; Bi *et al.*, 2022). Eficode (2022) argues that while a company's strategy may emphasise providing an excellent customer experience, it still needs to explicitly address accessibility to ensure successful implementation. However, this study's findings suggest that even without a dedicated focus on accessibility in the company's strategy and values, the interview participants believed that improving the customer experience inherently includes addressing accessibility for users with various disabilities.

Another important accessibility-ensuring practice followed by the company is the **integration of accessibility into the development process**. While the company’s approach to integrating accessibility into the development process did not strictly follow any of the process models or methodologies reviewed in this thesis, it included multiple best practices from the existing literature. Firstly, integrating accessibility evaluation and consideration in each phase of the development process was widely recognised as a crucial practice to recognise potential issues early and often in the development cycle (Nganji and Nggada, 2011; Pellegrini *et al.*, 2020; Romero-Chacón *et al.*, 2020; Campoverde-Molina, Luján-Mora and Valverde, 2021;

Eficode, 2022). Secondly, the company's approach to baking accessibility into the Design System is supported by Shah (2023), who states that integrating accessibility into the design system ensures that accessibility is a foundational aspect in the design process and it acts as a single source of truth for all members of the development team.

Thirdly, as WCAG support has been pre-defined and integrated into reusable components in design and development as far as possible, the development team members stated that they rarely need to use automated checkers or go through the specific WCAG criteria, and the focus on accessibility testing is on conducting screen reader testing. In the study by Bai, Mork and Stray (2017), screen reader testing was found to discover the highest amount of critical errors while automated accessibility checkers could only discover minor trivial issues. While this study did not investigate the different testing and evaluation methods and their ability to discover accessibility issues, the findings of this study bring forward multiple perceived benefits of the accessibility testing and evaluation approach of the case company. Through the Design System and the utilisation of reusable components in development, the mobile development team of the case company has reduced the need for WCAG walkthroughs and automated accessibility checkers during the development process, increased the designer and developer experience, and mitigated the possibility of human errors during development and design.

To improve accessibility beyond conforming to the accessibility requirements during the development process, the company also engages in **frequent collaboration and communication with customers**. To develop more physically and digitally accessible products and services, the company was said to collect large amounts of customer feedback and conduct accessibility testing with various user groups. Additionally, the company has created a co-development group with another organisation in the transportation industry, to improve physical and digital accessibility more holistically in the transportation domain. The objective of the co-development group was to involve the service users more in the service development by conducting accessibility testing with users and gathering feedback and insights directly from the service users.

Involving people with disabilities in product and service development, mainly through accessibility testing with users, is one of the key practices discussed in the existing literature to improve the accessibility of the developed digital systems (Horton and Quesenbery, 2014; Horton and Sloan, 2014; Abascal, Arrue and Valencia, 2019; Eficode, 2022; Vollenwyder *et al.*, 2023). However, an interesting finding from this study, which appears to be underrepresented in the existing literature, is the improvement of accessibility through cross-border cooperation with other organisations working in the

same or similar industry. Rather than each organisation independently investigating various user needs and requirements through accessibility testing with users and creating their own custom accessible implementations for recognised problematic areas in the digital channels, some initiatives, insights, and best practices could be shared between organisations. This collaborative approach could enhance the holistic user experience for all users within the e-commerce domain. However, it is also important to remember that companies might perceive their accessibility support and inclusive user experiences as a competitive advantage, as presented by Pellegrini (*et al.*, 2020). Therefore, it is possible that private companies, particularly those with high accessibility maturity, could be reluctant to form accessibility co-development groups with potential competitors in the same industry, even if doing so could lead to a holistic improvement in user experiences across the industry.

The presence of **self-organising and collaborative development teams** was another identified key factor supporting successful accessibility implementation within the company. Instead of commands or directives from higher up in the organisation dictating how something should be done, the development teams were mentioned to define their own processes and practices that they have found useful and comfortable to use. This approach is supported by Bai, Stray and Mork (2019), who state that methods for testing accessibility depend on the preferences, development phase, role, and context, making it crucial to allow software team members to choose the methods that work best for them. Furthermore, the interview participants mentioned that a lot of collaboration and discussion occurs among the whole development team when planning and designing new components or functionalities, which was stated to ensure that diverse viewpoints are considered early. This approach is also supported by Steen-Hansen and Fagernes (2016) who argue that for successful accessibility implementation, it should be ensured and encouraged that team members discuss and share knowledge about accessibility. Furthermore, Mudunuri and Thatikonda (2023) argue that tight collaboration between designers and developers is required to develop accessible services.

Related to autonomous and collaborative development teams, another key factor for accessibility implementation was identified as the **full ownership and control of accessibility implementation** inside the company. Since the beginning of the development of the current digital channels, the company decided to build accessibility knowledge in-house for the existing employees, instead of recruiting specific accessibility experts within the teams. Additionally, they decided to make accessibility implementation a shared responsibility in the company and within the development teams, instead of accessibility being the sole responsibility of a single person or a role.

The case company's approach of building all required accessibility expertise in-house for current employees and sharing the accessibility-related responsibilities among various roles differs from the approach of Fathauer and Rao (2019), who studied the integration of an accessibility specialist in the development team. In their study, Fathauer and Rao (2019) found that integrating an accessibility specialist in an agile development team enhanced the development process by being able to evaluate accessibility beyond visual checks and automated tools, using screen readers and conducting manual accessibility tests to identify issues and potential pitfalls. They also found that the accessibility specialist could reveal alternative solutions to accessibility-related problems. Additionally, the accessibility specialist helped shift the project team's focus from merely meeting technical conformance to genuinely enhancing the usability of the service for people with disabilities.

Based on the interview responses, the case company also demonstrated many of the benefits outlined by Fathauer and Rao (2019) from the integration of an accessibility specialist into the development team. However, rather than relying on a dedicated accessibility specialist, these benefits were achieved through collaborative teams and the extensive knowledge and skills acquired by the employees over time. Additionally, the interviews revealed several advantages of the company's approach towards full ownership and control in-house, including reduced reliance on external accessibility partners over time due to increased internal expertise, the acquisition of new professional skills by the employees, and enhanced control over service development and quality assurance.

However, it is also important to acknowledge that the findings from these interviews could have been different if they had been conducted during the initial years when accessibility implementation was new to the organisation and development teams. Therefore, it is difficult to directly compare the approaches by the case company and Fathauer and Rao (2019), as the case company has been working with accessibility since 2019, whereas Fathauer and Rao (2019) studied the insights from a shorter time frame.

Related to building accessibility knowledge within the company and training the employees on accessibility, the final supporting practice for accessibility implementation was identified as the **utilisation of external accessibility expertise**. The external accessibility expertise was sourced from the company's accessibility partners, disability organisations, and external accessibility auditors. Initially, the company consulted its existing accessibility partners, whom they had worked with regarding physical accessibility, to understand the accessibility requirements better for their digital channels and to assist the development teams in integrating accessibility within their work

processes and practices. This approach of leveraging familiar accessibility partners early in the process aligns with the recommendation of Horton and Sloan (2014). They argue that early involvement of external accessibility expertise ensures these partners are seen as collaborative allies rather than mere compliance officers, which can greatly increase their positive impact on improving the company's practices and processes around accessibility implementation.

Additionally, the interview participants mentioned that the company aims to regularly utilise external accessibility auditors, conducting accessibility audits approximately every two years. Prior research also discusses accessibility audits, but the focus has mainly been on quality assurance and testing that the digital system meets the required standards (Horton and Sloan, 2014; Dowden and Dowden, 2019). However, this study highlights a new important educational aspect of external accessibility audits. The audit reports were said to present concrete findings of the accessibility issues in their own context and give very practical suggestions on how to approach fixing them. Therefore, in addition to ensuring the quality of the digital system, the interview participants perceived the audits as highly important for improving their knowledge and skill levels in accessibility implementation and evaluation.

5.1.2 Challenges faced when implementing and ensuring accessibility

The semi-structured interviews revealed various challenges faced by the practitioners and the organisation when implementing and ensuring the accessibility of their digital sales channels. The challenges are categorised into six themes, including both current issues and those that were more prominent when accessibility was initially integrated into the company's renewed digital sales channels.

The first theme is **challenges in UX Design** which contains challenges mainly captured from the interviews with the UX designer and the design lead. They mentioned challenges, such as balancing diverse user needs in a single solution and ensuring that the relevant content and information are easily available without overwhelming the user and keeping the user experience lean. Additionally, they faced challenges related to the presentation order of additional services in the mobile application. Considering all these factors, it was described that designing a user-friendly experience for everyone becomes a complex task.

These findings highlight practical challenges in designing user experiences within a dynamic e-commerce context, an area not extensively covered in

prior research on accessibility implementation. Given the challenges identified in designing purchase paths and presenting additional services, e-commerce organisations could also face another accessibility-related dilemma: balancing accessibility with the pursuit of profit maximisation. For example, promoting upsell services can increase profitability, but it might also confuse customers and create additional work to decline these offers, potentially decreasing accessibility and deteriorating the user experience for some users. On the other hand, some additional services, such as the option to order food delivered directly to your seat during travel, can significantly enhance the user experience for individuals with certain disabilities.

The second theme concerns **challenges in development and implementation**. The interviews revealed that implementing accessibility support for map-based services was a significant challenge for the company from the development perspective, leading them to develop an alternative solution for screen reader users for their seat map functionality. The challenge of developing accessible map-based services could be a significant finding for e-commerce organisations, particularly in the travel and transportation industry, where users frequently use maps for selecting locations and seats when booking tickets.

The identified challenge and the way it was solved with a separate accessible solution also provide broader insights. The ISO/IEC 30071-1:2019 standard for developing accessible user interfaces states that a single design strategy should be used as the main accessibility design approach, meaning that the same solution is accessible to all users without the need for separate accessible solutions. However, user-personalized/individualised strategies can be used to complement the single design strategy when needed. Also, the Web Content Accessibility Guidelines (WCAG) state that conforming alternate accessible versions can be included if the standard version cannot be made conformant (W3C, 2023). However, Wentz, Jaeger and Lazar (2011) argue that when separate versions are made, one accessible and one inaccessible version, the version for people with disabilities often lacks the content and functionality when compared to the standard version. In addition, it requires additional resources from the development team as they must implement, maintain, and update two separate versions instead of a single solution. Therefore, while sometimes separate accessible versions might have to be made due to various reasons, such as technical restrictions, prior research suggests keeping the separate versions to a minimum.

Challenges in accessibility testing is the third theme which contains two sub-categories: screen reader testing and accessibility testing with users. The interviews revealed that even though the organisation is committed to accessibility implementation and attention to accessibility is paid during the

development process, there is still the need for constant balancing with thorough accessibility testing while still ensuring a high enough rate of development. The interviews also revealed two major challenges faced by the interview participants concerning screen reader testing, the first one being how time-consuming and labour-intensive screen reader testing was experienced to be, and the second one being the differences in how different screen readers work, making it difficult to ensure that the final solution works on all different devices that the customers might use.

Challenges in accessibility testing, especially with the use of different testing methods, have been a primary focus in prior studies (Abuaddous, Zalisham and Basir, 2016; Bai, Mork and Stray, 2017; Bai, Stray and Mork, 2019). In the study by Bai, Stray and Mork (2019), screen reader testing was recognised as highly useful but requiring practice to learn how to use it correctly, which aligns with the findings of this study as well. This study's finding that screen readers cause challenges in testing as they sometimes work in very different ways is supported by Steen-Hansen and Fagernes (2016), who emphasize the importance for development teams to understand that assistive technologies do not all work the same way, making it essential to test with different technologies to ensure quality.

Additionally, Abuaddous, Zalisham and Basir (2016) and Aizpurua *et al.* (2014) argue that a potential reason why organisations may not conduct more active accessibility testing with users might be due to challenges in finding representative participants with various disabilities. This challenge was not mentioned by the case company, as they actively collaborate with various disability organisations from where they also receive representative users for accessibility testing. Furthermore, they reported to have conducted lighter prototype testing in the field by identifying representative users of their physical services through ticket types and approaching them respectfully.

The fourth theme emerging from the interviews is **challenges in content design**, which in some parts were similar to the challenges in UX design. The digital channels of the company contain large amounts of information and content which poses a challenge on how to present the information concisely and how to make them easy for users to find and understand. These findings highlight practical challenges in content design that have not been extensively discussed in the existing literature but could benefit from further research.

The interviewed content designer highlighted also another challenge related to their work: effectively presenting new products or services in digital channels, particularly during the early stages where the initial version may be difficult for some users to use or understand. While this was a specific issue

identified from the viewpoint of content creation and design, it also underscores a potentially broader problem with accessibility implementation and the minimum viable product (MVP) approach to releasing new products. As stated by Pellegrini *et al.* (2020, pp. 275-276), agile practices, including the MVP approach, can present limitations for accessibility if accessibility requirements are not prioritized as critical already for the first release. Based on the interviews, the case company views technical accessibility as a critical requirement, ensuring that all new developments must support screen readers and meet WCAG Level AA requirements. However, as presented by the Regional State Administrative Agency (2024a), technical accessibility is only one aspect of digital accessibility—understandability and ease of use being equally important. Therefore, in addition to ensuring technical accessibility during development, it is crucial to incorporate accessibility considerations in higher-level decisions to ensure that all aspects of accessibility are addressed from the outset.

The fifth identified theme is **challenges in communication and documentation of accessibility efforts**. Initially, in the organisation, there were issues with fragmented information across different channels, with physical and digital accessibility managed separately. While communication has improved, interviewees noted ongoing challenges in understanding and documenting current accessibility efforts. The need for a more comprehensive understanding of collaboration with other organisations and development team roles and their responsibilities was emphasized, as the company changes and evolves continuously but the level of accessibility in the digital channels must not decrease. The interview participants identified enhancing internal accessibility documentation and establishing a more high-level future vision for what the company wants to achieve in terms of physical and digital accessibility in the long term as improvement areas.

The development teams of the company embrace agile ways of working which could contribute to the challenges in internal documentation of accessibility efforts. In general, internal documentation in agile projects is perceived as highly important but too little documentation is available due to the nature of agile thinking of creating only “lean” documentation (Stettina and Heijstek, 2011, p. 165). The ISO/IEC 30071-1:2019 standard advocates for the creation and maintenance of at least two internal accessibility documents throughout the system life cycle. The first is the organisational ICT policy, which should include how accessibility has been considered in the organisation’s broader ICT policies, procedures, activities and standards, and present the accessibility goals for the organisation’s digital systems. The second document for internal use should be an actively updated accessibility log for each digital channel where the accessibility requirements and decisions regarding accessibility are documented throughout the system’s life cycle to support the

development and maintenance of the systems. However, there is a lack of empirical studies that would have researched the use of the presented documents in practice, or documentation during accessibility implementation in general, making it difficult to assess how well they can be managed in a real-world setting and who should be responsible for updating the documentation.

The last theme is **challenges in understanding accessibility requirements and user needs**. The interview participants highlighted difficulties, especially when accessibility was initially adopted into the organisation and digital channels, in differentiating critical and non-critical requirements, particularly due to unclear and subjective criteria of WCAG standards. Additionally, the interviewed development team members noted that even though they have the ability and knowledge to test the accessibility of the system, they sometimes have challenges understanding how customers with different disabilities interact with the system in practice.

To address the identified challenges in understanding user needs and accessibility requirements better, the existing literature recommends two main approaches. First, Horton and Sloan (2014) and Fathauer and Rao (2019) state that companies should utilise external accessibility experts to better understand the accessibility requirements and user needs in their own context of use. The interviews revealed that the case company had utilised external accessibility experts more regularly early in the project and currently more on a case-by-case basis. Therefore, keeping track of current skill levels and potential skill and knowledge gaps of the employees, for instance through regular internal surveys, could help assess the need for guidance or workshops facilitated by external accessibility experts.

Second, as advised by Steen-Hansen and Fagernes (2016, pp. 443–444) allowing development team members to observe firsthand how people with different types of disabilities use digital systems can increase their motivation to create accessible solutions and deepen their understanding of accessibility and various disabilities. In the case company, channel designers were mentioned to be included in accessibility testing sessions with users, but involving developers and QA specialists could also be beneficial. This practice could enhance the knowledge and understanding of user needs and requirements within the development teams, beyond mere compliance with accessibility requirements.

5.2 Practical Implications

This chapter presents practical implications that organisations developing B2C e-commerce should take into consideration when adopting and

implementing digital accessibility in their digital sales channels. These implications have been derived from the existing literature and the findings from the single-case study.

To successfully adopt and implement accessibility into the digital channels, the whole organisation, from top-level executives to the development team members, should be committed to accessibility. Organisation-wide commitment to accessibility ensures that everyone views accessibility as a priority and enough resources are allocated towards considering and ensuring an accessible user experience for everyone. Furthermore, accessibility should not be the responsibility of a single role or person in the company, instead, the responsibilities should be shared between the practitioners and development team members.

If the development organisation has the required resources, the findings of this study advocate aiming for full ownership and control of accessibility implementation in-house. Having full ownership and control in-house ensures that the company can directly manage the service development of the digital channels, quickly react to any discovered accessibility issues, and fully control the quality of the work minimising the dependencies on any external factors. Moreover, having full ownership and control of accessibility implementation and evaluation inside the company increases the internal expertise of the company over time and enables employees to grow and learn new professional skills around accessibility.

Having full ownership and control of accessibility implementation in-house also means that there must be high skill and knowledge levels around accessibility in the company and within the development teams. Current accessibility knowledge levels within the company should be regularly tracked, for example through internal surveys, to be aware of any knowledge gaps and to be able to support the employees better in their work. After discovering potential knowledge or skill gaps, the company should, for instance, arrange accessibility training sessions by external accessibility specialists or ensure that enough time is set aside for the employees to learn about accessibility implementation in their own work context. In addition, this study found accessibility audits conducted by external accessibility specialists to be an important factor in increasing the practical knowledge of accessibility implementation and evaluation among the employees of the company.

To maintain the level of accessibility in the digital channels, accessibility must be integrated into the development process so that it can be monitored every time something is added or changed in the consumer-facing digital channels. Baking accessibility into the Design System of the company and pre-defining accessibility into reusable components in design and

development can improve the designer and developer experience, reduce duplicate work resulting in time and cost savings during design and development, and minimise the possibility of accessibility issues arising from human errors.

Furthermore, while integrating accessibility conformance into the development process is important to ensure that the developed digital services comply with the legal requirements, organisations should also focus on improving the accessibility and user experience for people with disabilities through other activities. Involving users with various characteristics in the service development, for example, through accessibility testing with users, ensures that not only is the developed digital system technically accessible but it is also easy and satisfying to use for users with disabilities. By collaborating with various disability organisations, companies can gather valuable feedback on their digital systems and recruit representatives for accessibility testing sessions. Furthermore, to increase the knowledge around accessibility and various disabilities, development team members from different roles should be involved in the accessibility testing sessions with users where they would be able to observe how the users interact with the system in practice.

The findings of this study suggest that accessibility testing for digital sales channels should focus on ensuring the entire purchase path is fully functional, easy to understand, and simple to use for diverse user groups. Insights from these testing sessions can help the company identify problematic areas faced by different users and provide guidance on balancing different user needs within the same solution.

5.3 Limitations of the study

As with all empirical studies, this research also has its limitations which are important to understand to assess the significance of the findings. The case study approach and purposive sampling strategy were used to select a company that actively considers accessibility and complies with legal requirements in their consumer-facing digital channels, as not all companies do this yet. The selected company was found to be particularly valuable for this study because it has been legally required to follow accessibility standards for several years, indicating that they have had time to experiment with different approaches for managing continuous accessibility in its digital channels and to discover effective practices and processes. This made the company suitable for investigating and analysing their practices, workflows, and the challenges they have faced and continue to face in implementing accessibility in their e-commerce channels. However, using a single-case study can introduce bias in data collection and analysis. The unique characteristics of the selected company, along with the greater emphasis on the mobile application development team in the interviews, may not accurately represent other

organisations developing consumer-facing e-commerce. To address this limitation, the context and background of the case company have been presented as thoroughly as possible, while maintaining the anonymity of the company and the interview participants.

The semi-structured interview method as the main source of qualitative data also poses some limitations. The reliability of the data depends on the honesty and accuracy of the participants' responses. Therefore, there exists a potential risk for response bias, where participants might give answers that they believe the researcher wants to hear, rather than their genuine perceptions of the interview questions. In addition to response bias, conducting and analysing the semi-structured interviews presents the possibility of researcher bias, where prior assumptions or expectations may have unconsciously affected the interview questions or data analysis. The effects of researcher bias were mitigated by focusing on non-leading interview questions and revising the interview plans together with the supervisor of this thesis.

The participant selection process for the semi-structured interviews must also be considered when assessing the limitations of the study. After presenting the research objective to the case company, the interview participants were chosen by the case company, introducing the possibility of selection bias. It is possible that the company consciously or unconsciously chose participants who have been heavily involved in accessibility initiatives or who possess significantly different perceptions or levels of knowledge around accessibility compared to others in similar roles. Furthermore, the number of interview participants was relatively small, comprising seven individuals with diverse roles related to accessibility. Ideally, multiple individuals from each role would have been interviewed to better understand and separate the organisational practices and attitudes from the perceptions and practices of single individuals.

Another significant limitation was the absence of interviewees directly working on the development team of the web channel. This lack of representation meant that it was not possible to gather first-hand insights into the practices and challenges faced by the web channel development team. Instead, the findings related to the development teams and the development process mostly reflect the experiences and practices of the mobile application development team, which may differ from those of the web team. Additionally, it is possible that not all relevant roles or individuals for accessibility implementation were recognised, and thus not interviewed, resulting in the possible exclusion of data that could have provided valuable additional insights into the practices and policies of the organisation.

In summary, while this research presents new insights into accessibility implementation in an e-commerce development context, the limitations of this study must be considered when interpreting the findings and assessing their applicability to other settings. Based on the identified limitations,

recommendations for future research will be presented in section 5.4 to further validate and verify the findings from this research.

5.4 Recommendations for future research

To address the limitations identified in this study and investigate the reliability and validity of the research findings, there are several directions for future research supporting accessibility implementation in e-commerce development contexts. Instead of conducting a single-case study, future research could explore multiple case studies across different industries and geographical regions. This approach would provide a broader perspective on accessibility practices, key factors, and challenges in e-commerce development, instead of the findings being tied strictly to any single industry or geographical location.

Furthermore, the qualitative research methods utilised in this study could be accompanied by quantitative research methods in future research, offering a more comprehensive understanding of accessibility implementation in e-commerce development. For example, interviews could be accompanied by collecting quantitative data, such as analysing the time spent on accessibility testing, or conducting organisation-wide surveys to collect information about how the employees perceive the accessibility maturity of their organisation and how important different practices are perceived to be for successful accessibility implementation. These methods would provide empirical support for the perceptions gathered from interview participants and offer a more comprehensive understanding of the actual key practices and challenges related to accessibility implementation in e-commerce development.

While this study concentrated more on the development process and practices of the development team members working in the mobile application channel, future research should aim to include representatives from both web and mobile development teams in the study sample. By gathering insights from diverse teams, researchers can better understand platform-specific challenges and practices in accessibility implementation. Including representatives from both web and mobile development teams will also ensure that findings are relevant to e-commerce development as a whole, rather than being limited to web or mobile development alone.

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A. Activities and practices for accessibility implementation from accessibility literature

Table 1: Recommendations for building a successful environment for accessibility implementation in an organisation

Recommendation	Activities and practices
Analyse the status of accessibility and identify the requirements	If possible, consider accessibility as early into the project as possible to improve usability and reduce expensive rework later in the project (Abuaddous, Zalisham and Basir, 2016; Steen-Hansen and Fagernes, 2016; Dowden and Dowden, 2019)
	First step is to determine the accessibility of the current system (Dowden and Dowden, 2019; Eficode, 2022)
	Discover applicable accessibility requirements (ISO/IEC 30071-1:2019)
	Analyse current resources, attitudes, knowledge levels, and technical skills on accessibility (Horton and Quesenbery, 2014)
Establish an accessibility culture	The whole company should commit to making accessibility a priority (Horton and Quesenbery, 2014; Horton and Sloan, 2014; Velleman, Nahuis and van der Geest, 2017)
	Include accessibility and inclusion in the business strategy and company values (Eficode, 2022)
	Define and communicate a common target level for accessibility (Eficode, 2022)
	Ensure enough time is set aside for people to discuss and share knowledge about accessibility (Steen-Hansen and Fagernes, 2016)
Build internal accessibility expertise	Identify and communicate all relevant roles and their responsibilities related to accessibility implementation and maintenance (Horton and Sloan, 2014; ISO/IEC 30071-1:2019; Eficode, 2022)
	Provide relevant training and support for different roles (Horton and Quesenbery, 2014; Abuaddous, Zalisham and Basir, 2016; Eficode, 2022)
	Arrange time for development team members to observe how users with different disabilities use the service (Steen-Hansen and Fagernes, 2016)
	In recruiting, include accessibility as a job requirement and list accessibility-related tasks in the responsibilities (Horton and Sloan, 2014)

	Ensure you possess team members with high competence, expertise, and motivation (Steen-Hansen and Fagernes, 2016; Bi <i>et al.</i> , 2022)
Utilise external accessibility expertise	Arrange regular audits (Dowden and Dowden, 2019)
	Establish partnerships with accessibility experts (Horton and Sloan, 2014)
	Ask for help understanding requirements (Horton and Sloan, 2014; Fathauer and Rao, 2019)
	Involve people with disabilities in product development process (Horton and Quesenbery, 2014; Horton and Sloan, 2014)
Maintain accessibility documentation	prepare an ICT accessibility policy for the organisation (ISO/IEC 30071-1:2019)
	Prepare an accessibility statement for each separate system (ISO/IEC 30071-1:2019 + (Also mandatory accessibility requirement in the Digital Services Act))
	Prepare an accessibility log where accessibility requirements and accessibility-related decisions are documented throughout the system's life cycle (ISO/IEC 30071-1:2019)
Embed accessibility into organisation's systems and tools	Attain accessible code repositories, style guides, content and development tools (Horton and Sloan, 2014)
	Incorporation of WCAG 2.1 into Design Systems presents remarkable benefits (Shah, 2023)
	Assess the accessibility support and limitations of third-party integrations (Ng, 2017; Dowden and Dowden, 2019)
Integrate accessibility into the development process	Agile software development practices offer a good basis for active customer collaboration, continuous consideration of accessibility, and early detection of accessibility issues (Luján-Mora and Masri, 2012; Pellegrini <i>et al.</i> , 2020; Bi <i>et al.</i> , 2022)
	Accessibility should be considered in each phase of the development process (Nganji and Nggada, 2011; Pellegrini <i>et al.</i> , 2020; Romero-Chacón <i>et al.</i> , 2020; Campoverde-Molina, Luján-Mora and Valverde, 2021; Efi-code, 2022)
	Select the appropriate evaluation methods and combination of accessibility testing tools to enable continuous accessibility (Bai, Mork and Stray, 2017; Abascal, Arrue and Valencia, 2019; Bai, Stray and Mork, 2019; Stray <i>et al.</i> , 2019)

B. Challenges in accessibility implementation from accessibility literature

Table 2: Challenges faced by organisations and digital practitioners when implementing digital accessibility

Theme	Challenges
Organisational and management challenges	Lack of management support and commitment for accessibility work (Inal <i>et al.</i> , 2020; Bi <i>et al.</i> , 2022)
	Small organisations and groups lack resources and support, large groups lack comprehensive accessibility evaluation (Bi <i>et al.</i> , 2022)
	Lack of communication, management was found to think Universal Design is anchored well in the project but development team members disagreed (Bai, Mork and Stray, 2018)
Skills and knowledge gaps	Lack of accessibility-related skills and knowledge in the development teams due to lack of training and education in accessibility (Abuaddous, Zalisham and Basir, 2016; Inal <i>et al.</i> , 2020; Bi <i>et al.</i> , 2022; Mudunuri and Thatikonda, 2023)
	Lack of project management competence (Bi <i>et al.</i> , 2022)
Content Management challenges	High frequency of creating and editing content on the website raises the risk of human errors or negligence regarding accessible content (Leitner, Strauss and Stummer, 2016)
	Content Management Systems missing accessibility features (Leitner, Strauss and Stummer, 2016)
Process and planning challenges	Lack of integrated processes and routines for practicing universal design (Bai, Mork and Stray, 2018)
	Implementing and integrating accessibility to already existing digital solutions is difficult and expensive (Leitner, Strauss and Stummer, 2016)
	Unclear project planning and scope, as well as unclear requirements for accessibility (Bi <i>et al.</i> , 2022)
	Lack of complete set of accessibility practices (Bi <i>et al.</i> , 2022)
	Lack of customer role and presence in the software process (Bi <i>et al.</i> , 2022)
Design and development challenges	Balancing accessibility in design, finding solutions that prioritize both aesthetics and inclusivity (Mudunuri and Thatikonda, 2023)
	Time and cost constraints for designing and implementing accessibility (Inal <i>et al.</i> , 2020)
	Lack of awareness or motivation in designing and developing accessible software (Abuaddous, Zalisham and Basir, 2016)

Standards and guidelines challenges	Accessibility guidelines and standards are viewed as ambiguous, incomplete, and hard to navigate (Abuaddous, Zalisham and Basir, 2016; Bi <i>et al.</i> , 2022)
	Conformance with WCAG requires perfection (Abuaddous, Zalisham and Basir, 2016)
	WCAG walk through as a testing method is perceived hard to use and unsatisfying to work with (Bai, Stray and Mork, 2019)
Evaluation and testing challenges	Automated tools cannot identify missing components, inconsistencies, or validity of content (Fathauer and Rao, 2019)
	Automated tools are able to find minor issues, but not critical issues or fundamental problems (Bai, Mork and Stray, 2017)
	Automated tools are not complete and the results can vary from tool to tool, requires manual inspection alongside automated tools (Abuaddous, Zalisham and Basir, 2016)
	Using Personas as an accessibility testing method is difficult, subjective, and requires extensive knowledge about different disabilities (Bai, Stray and Mork, 2019)
	Accessibility testing with users requires expertise and is more time consuming than other testing methods (Abuaddous, Zalisham and Basir, 2016)
	Planning the accessibility testing sessions with users and finding users with certain disabilities can be difficult (Abuaddous, Zalisham and Basir, 2016)

C. Interview Plan

To start, I will briefly introduce myself and the topic of my thesis, and I will explain a bit about what will be discussed in the following interview.

I will inform the interviewee that they will be addressed by their role and not by their name in the thesis. I will also remind them that they can choose not to answer any question if they wish. I will ensure it is okay for the interview to be recorded so that I can collect all the essential information accurately. The recording will be deleted immediately after transcription.

Background information about the interviewee

- 1) What is your role in the company?
- 2) How long have you been working in your current role?
- 3) How much overall experience do you have in this type of role?
- 4) How much experience do you have working with accessibility?
 - a) Do you have any previous experience before working at the current company? If yes, what kind?

Accessibility experience and knowledge

- 5) Were you expected to have any accessibility knowledge when you joined the company?
- 6) How would you rate your current knowledge about accessibility?
- 7) Have you studied accessibility independently, or has the company provided coaching or training?
 - a) If independently, what materials have you used, and how have you found using them?
 - b) If the company provided coaching or training, when did this happen and how regularly? Is it ongoing or was it only at the beginning?
 - c) Were these conducted by someone within the organisation or by an external expert?
 - i) What are your experiences from these training sessions?
- 8) If you have any questions or uncertainties related to accessibility, how do you go about finding answers?
 - a) Has the company designated specific individuals or a common channel within the organisation where questions could be asked?

Accessibility practices and responsibilities

- 9) What are your responsibilities in the company in ensuring and maintaining accessibility? (Specify more specifically the interviewee's own role in

accessibility development and maintenance if the answer remains too abstract)

- 10) What responsibilities do you see assigned to other team members?
 - a) If you think about a single specific work task, what do you expect has been done to ensure accessibility before the task comes to you?
 - b) Is there anything else that needs to be done by someone else after you've completed your task to ensure the accessibility of the final product?
 - c) Are there ever any challenges in this division of labor or do you feel there could be improvements in this process?
- 11) Are there any specific tools/practices you use to ensure or test accessibility?
 - a) What are your experiences with these tools?
 - b) Have there been challenges or problems in using them?
- 12) If you happen to find an accessibility issue, what are the next steps you take?
 - a) Do you have a way to ensure that the same or a similar issue does not occur later again?
 - b) Are the accessibility issues documented somewhere?
- 13) If you think about your own role or other roles in the team, do accessibility-related tasks often go to the same specific people or are they evenly distributed among everyone?
- 14) Are there any specific user groups for whom accessibility assurance or testing is particularly focused?

Accessibility of the Online Store

- 15) Have certain parts or areas of the online store or the purchase path of the customer been identified to pose challenges for customers with disabilities?
- 16) Have any problematic areas been identified where testing accessibility or ensuring it is difficult or poses challenges?
- 17) From your perspective, do the technologies and systems you use support the development of an accessible online store?

Interaction with Accessibility Experts and Special User Groups

- 18) Do you interact with accessibility experts or auditors?
 - a) In what situations has this collaboration occurred and how often?
 - b) What are your experiences from these interactions?
 - c) Do you feel like there is a sufficient amount of collaboration with accessibility experts?

- 19) Do you interact directly with users with disabilities, for example, in accessibility testing with users, or in other contexts?
- a) If yes, how often does this happen and what are these sessions like?
 - b) How useful do you perceive this for your own role?

Evaluation of Organisational Accessibility Capabilities

- 20) How would you assess the company's ability to develop and maintain accessible solutions?
- a) What are the main factors supporting this achievement?
 - b) Are there areas or aspects where there is still room for improvement?
- 21) Is there anything else that comes to your mind that we have not yet discussed?