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# Masterthesis (M.Sc.)

# Ability-Based Design: A Design Case Study of a Web Design Company in regards to the European Accessibility

Act

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# 1 Introduction

Since the Covid-19 pandemic, digital literacy has gained more importance than ever with most aspects of work and private life shifting to the digital space (Hantrais et al., 2021). In 2022, 95% of Germans used the internet (Statistisches Bundesamt, 2022a). While internet usage has become an immense part of daily life for most of society, research shows that people with disabilities continue to experience greater digital exclusion than those without disabilities (Al Mahmud & Martens, 2011; Chadwick et al., 2022; Ferati & Vogel, 2020; Gurbai & Allen, 2022; Jevremovic, 2023; Mikulak et al., 2023; Murphy et al., 2022).

The disabled community constitutes approximately 15% of the global population (United Nations, 2020) and 9,4% of the German population (Statistisches Bundesamt, 2022b). In Germany, 79% of people with a severe disability are older than 55, with the elderly population growing due to increased life expectancy (Statistisches Bundesamt, 2022b). By 2050, it is projected that individuals aged 65 and above will comprise 17% of the world population, compared to 9% in 2019 (United Nations, 2020). Thus, the needs of these growing groups are getting more and more relevant, demanding designers and developers to take extra measures in creating accessible web services.

Web accessibility refers to the design of websites, web applications, and other digital content to make them accessible to everyone, such as people with physical and cognitive disabilities and elderly people. Thus far, in Europe, accessible design has been a recommendation rather than an obligation. The European Accessibility Act (EAA) was officially adopted on April 17, 2019, and will be in force starting on June 28, 2025 (EAA, 2019/882). It aims to promote and ensure the accessibility of products and services across Europe, including websites and mobile applications.

The importance of web accessibility in human-computer interaction research cannot be overemphasized. It enables individuals with disabilities to participate fully in digital activities, promoting inclusivity and social equality (de Carvalho et al., 2020). However, despite the benefits of accessible digital content, at least 70% of the websites worldwide currently lack accessibility features and are continuously becoming less accessible over time (Cao & Loiacono, 2021; Ferati & Vogel, 2020; Wobbrock et al., 2011). Lack of awareness, missing resources, inadequate expertise, and lack of standards are some of

the most relevant reasons why companies refrain from designing inclusive technologies (Crabb et al., 2019; Dowden & Dowden, 2019; Farrelly, 2011; SWD/2015/0624).

So far, no consensus has been reached on the implementation of accessible web design (Aizpurua et al., 2016; Law et al., 2007; Persson et al., 2015; Wobbrock et al., 2011). Various design methodologies are discussed and employed in accessibility research to address the needs of different user groups. Even though all methodologies have the inclusion of all user groups in mind, they differ in point of view and suggestions for design. This thesis will take up three approaches as representatives to illustrate similarities and differences between different approaches: universal design, ability-based design and end-user design.

The primary approach to ensuring web accessibility is to adhere to and implement the Web Content Accessibility Guidelines (W3C, 2023). These guidelines offer instructions for making online content accessible to people with disabilities, aiming to include everyone in one solution. In Germany, the *"Barrierefreie-Informationstechnik-Verordnung"* (BITV) offers additional testing steps according to current law (DIAS GmbH, 2023). Previous studies have indicated that accessibility guidelines, while offering an excellent first approach to accessibility, are not sufficient to include the needs of everyone, especially those with cognitive disabilities (Al Mahmud & Martens, 2011; Berget & MacFarlane, 2020; Borg et al., 2015; Farrelly, 2011; Friedman & Bryen, 2008; Habil & Trescher, 2018; Sevilla et al., 2007; Small et al., 2005). Thus, the question can be raised whether universal design approaches can meet the needs of all users or if other approaches would be more beneficial.

This thesis aims to showcase an organizational setting that displays the challenges and opportunities that come with adhering to accessible design standards implemented by the EAA. Furthermore, possible guidelines or suggestions to facilitate the integration of accessible design will be made. Finally, it will be discussed which design approaches are most actionable and beneficial in a company setting. The thesis thus poses the following research questions:

#### 1. How do web design companies approach the design for accessibility?

The first research question investigates the current organizational structures in web design companies regarding accessible design. It thus serves as a basis for disclosing a problem statement.

# 2. What are the opportunities and challenges in designing for accessibility in the context of web design?

The second research question helps to further concretize the problem statement by detecting challenges and opportunities. These findings can be used to come up with solutions that help overcome challenges and focus on opportunities instead.

# 3. How does the European Accessibility Act impact the design of web-based products and services?

The third research question aims to explore whether the European Accessibility Act has the potential to change web infrastructure and what kind of changes companies need to make to adhere to new accessibility standards.

# 4. What can be done to facilitate the implementation of accessible design in web design processes?

Based on the fourth research question, suggestions to facilitate implementing accessible design will be made and evaluated.

### 5. Which design approaches are most efficient to implement in a company setting?

Different design approaches will be discussed from the perspective of organizational practices, especially in consideration of existing challenges, aiming to contribute to the existing discussion on finding a consensus in the approach towards web accessibility. "Efficient" means that the design approach meets accessibility goals and can be realistically and practically integrated into existing workflows.

By conducting this research, I hope to contribute to the growing body of knowledge on web accessibility in human-computer interaction (HCI) and socio-informatics research. Furthermore, I hope to raise awareness and provide practical recommendations for web designers and companies to improve their digital accessibility practices, and possibly even nudge new discussions on implementing accessible solutions.

# 2 State of the Art

# 2.1 Accessibility

Accessibility is an attribute that refers to the usability and availability of products, services, technical devices, information, communication facilities, and other designed environments for everyone, including people with disabilities (BGG, 2022; Kim et al., 2023). According to Article 4 of the Disability Equality Act (BGG, 2022), these areas are considered accessible if they can be accessed and used by people with disabilities in a generally customary manner, without difficulty and essentially without outside assistance, except for impairment aids (BGG, 2022).

While the terms disability, impairment and handicap are often used interchangeably, they each have different meanings (Dowden & Dowden, 2019). The European Accessibility Act defines persons with disabilities as individuals who have "*long-term physical, mental, intellectual or sensory impairments which in interaction with various barriers may hinder their full and effective participation in society on an equal basis with others*" (EAA, Art. 3). Accordingly, an impairment is a health condition resulting in "*loss of (or an abnormality of) function or structure of mind or body*" (Dowden & Dowden, 2019, p.4). Disability occurs whenever there is a mismatch between the needs and abilities of an individual and their environment, resulting in a barrier, or handicap (Berget & MacFarlane, 2020; Dowden & Dowden, 2019; Habil & Trescher, 2018; Kim et al., 2023; Shum et al., 2016). Physical, cognitive and social exclusion can result from said mismatched interactions (Kim et al., 2023).

Impairments can appear in different forms: permanent, temporary and situational (Kim et al., 2023; Shum et al., 2016; W3C, 2022; Wobbrock et al., 2011). Permanent impairments are often attained in advanced age, with only 3% of impaired individuals being below the age of 18 (Statistisches Bundesamt, 2022b). The degree of disability (GdB) is a concept used in Germany to assess the severity of a disability (beta Institut, 2023). In Germany, the degree of disability is measured on a scale from 0 to 100, with 0 meaning no degree of disability and 100 representing a very high degree of disability. This degree is determined by medical experts based on medical examinations and other relevant information. The degree of disability affects various aspects of life, including access to certain services and supports. Its terminology and rating criteria may vary in other European countries. While disabilities can be categorized into affected body functions, it is important to note that these categories are not mutually exclusive, and

individuals may have disabilities that fall into multiple categories (Dowden & Dowden, 2019). Temporary impairments are conditions that temporarily affect an individual's abilities or functioning but are expected to improve or resolve over time (Kim et al., 2023; Shum et al., 2016; W3C, 2022; Wobbrock et al., 2011). These impairments can result from injuries, illnesses, medical procedures, or other short-term factors. Situational impairments occur as a result of specific situations or environmental factors (Kim et al., 2023; Shum et al., 2016). For instance, cold weather might complicate a person's ability to use a touch screen or bright sunlight might interfere with vision. In summary, accessibility features do not exclusively support users with impairments, since "*what is essential for some specific users for them to be able to use a product, often makes it more efficient to use for most people*" (Persson et al., 2015, p.2).

## 2.1.1 European Accessibility Act

The European Accessibility Act (EAA) was formed to ensure the accessibility of products and services for people with disabilities within the European Union. The act was passed in 2019 and will come into effect on June 28, 2025. Its main goal is to harmonize accessibility requirements across member states and to ensure that a wide range of products and services, including websites and mobile apps, are accessible to people with disabilities. The EAA requires member states to establish a national monitoring mechanism for ensuring compliance with the act and to provide information to the public on accessible products and services. The act also contains provisions for the development of European accessibility standards and certification schemes (EAA, 2019/882).

The directive applies to products and services. Affected products are hardware and operating systems, self-service terminals, consumer terminal equipment and e-readers. Affected services include electronic communication, audiovisual media, public transport and travel, banking, e-books, and e-commerce (EAA, 2019/882). Formats and websites that are published before 28 June 2025 are not affected. The legal document itself does not offer concrete guidelines or technical requirements for implementing accessibility in digital infrastructure.

The guidelines can be disobeyed if meeting the requirements entails a fundamental change in technology or a disproportionate burden on economic operators (EAA, 2019/882, Art. 14). Moreover, companies have a transition period of five years to adhere to the new accessibility standards. Since the act is relatively recent, there is little literature or critical voices besides the legal documents.

#### 2.1.1.1 Impact Assessment

When proposing the directive, several stakeholders were consulted on issues of accessibility, resulting in a summarized impact assessment.

Firstly, 25,516 European citizens were questioned on their perception of accessibility. They were asked about three main aspects: "1. Profile of people with disabilities and the difficulties they are facing in their daily life, 2. Perception of improved accessibility of goods and services in removing barriers, 3. How to improve and guarantee accessibility" (SWD/201570624 final, 2015b, p.7). The results showed that 29% of the questioned Europeans have a member in their household who currently has or had a longstanding illness in the past. A fourth of said interviewees witnessed that household member having difficulties with digital services. Almost all European citizens agree that people with disabilities should have the same participation in daily life as non-disabled citizens. When asked whether current regulations are sufficient to ensure accessibility, an average of 48% agreed. However, these replies vary a lot depending on the country. For instance, 70% agreed in the United Kingdom, while only 24% of Greek citizens agreed to that statement. This shows the severe differences between accessibility standards throughout the EU. 78% of interviewees consider common regulations among EU states to facilitate the implementation of accessibility. (SWD/201570624 final, 2015b)

Secondly, a public consultation was opened to address all citizens and public and private sector organizations. Only 19% of participating citizens considered the accessibility level of information and communications technology (ICT) infrastructure to be medium or high. Moreover, among companies, ICT was ranked as the most important area for accessibility. NGOs pointed out ICT barriers such as *"lack of including people with disabilities in the design stage of technology development, basic ICT equipment not having inbuilt accessibility features, [...] information being inaccessible, [...] lack of awareness campaigns to inform professionals and public authorities" as well as costs of assistive equipment and technologies (SWD/201570624 final, 2015b, p.17). Citizens mentioned a lack of standards, and the need for enforcement and control mechanisms, fines and cooperation between public bodies. They suggested the EU to set common standards and offer awareness campaigns, information, training and incentives to implement said standards. Moreover, NGOs suggested concrete measures: Involving people with disabilities and experts in design and development processes and understanding end-user needs better. (SWD/201570624 final, 2015b)* 

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Among ICT infrastructure, websites and website content management systems were ranked to be the most relevant services and making them accessible should thus be prioritized. Currently, public sector sites underly different requirements based on EU states. While some countries, for instance Spain, have more strict regulations and already apply accessibility regulations to both public and private sector sites, most countries do not require private sector sites to be accessible yet. (SWD/201570624 final, 2015b)

Through this impact assessment, expected costs and benefits were estimated. Thus, calculations were made on different policy options, leading to the European Accessibility Act being implemented as a directive rather than a recommendation (SWD/201570624 final, 2015c).

### 2.1.2 Web Accessibility

The Web Accessibility Initiative (WAI) defines web accessibility as the design of web services such as sites, tools and technologies that are usable for people with disabilities. They specify the use of websites as people being able to "*perceive, understand, navigate, and interact with the Web*" and "*contribute to the Web*" (W3C, 2022). According to the WAI, all disabilities that affect web usage are included, that is visual, auditory, cognitive, neurological, physical, and speech impairments. Moreover, they conclude that web accessibility also benefits people without disabilities in special usage contexts, for instance, small screens, bright sunlight or during movement. These usage contexts are defined as temporary or situational limitations, as described in Chapter 2.1.1.

Creating accessible websites, tools, and technologies serves a dual purpose: it not only enhances their usability for individuals with disabilities but also broadens their accessibility to a wider range of internet users who do not have disabilities (Dowden & Dowden, 2019; Rozek, 2009). This inclusive approach benefits various user groups, including individuals using different devices such as mobile phones and smartwatches, as well as various input methods like keyboards and touchpads. It also caters to those experiencing changes in their abilities due to aging, temporary disabilities such as a broken arm or misplaced glasses, situational constraints like bright sunlight, and even those dealing with a slow internet connection. (Shum et al., 2016; W3C, 2022; Wobbrock et al., 2011)

To maximize the accessibility of websites, tools, and technologies, it is essential to make adjustments not only in technical aspects but also in design and structural elements (Rozek, 2009; Westbomke, 2008). Achieving this objective can be facilitated by adhering to specific guidelines and principles, such as the Web Content Accessibility Guidelines (WCAG) and Barrierefreie-Informationstechnik-Verordnung (BITV) testing steps.

In HCI research, there is no clear consensus as to how web accessibility should be implemented (Aizpurua et al., 2016; Law et al., 2007; Persson et al., 2015). Different design approaches exist, offering different points of view as well as technical requirements (De Macedo & Ulbricht, 2013; Cremers & Neerincx in Stary & Stephanidis, 2004; Persson et al., 2015; Treviranus, 2023; Wobbrock et al., 2011). A study by Law et al. in 2007 already pointed out the need for a clear definition of design approaches, as well as an agreement to "*provide people who are outside the field with a valid and widely accepted starting point from which they approach their design problems*" (p.9). Since then, most laws and regulations are based on the concept of universal design.

### 2.1.2.1 Web Accessibility Guidelines

The Web Content Accessibility Guidelines (WCAG) encompass a broad set of recommendations to enhance the accessibility of online web content. These guidelines consider web content across various platforms, including desktops, laptops, tablets, and mobile devices. Adhering to these guidelines enables a diverse audience, including individuals with disabilities such as blindness, low vision, deafness, hearing loss, limited mobility, speech impairments, photosensitivity, and various combinations of these disabilities, to use web services. While the WCAG makes some suggestions for accommodating learning disabilities and cognitive limitations, they do not cover all user requirements for individuals with these disabilities (Borg et al., 2015; Brajnik et al., 2012; Friedman & Bryen, 2008; Habil & Trescher, 2018; Sevilla et al., 2007; Small et al., 2005). It is important to note that even content conforming to the highest level (AAA) may not be fully accessible to individuals with every type, degree, or combination of disabilities, particularly in cognitive, language, and learning areas (W3C, 2023).

The WCAG 2.1 consist of principles and guidelines, underlined with practical examples, suggestions and further sources. Four fundamental accessibility principles serve as categories: perceivable, operable, understandable and robust (W3C, 2023). These principles are again divided by guidelines, that section criteria based on content. While these guidelines cannot be tested, they describe the importance of corresponding objectives. Testable success criteria are provided to accompany each guideline, allowing for the practical application of WCAG 2.1 in situations that require specific requirements and conformance testing, such as design specifications, procurement, regulations, and

contracts. To accommodate different user groups and scenarios, WCAG defines three levels of conformance: A (basic), AA, and AAA (highest). A conformance of A is essential for assistive technologies to operate the page. An AA level is considered to be ideal support for public websites in current law. AAA conformance offers specialized support and is mostly used for websites with a specialized audience. Each guideline and criterion is accompanied by suggested techniques for implementation that are either sufficient or advisory. (W3C, 2023)

#### 1. Perceivable

The first guideline to adhere to perceivability standards is called "alternatives for nontext content" (W3C, 2023). Companies are advised to offer texts for control and input elements, media and sensory elements. CAPTCHAs need to be accessible in more than one way. Moreover, decorative elements should be programmed in a way that assistive technology can ignore them. The second guideline is time-based media. This category defines how captions and audio descriptions should be implemented. While captions are required in AA standards, media alternatives, live-audio substitution, extended audio description and sign language are part of the AAA standards. The third guideline, adaptability, asks to create content in a way that can be presented in different ways without losing meaning. The success criteria define how HTML structures can be used for assistive technology and different formats, by using corresponding tags for headlines, lists, tables, forms, quotes and links. Web content should be distinguishable. Hence, colours are never used solely to indicate a status. Hover and focus status are used and if they lead to additional features appearing, these features need to be persistent until the user chooses to either dismiss or act on it. The colour contrast between and within elements must adhere to current standards. Sound on a website should be controllable, allowing the user to change volume, pause it or turn it off. The user should be able to resize texts and spacings. For AAA standards, colours and contrast should be customizable. (W3C, 2023)

#### 2. Operable

The criteria for operability require a website to be keyboard accessible. All functionality needs to be dialled and undialed through a keyboard only. Shortcuts should be customizable and can be turned off. Time frames and time pressure to perform certain actions should be avoided or the user should be able to perform easy actions to adjust the time frame. Any elements that are moving or updating automatically must be pausable or controllable. Flashes and animations that can cause seizures or physical

reactions may not be used. Web content should be structured in a way that is easy to navigate. Titles and sections should be aptly named, and links should be described according to their purpose. Repeated sections of a site should be skippable. Moreover, there should be several ways to access a certain web page within a page. The focus status needs to be visible. If adhering to AAA standards, the user should be able to inform themselves about their location within a set of web pages. Furthermore, section headings should be used. Any actions that require dragging or path gestures should be completable differently and an effect should be reversable. Actions that require device or user motion must offer alternative ways of completion. Labels that include text should be named accordingly. Finally, the target size of user inputs needs to exceed 44 CSS pixels. (W3C, 2023)

#### 3. Understandable

The third principle requires websites to be understandable. Firstly, the content should be readable, meaning, the language of a webpage can be determined programmatically. Moreover, mechanisms to understand abbreviations and idioms are available. If pronunciation is essential to understanding a word, mechanisms to read aloud should be available. Content on web pages should not require larger readability than acquired at a lower secondary education level or should offer alternatives in simpler language. Web content should behave predictably. Context changes in cases of focus or input should be avoided or only performed after a user confirms them. Navigation and identification should be consistent. Users should be assisted by offering labels, for instance when completing a form, and through error identification and description. If an input error is found, according suggestions should be made. Any input can be corrected or reversed and content-sensitive support is available. (W3C, 2023)

#### 4. Robust

Web content needs to be compatible with current and future (assistive) technologies. Proper HTML syntax holds significant importance. All user interface elements must be correctly labelled to be recognized according to their type and value. For instance, status messages need to be labelled as such to be shown to the user without changing focus. (W3C, 2023)

### 2.1.2.2 BITV Test Guidelines

The BITV test procedure was developed by the 'Bundesministerium für Arbeit und Soziales' within the project 'Barrierefrei informieren und kommunizieren' (BIK). It is based on the requirements of the 'Barrierefreie-Informationstechnik-Verordnung' (BITV). The BITV, in turn, is based on the specifications of the Web Content Accessibility Guidelines (WCAG) of the Web Accessibility Initiative (Weckenmann, 2019).

Since revisions based on current European accessibility norms in early 2022, the BITV test includes 98 test steps. For each test step, there are detailed explanations that state exactly what is being tested, why it is important, and how to proceed with the test. The test procedure is fully disclosed. A BITV test carried out by experts can be commissioned, yet, the detailed guidelines allow for a self-assessment of the accessibility status of a website. The test steps are separated into different categories based on content. Chapters 5, 6 and 7 were added based on EN 301 549 'Accessibility requirements for ICT products and services' (2021) which is required for all digital applications in the public sector. Chapter 9 is identical to the WCAG 2.1 guidelines. (DIAS GmbH, 2023)

The steps in Chapter 5 relate to general accessibility functions such as maximizing colour contrast, manually changing font sizes, voice output, plain language or deactivating autoplay functions. These settings must be accessible. Moreover, documents should keep encoded accessibility features when converted to different file formats. If a software makes use of biometric features, an alternative needs to be offered. The testing steps in chapter 6 relate to two-way communication. Any communication needs to happen in real time and synchronously. Moreover, it needs to fulfill certain video and sound quality standards. Sent and received messages need to be visually distinguishable. Chapter 7 defines testing steps related to videos. Subtitles and audio descriptions need to be synchronous. If video content is in a different language than other web content, audio descriptions need to be translated accordingly. Operating elements and accessibility settings should be on the same layer as other settings (DIAS GmbH, 2023). Since the contents in chapter 9 are identical to those in WCAG 2.1, they are not repeated here.

A website is BITV-conform if it fulfills all requirements, meaning the conformity of each test step is rated greater than or equal to 4 on a scale of 5. Upon request, a certificate can be issued and the website can be added to the list of BITV-compliant websites. However, to achieve this standard, the website needs to be tested officially, not as a self-assessment. In this process, the website is mostly tested twice: firstly, the current state

of accessibility is assessed and suggestions are made. Next, the company has time to change its website based on the first assessment. Ideally, the second step consists of confirming that the changes led to the fulfillment of the BITV accessibility standard. (DIAS GmbH, 2023)

### 2.1.2.3 Assistive Technology

People with disabilities encounter certain barriers when using computers and other terminal devices that prevent them from accessing the information they are looking for. Assistive technologies are tools used to overcome said barriers, mostly custom-made or adapted for a specific target group (Institut der deutschen Wirtschaft Köln e.V., 2019). While disabilities can be categorized into affected body functions, it is important to note that these categories are not mutually exclusive, and individuals may have disabilities that fall into multiple categories (Dowden & Dowden, 2019; Jevremovic, 2023). However, to structure this chapter, assistive technology will be explained based on affected body functions.

### 2.1.2.3.1 Visual Impairments

Globally, approximately 1.3 billion individuals experience some degree of vision impairment. Visual impairments can range from minor to severe, and they can affect one or both eyes with no possibility of correction. There are several types of visual impairments. Refractive errors include conditions like nearsightedness, farsightedness, and the presence of curved corneas leading to visual distortion. Cataract is characterized by the clouding of the eye's lens, which hinders clear vision. Glaucoma comprises a group of conditions marked by optic nerve damage resulting from elevated fluid levels and pressure within the eye. Another type of visual impairment that frequently hinders the interpretation of visual content on the internet is colour blindness, which affects approximately 8% of males and 0.5% of females. (Dowden & Dowden, 2019)

One of the assistive technologies utilized by individuals with visual impairments is a screen reader (Yoon et al., 2016). Screen readers are devices that provide blind users with the capability to navigate websites by vocalizing the content. They audibly relay textual information and, if properly labelled, describe graphics and images to the user. This auditory output can be delivered through either loudspeakers or headphones. When a website adheres to current web accessibility guidelines, the screen reader can identify links and forms, allowing the user to execute actions or skip through navigation elements

as needed. (Dowden & Dowden, 2019; Riverview Intermediate Unit #6, 2022; Westbomke, 2008)

Apart from screen readers, Braille displays are relevant for individuals who are blind or deaf-blind. Braille displays consist of a perforated surface with pins that rise when text is read, rendering it in Braille format. In this case, information is conveyed tactually rather than audibly. (Dowden & Dowden, 2019; Riverview Intermediate Unit #6, 2022; Westbomke, 2008)

For those with temporary or permanent visual impairments, magnification software proves valuable. This software enables users to zoom in on the computer screen manually. It consistently displays an enlarged portion of the screen that users can modify visually through specialized colour and contrast settings. (Microsoft, 2023; Riverview Intermediate Unit #6, 2022; Westbomke, 2008)

Many individuals with visual impairments use software solutions that allow them to interact with the computer through speech commands. Speech recognition software is particularly helpful, as it converts spoken words into text, processes them, and provides a textual output. There are two primary types of speech recognition: speaker-dependent and speaker-independent. Speaker-dependent systems require customization to match the user's voice and speech patterns, necessitating specific training. (Dowden & Dowden, 2019)

### 2.1.2.3.2 Auditory Impairments

Approximately 15% of the global population encounters various forms of hearing impairment. This includes around 466 million individuals, constituting 5% of the world's populace, who have severe hearing loss. Severe hearing loss is defined as a loss exceeding 40 decibels for adults or 30 for children in their better ear. Projections suggest that by 2050, this figure will swell to surpass 900 million people, equating to 10% of the world's population. One-third of individuals aged 65 and above are currently impacted by this issue. (Dowden & Dowden, 2019)

Several factors contribute to hearing loss, such as exposure to loud noises, genetic predisposition, injuries, aging, and illness. Auditory disabilities can manifest in various forms, ranging from profound hearing loss in one or both ears to milder impairments. People with these disabilities may still perceive sounds but might struggle to comprehend speech, especially when it is unclear, distorted, or amid substantial background noise. (Dowden & Dowden, 2019)

There are few assistive technologies for people with hearing impairments, apart from functionalities mentioned by WCAG or BITV-Test. While videos on public websites are required to have captions and audio descriptions, other video content often does not. Popular streaming platforms such as YouTube offer captions generated by artificial intelligence which can also be generated synchronously in live-streams. Yet, these captions are sometimes faulty based on the quality of sound and speech.

When designing web content for people with auditory impairments, alternatives to sounds should be provided. To substitute video sound, sign language or manually created captions can be used. In the case of sound signals and alerts, additional visual alerts can be used, for instance blinking. Many video games offer visual sound cues such as damage directional indicators, timing cues, pathfinding hints and highlights over loots or drops (Baker, 2020).

### 2.1.2.3.3 Motor Impairments

Physical disabilities encompass various constraints related to movement, mobility, manual dexterity, or endurance. These disabilities may arise from factors such as muscle weakness, including tremors, coordination difficulties, paralysis, reduced sensation, joint ailments, restricted range of motion, or the absence of limbs. The origins of physical disabilities are diverse, including circumstances like amputation, rheumatism, injuries, and medical conditions such as muscular dystrophy or fibromyalgia. (Dowden & Dowden, 2019; Westbomke, 2008)

Individuals with motor impairments face challenges when using traditional input devices and may have limited functionality with them. The realm of available assistive technologies is extensive and varies to accommodate different types of impairments, encompassing both hardware and software solutions. Thus, a few variations are subsequently exemplified (Microsoft, 2023; Riverview Intermediate Unit #6, 2022):

<u>Specialized Keyboards</u>: There is a wide range of specialized keyboards designed to cater to diverse needs. These keyboards come in various sizes, feature differently-sized keys, and offer unique key layouts for one-handed operation. They can be manually operated or activated using other body parts, such as the elbow or head.

<u>Trackball Systems:</u> As an alternative to the standard mouse, trackball systems are available. These devices allow users to control the cursor by manipulating a ball on top of the device, eliminating the need for precise coordination on a specific surface. The ball can be rotated in all directions for cursor movement.

<u>Electronic Pointing Devices</u>: Electronic pointing devices provide various methods for controlling the mouse cursor, including ultrasound, eye movements, nerve signals, and even, in some cases, brain waves.

<u>Integrated Dictionary Function:</u> Some software incorporates an integrated dictionary function that assists users by identifying and suggesting possible words as they type. This feature reduces the number of keystrokes required and eases the user's workload.

<u>Touch Screens</u>: The use of touch screens enhances accessibility by enabling users to directly select and perform actions, eliminating the need for mouse coordination or keyboard operation.

<u>Breath-Operated Systems:</u> For individuals with severe motor limitations, some systems allow computer operation through breath control, involving both sucking and blowing actions.

Moreover, people with motor impairment might also use speech recognition software, as described in chapter 2.1.2.3.1. (Microsoft, 2023; Riverview Intermediate Unit #6, 2022)

### 2.1.2.3.4 Cognitive & Neurological Impairments

Neurological disorders refer to conditions affecting both the central and peripheral nervous systems (World Health Organization, 2016). Cognitive impairments relate to the processes of thinking, comprehending, learning, and remembering. They cover "*a wide spectrum, from mild reading difficulties or dyslexia to severe autism*" (Berget & MacFarlane, 2020, p.5). A cognitive disability does not necessarily imply reduced intellectual functioning, and many individuals with cognitive impairments do not experience any limitations in their intellectual abilities (Dowden & Dowden, 2019).

A prevalent cause of cognitive and neurological disabilities is dementia, a significant contributor to disability among older populations, affecting approximately 50 million individuals globally, which accounts for 5–8% of those aged 60 and above (Scherer et al., 2012; World Health Organization, 2023). Other contributing factors encompass epilepsy, various illnesses like meningitis or zika (caused by bacteria, viruses, or fungi), trauma, strokes, and Parkinson's disease (World Health Organization, 2016). Cognitive impairments such as Down syndrome, learning disabilities such as dyslexia, and autism are also prevalent but not well-researched in the context of web accessibility (Berget & MacFarlane, 2020; Jevremovic, 2023; McCarthy & Swierenga, 2010; Rello et al., 2012).

Since cognitive and neurological impairments include such a wide spectrum of disorders, there are no clear instructions on making a website accessible to said user groups. However, barriers to accessing information for those with cognitive or neurological impairments often arise from intricate or perplexing website navigation and content structure (Barbieri et al., 2010; Berget & MacFarlane, 2020; Borg et al., 2015; Friedman & Bryen, 2008; Habil & Trescher, 2018; Sevilla et al., 2007; Small et al., 2005). Therefore, content needs to be well-organized, consistent, and predictable. Utilizing straightforward text alongside visual aids such as illustrations and graphs to convey information visually is immensely beneficial. Additionally, it is essential to consider the presence of blinking, flashing, or flickering images or persistent background audio tracks that cannot be muted. These elements are particularly problematic for individuals with photosensitive epilepsy which can trigger seizures upon exposure to rapidly flashing lights. Common triggers include television screens and computer monitors displaying flickering or scrolling images. (Dowden & Dowden, 2019)

Individuals with cognitive or neurological disorders may employ various web browsing methods depending on their specific needs, such as text-to-speech, captioning, or speed control to adjust the rate of information consumption. These adaptations overlap with accessibility requirements for individuals with auditory, physical, speech, and visual impairments, depending on the chosen method. (Friedman & Bryen, 2008)

### 2.1.2.4 Web Accessibility Tools

HTML and JavaScript already offer a set of functions to support the accessibility of a website (W3C, 2023). For instance, developers can include ARIA labels in their code. An ARIA label, short for Accessible Rich Internet Applications (ARIA) label, is a web accessibility feature used to provide additional information about an element on a web page to assistive technologies like screen readers. ARIA is a set of attributes that can be added to HTML elements to convey information about the structure and behaviour of web content to assistive technologies. The ARIA *label* attribute, or *aria-label*, is used to provide a text label or description for an element that may not have a visible label. It is particularly useful for elements like buttons, links, icons, or form elements that rely on visual cues for their meaning. By adding an *aria label*, assistive technologies can announce the purpose or function of the element to users. (W3C, 2023)

An external tool for testing accessibility standards is Google Chrome Lighthouse. It is an open-source tool that is used for auditing and assessing the performance, accessibility, progressive web app features, SEO, and best practices of websites and web

applications. It checks for accessibility issues, such as missing alt attributes on images, semantic HTML usage, and other issues that may affect users with disabilities. Lighthouse assigns scores from 0 to 100 for each category, with higher scores indicating better performance. It also generates detailed reports with actionable recommendations for improving the website's performance and user experience. (Chrome for Developers, 2022)

Another external testing tool is the WAVE toolbar, developed by WebAIM.org. The WAVE toolbar is a browser extension that scans a webpage and highlights potential accessibility problems visually on the page directly. It visualizes the kind of problem by providing different icons. The WAVE tool checks for WCAG requirements such as alt texts, HTML semantics, keyboard accessibility and labels. It also offers a contrast checker tool that checks whether colour combinations meet contrast requirements. Moreover, it verifies ARIA best practices. Finally, it gives a feedback report that summarizes all issues found on a page. (Institute for Disability Research, Policy & Practice, 2023)

The Global Public Inclusive Infrastructure (GPII) is a cloud-based tool that allows for the auto-personalization of information and communication technologies. Its long-term goal is to save user preferences and thus standardize all technology a user encounters responsively to match their abilities. It does so by combining preference-configuration, auto-adjustment and user selection interfaces (Wobbrock et al., 2018). The GPII supports a one-size-fits-one approach, as also given in ability-based design (see Chapter 2.2.2).

Finally, there are several versions of colour contrast analyzers that check websites or individual colours for conformity with accessibility requirements. While there are other web accessibility tools, these are most known and used free of charge. Some companies also offer fee-based accessibility checks. It is important to note that automatic testing tools might yield misleading, incomplete or simplified results (Cao & Loiacono, 2021). Accessibility testing is very complex and thus should be conducted by real users whenever possible.

# 2.2 Design Approaches

Over the years, many approaches to accessible design have been suggested and there is no consensus yet: Barrier-free design, universal design, design for all, inclusive design, ability-based design, accessible design and design for dynamic diversity are only a few terms that are mentioned when talking about including individuals with impairments (Berget & MacFarlane, 2020; Coleman, 2007; Law et al., 2007; Persson et al., 2015). Since taking into account all differences in these approaches is beyond the scope of this thesis, solely the main difference will be illustrated: While approaches such as universal design and design for all suggest one solution that suits all users, ability-based design and end-user development emphasize the adaptivity of software to create individual experiences for each user.

Both kinds of approaches are already being implemented in current software. Universal design approaches are often mentioned with guidelines such as the WCAG or BITV testing steps, promising accessibility by following a checklist of design criteria to create an equal experience for everyone (De Macedo & Ulbricht, 2013; T. Schulz et al., n.d.). A more individualized approach to software design on the other hand is already common in modern user interface design with customizable options such as light or dark mode. Some universal design guidelines also include the requirement for customization as seen in chapter 2.1.2 (DIAS GmbH, 2023; W3C, 2023). Thus, while these approaches fundamentally differ, they partially consist of the same technical requirements and therefore cannot be completely separated (Persson et al., 2015).

Studies show that universal design approaches have not been able to cater to everyone's needs (Borg et al., 2015; Brajnik et al., 2012; Friedman & Bryen, 2008; Sevilla et al., 2007; Small et al., 2005; Treviranus, 2023). Especially solutions for people with cognitive disabilities can occasionally conflict with other user needs, hence leading to cases of extra web pages just for plain language or simple user flows. This separation can lead to further exclusion and marginalization and should therefore be avoided. Moreover, some critics of universal design emphasize that disabilities can be extremely diverse, making it impossible to cater to everyone with one checklist (Law et al., 2007; Treviranus, 2023). Thus, the personalization of interfaces is often mentioned as a solution to weaknesses of universal design approaches. For instance, Cremers & Neerincx in Stary & Stephanidis (2004, pp. 119-124) suggest personalized user profiles including certain abilities and characteristics that influence the customization of an online service. These aspects could include demographics, capabilities, personality and preferred settings, use cases and possible medical conditions and assistive devices. While such a profile would enable software to customize settings automatically, it is necessary to point out the privacy issues resulting from collecting such valuable personal information and enabling software to use it (Baneres et al., 2020; Bariffi & Quinn, 2021).

To illustrate the conflict between usability, accessibility, and privacy, three design approaches will be described in more detail: Universal design, ability-based design, and end-user development.

## 2.2.1 Universal Design

Universal design, a term first used in the context of architecture in product design, aims for "*products and environments to be usable by all people, to the greatest extent possible, without the need for adaptation or specialized design*" (University of Washington, 2004). This concept is closely related to approaches such as "inclusive design" or "design for all" and is often used interchangeably (Helvacioglu & Karamanoglu, 2012; Persson et al., 2015). Seven principles have emerged that provide guidelines for implementing universal design (Helvacioglu & Karamanoglu, 2015; University of Washington, 2004).

<u>1. Equitable Use:</u> Universal design strives to provide equal access and use for everyone. Products and environments should be designed so that all individuals, regardless of their abilities, can benefit from them equally.

<u>2. Flexibility in Use:</u> Universal design incorporates the idea that products and spaces should have multiple uses or functions that can be chosen freely and adapted according to context. This flexibility ensures that a wide range of individuals, with varying abilities and preferences, can use them effectively.

<u>3.</u> <u>Simple and Intuitive Use:</u> Universal design emphasizes simplicity and intuitiveness in the design of products and environments to ensure that all users regardless of previous experiences, background, knowledge, language skills or other factors can use a product. Thus, complexity should be reduced, user expectations should be fulfilled and user flows and feedback should be effective.

<u>4. Perceptible Information</u>: To accommodate individuals with different sensory abilities or varying ambient conditions, universal design promotes the presentation of information in multiple forms.

<u>5. Tolerance for Error</u>: Recognizing that errors are a part of the human experience, universal design aims to minimize the consequences of mistakes. Thus, designs should discourage the user when taking possibly consequential actions such as giving away private data in chat messages. Moreover, all actions should be reversible.

<u>6. Low Physical Effort:</u> Universal design seeks to reduce the physical effort required to use a product or environment, making it more accessible to a wider range of people. Thus, products and designs should align with ergonomic requirements.

<u>7. Size and Space for Approach and Use:</u> Ensuring that products and spaces are designed to accommodate various body sizes, mobility aids, and postures is another critical aspect of universal design. All users should be able to reach all components of a product regardless of hand or grip size.

In an architectural context, universal design is a suitable approach since physical spaces are static and thus need a one-size-fits-all approach. However, interactive systems are subject to ongoing change. Moreover, web infrastructure allows for adaptation and customization based on user needs. Thus, studies show that the approach of one design that works for all is not ideal for the structural preconditions of web infrastructure (Harper, 2007 in Wobbrock, 2011), as well as excluding user groups with cognitive or learning disabilities because of contradicting user needs or little awareness (Berget & MacFarlane, 2020; Mikulak et al., 2023; Murphy et al., 2022; Sevilla et al., 2007; Small et al., 2005; Treviranus, 2023). It should therefore be considered if the adaptivity of interactive systems can be used to implement a design for one approach that can support individual user needs.

## 2.2.2 Ability-Based Design

Wobbrock et al. (2011, 2018) suggest ability-based design as the opposite of universal design, as a 'design-for-one' approach. It is argued that a focus shift needs to happen: instead of focusing on disabilities and trying to find one way to include everyone despite their disabilities, designers should focus on people's abilities and diversity. Since all users have highly individual needs, abilities and preferences, Wobbrock et al. (2011, 2018) suggest adaptable user interfaces that are customizable and enable everyone regardless of abilities, demographics, expertise and preferences to use them.

By adhering to ability-based design, designers are not obliged to find a one-fits-all solution and the system adjusts to the users' needs rather than the user adjusting to the system. One option is for systems to include automatic adaptation based on user abilities, termed 'adaptivity'. The second option, called 'adaptability', enables users to customize a system themselves. (Wobbrock et al., 2011, 2018)

Wobbrock et al. recommend seven principles of ability-based design (see Table 1). The first two principles, ability and accountability, relate to the designer's point of view, or

"stance" (Wobbrock et al., 2011, p.9). They thus form the essential requirements for designing for the user's abilities. The interface should offer adaptation or adaptivity and communicate these options transparently, enabling the user to act self-determined and make changes when needed. Finally, Wobbrock et al. (2011) define three system recommendations: performance and context relate to a system considering user actions, thus fitting the system for usage context and user abilities as well as protecting the user from error. Finally, designers are encouraged to lower the barriers to accessing technologies by implementing easily accessible and affordable software and other components.

#### Table 1

STANCE	1. Ability.	Designers will focus on ability not <i>dis</i> -ability, striving to leverage all that users <i>can</i> do.	Required
	2. Accountability.	Designers will respond to poor performance by changing systems, not users, leaving users as they are.	Required
INTERFACE	3. Adaptation.	Interfaces may be self-adaptive or user-adaptable to provide the best possible match to users' abilities.	Recommended
	4. Transparency.	Interfaces may give users awareness of adaptations and the means to inspect, override, discard, revert, store, retrieve, preview, and test those adaptations.	Recommended
SYSTEM	5. Performance.	Systems may regard users' performance, and may moni- tor, measure, model, or predict that performance.	Recommended
	6. Context.	Systems may proactively sense context and anticipate its effects on users' abilities.	Recommended
	7. Commodity.	Systems may comprise low-cost, inexpensive, readily available commodity hardware and software.	Encouraged

Seven Principles of Ability-Based Design

Note. From "Ability-based design" by J. O. Wobbrock et al., 2011, *ACM Transactions on Accessible Computing*, *3*(3), p.8.

So far, ability-based design has been realized in several projects, including dynamic keyboards, building user interfaces based on an assessment of user tasks, or controllers that can be used through voice control. The projects displayed in the paper of Wobbrock et al. (2011), so far have little in common with current ICT infrastructure. Thus, it is hard to estimate whether ability-based design as a concept could work on a bigger scale. Wobbrock et al. (2011) suggest the implementation of performance tests and ways to sense user context. Another option suggested is a more flexible approach to adaptation by letting the user make adaptions themselves. Then, no performance tests or sensing user context would be needed. This approach, which Wobbrock et al. (2011) call "*end-user adaptation*" (p.20) resembles end-user development, which will be defined in the next segment.

## 2.2.3 End-User Development

End-user development is a multidisciplinary approach based in human-computerinteraction, software engineering and computer-supported-collaborative-work (CSCW) to help conquer the rising diversity in end-user needs and requirements. Its goal is to empower users to customize software themselves despite being non-professionals in the field, thus leading to more individualized user experiences. Contrary to universal design, which aims to create one design that can be used by everyone, end-user development argues that individualized solutions are needed to keep up with a multitude of user requirements that are constantly changing. Lieberman et al. (2006) emphasize that professionals in regular project flows will not have the time and resources to adapt. Hence, giving users the means to adapt their systems themselves allows for a better user experience by fitting systems to abilities and contexts. Lieberman et al. (2006) differentiate between two types of end-user adaptation: firstly, "parameterization or customization" (p.3), either letting the user choose between predefined options or making use of adaptive systems that customize automatically based on user behaviour. Secondly, "program creation and modification" (p.3), enables the user to create components anew or to modify given artifacts, for instance through programming.

The biggest challenge is closing the gap between professionals and non-professionals. This means keeping the complexity low while still allowing the user to make great customizations. It is recommended to use visual examples to avoid technical terms and allow for visual feedback on implemented changes. Similarly, Lieberman et al. (2006) suggest a gentle slope of complexity: firstly, allowing the user to make selections, then to modify components, and lastly to program new components. Thus, all users can easily make small changes while some might make use of more complex adaptations. Yet, users would be required to invest in additional mental capacities and take on responsibilities for their operations and possible resulting errors.

Implementing end-user development is thought of as a socio-cultural activity and should be practiced in a participatory approach to ensure the systems can adapt to changing contexts and requirements of a large variety of people (de Carvalho et al., 2020). Similarly, they need to support several generations of devices, changing environments and the personal evolution and learning of the user. (Lieberman et al., 2006)

Thus far, possible application domains listed by Klann et al. in Liebermann et al. (2006, pp. 475-486) contain smart home devices, industrial design, science and systems for data-intensive businesses. End-user development is not yet thought of as an approach

to accessible design due to its cognitive user requirements. However, the personalization of interfaces is suggested as an approach to accessibility as seen in former chapters. Since automatically adapting systems might be at risk of not complying with personal data processing rights (Gooding, 2023; Knockaert & De Vos in Baneres et al., 2020), end-user development might be an approach to use personalization to enhance a software's accessibility while keeping customizations transparent and the user in charge. That is if self-customization functions can be made easily accessible, as pointed out by Wulf & Golombek (2001). It should be emphasized that end-user development requires certain cognitive skills and could therefore create further barriers instead of removing them. It thus needs to be cautiously implemented, keeping accessibility in mind.

# 3 Methodology

Since this thesis aims to evaluate existing organizational practices on accessible design, it is situated in Computer Supported Collaborative Work (CSCW) and socio-informatics research (Müller, 2018). Thus, a qualitative design case study was chosen as a research approach (Müller, 2018; Wulf et al., 2011).

The first step in conducting a design case study is familiarization with the research field. In this case, gaining an insight into socio-organizational practices within the web design company. After a problem context is defined, an innovative information and communications technology (ICT) artifact should be created in a participatory approach to change social practices according to the problem context, in this case, the company's ability to implement accessibility. According to Wulf et al. (2011), the last step of a design case study is ideally to investigate the appropriation of the artifact over a longer period of time. While this process is an idealized version of a design case study, not all phases may be conducted (Wulf, 2011). In the scope of this thesis, the first phase of defining social practices will be conducted to its full extent. However, since this thesis is limited to a period of six months, suggestions will be made by evaluating possible solutions to the problem context in a participatory manner, yet a concrete artifact will not be created nor evaluated in practice.

There is no agreement on quality criteria to be used in sociological research (Döring & Bortz, 2016; Mey & Mruck, 2010). However, Lincoln & Gruba (1985 in Döring & Bortz, 2016) mention four quality criteria that are commonly used to indicate research validity:

<u>1. Credibility:</u> The purpose, method and process are described clearly and the method suits the purpose.

<u>2. Transferability:</u> Results can be re-created in a similar context and context and participants are transparent.

3. Dependability: The interpretations can be retraced and the findings are credible.

<u>4. Confirmability:</u> The researcher and their background, pre-understandings and the theories their findings are based on are stated.

Mayring formulates similar criteria, requiring research to be done close to the field to be examined, interpretations to be re-traced, adhering to set rules for evaluation, enabling participants to validate or correct exclamations before publishing a study, and including other relevant approaches to the topic (Döring & Bortz, 2016).

This study aims to find out how web design companies currently implement web accessibility, where challenges and opportunities lie and what impact the EAA has. Therefore, a multi-methods design approach was chosen, consisting of eight semistructured qualitative problem-centred interviews and a final focus group (Dresing & Pehl, 2018; Mey & Mruck, 2010; M. Schulz et al., 2012). Both were conducted with employees of a web design company to empirically analyze the existing tools and practices as well as attitudes towards the topic (Mey & Mruck, 2010). All content was transcribed according to transcription guidelines by Kuckartz & Rädiker (2022). The transcripts were then evaluated using qualitative content analysis by Mayring (Mayring & Fenzl, 2019; Mayring & Gläser-Zikuda, 2008; Weber & Wernitz, 2021). Based on interview findings, challenges and opportunities were defined and later introduced to a group of employees. In this participatory approach, the participants engaged in a constructive dialogue, addressing challenges, and proposing solutions. The interviewees were able to corroborate or rectify any potential misunderstandings that the researcher might have encountered during the interviews. Furthermore, the design approaches discussed in the state of the art were discussed regarding the preferences of the web design company. This focus group was again evaluated using a gualitative content analysis. Finally, the thesis was given to the research participants to ensure nothing was taken out of context or personal information shared, yet, there were no instances of such a case.

It is important to point out that the research field is a small web design company, thus only a small number of employees in the same context were interviewed. Further studies need to consider larger sample sizes, perhaps in a different international context or a different German city, since some findings could be led back to the regional context. Also, potential biases might result from interviewing employees about their work structures rather than spectating their work. Similarly, researcher bias can occur when results differ from personal values. Thus, researchers should disclose their values and evaluate empirical data conscientiously (Kiegelmann in Mey & Mruck, 2010).

# 3.1 Interviews

The problem-centred interview is a common method in psychological and sociological research. The interviewer takes an active role, allowing them to flexibly react to what the interviewees are saying or ask further questions when needed rather than adhering to a strict guideline (Mey & Mruck, 2010). A semi-structured approach was chosen because it ensures that interviews mostly contain similar contents, in this case, aspects of all

research questions, without forcing the conversation into a certain direction (Gläser & Laudel, 2009; Mey & Mruck, 2010; Weber & Wernitz, 2021). Since the interviewees had different backgrounds, this approach allowed them to highlight the topics they were most familiar with. By conducting interviews with employees, it can be ensured that the problem context is defined precisely and accurately from the organizational perspective and based on employee experience and needs, close to the research field.

The interviews were conducted in June and July 2023. The interview questions were posed in German since all interviewees are German native speakers. Most of the interviews were conducted face-to-face in the office of the web design company to ensure the interviewees feel comfortable in familiar and thematically relevant surroundings (Döring & Bortz, 2016; Mey & Mruck, 2010). Two of the interviews had to be conducted online via Zoom due to the employee living in another town and working from home.

Apart from the environment, it is important to ensure that the way of recording the conversation is not disruptive for the course of the conversation (Döring & Bortz, 2016; Mey & Mruck, 2010). In this study, video recording was not necessary. Thus, the interviews were recorded via the interviewer's phone, which was turned on 'do not disturb' mode and put face down on the table.

The survey of interviews focuses on one small-sized web design company in Germany and should therefore be considered as introductory research to the topic. It is important to note that all interviewees knew the interview topic beforehand, thus most of them mentioned accessibility before it was included in any interview questions. One of the online interviews needed to be rescheduled after a few minutes due to severe connection issues.

## 3.1.1 Interview Participants

A purposeful homogenous sample was chosen to ensure that the interviewed employees are working in positions relevant to web accessibility (Döring & Bortz, 2016). Thus, the technical director of the web design company, who was interviewed himself, recommended seven more employees to be interviewed. The employees were selected for their overlap with web accessibility, while also attempting to reflect diversity in terms of job title, sex, and age groups to avoid biases. This choice resulted in the following sample: One-fourth of the interview participants are female and the age range is from late 20s to late 60s. The ID 'WD' stands for Web Designer / Developer.

### Table 2

Interview Participants

ID	Job title	Sex	Online/in	Responsibilities
			-person	
WD01	Technical Director	male	in person	Technical & project manager,
				commercial functions, trainer
WD02	CEO	female	in person	Management, personnel
				management, concepts
WD03	Web Development	male	in person	Project lead, web development,
				support, focus public sector
WD04	Web Development	male	online	Content management systems,
				domains, forms
WD05	Web Development	male	in person	Web development with TYPO3
WD06	Web & Marketing	female	in person	Team leader, project manager
	Manager			online marketing, SEO, trainer
WD07	Designer	male	in person	Web design, graphic design
WD08	Sales Manager	male	online	Sales, data protection (in semi-
				retirement)

# 3.1.2 Interview Guidelines

Before conducting the interviews, interview guidelines were derived from research questions formulated in Chapter 1 and 2. After writing several drafts, the final interview guidelines consist of 11 questions plus a short introduction to inform the participants of their personal rights and data security. The complete interview guidelines in the German language are attached in the appendix.

Interview guidelines should contain approximately eight to fifteen questions to ensure all interviews follow similar structures while still allowing the interviewer to respond flexibly to interview partners (Mey & Mruck, 2010). In this case, the participants occupy different positions in the company and thus have expertise in different fields. While some

elaborated more on contexts of accessibility in design, others focused on web development. In turn, the interviewer was able to adjust further questions based on the thematic focus of the interviewee (Mey & Mruck, 2010). The guidelines are semi-standardized and entail mostly open-ended, but some closed questions (Mey & Mruck, 2010).

The interview guidelines were structured in the following way: Firstly, the interviewees were informed about their personal rights and data protection. If there were no further questions, they were asked to introduce themselves in an initial open question. This question served the purpose of both getting to know the interviewees and their role in the company, as well as them acclimating with the interview situation by answering an entry question. Since most interviewees introduced themselves in detail, the additional questions of "What kind of work do you do?" and "Are there certain tasks or responsibilities you take on?" were often not necessary. The interviewees were then asked to describe the usual planning and execution of a web design project. They were asked about how they structure and execute their work, in regards to teams and tools they use. This first part of the interview allowed for the interviewee to gain an overview of the project flow and thus the context in which accessibility is implemented, as enquired in research question 1. The second part of the interview introduces the topic of web accessibility. The interviewees were asked to describe how they are in contact with web accessibility. Depending on the extent of their answer, they were asked in which contexts they implement accessibility and to what extent. To examine whether there were any difficulties with finding resources, the employees were asked what sources and resources they have used to educate themselves on the topic. They were then asked if they knew what the Web Accessibility Act was about. This question served the purpose of estimating their expertise on current web accessibility developments. Regardless of whether the interviewees knew what the Web Accessibility Act meant, the interviewer explained its content so for the next part of the interview, the interviewees were aware of current developments and could go into more detail when asked about possible opportunities and challenges. The final question asked the interviewees to suggest ideas on how their processes of implementing accessibility could be optimized or facilitated.

It is important to point out that the fifth research question was formulated due to some unexpected results in the interviews. Thus, it was not explicably addressed in the interviews and instead discussed separately in the subsequent focus group. However, some interviewees partially mentioned some aspects related to design approaches, as seen in the interview findings.

# 3.2 Focus Group

Following the interviews, aspects were re-iterated and discussed in more detail in a group context in September 2023. A focus group is a useful measure since it aims to represent a diversity of opinions and to discuss and evaluate potential measures in which group dynamics play a role (Schulz et al., 2012). It enables the exchange of collective knowledge and thus allows for evaluating challenges and useful measures to implement accessibility in a web design context (Przyborski & Riegler in Mey & Mruck, 2010).

The focus group was based on a short presentation of the interview results regarding the challenges identified in the interviews, also mentioning the solutions already proposed by the interviewees. The presentation included a total of 18 slides. The first part, consisting of 14 slides, summarized the essential findings on all codes in the category challenges, as well as adding according interview quotes. In the second part, the participants were faced with the solutions mentioned in the interviews. In addition to the starting presentation, a short semi-structured guideline can be used to ensure that all relevant topics are addressed (Schulz et al., 2012). In this case, instead of a guideline, each aspect of the presentation was followed by a short pause, enabling the participants to add anything or discuss certain points. After the final presentation slide, the interviewees were invited to an open discussion. The presentation in German language is attached in the appendix.

The purpose of the focus group was to discuss organizational structures and methods to implement accessibility in more detail, especially focussing on research question number 5, as interview results showed that the employees are not entirely convinced of the universal design approach. Thus, to combine critical research findings with first impressions from the interviews, the interviewees were nudged to tie into the design for all vs. design for one conflict as presented in the interview results. Despite planning to address the topic as a start to the open discussion, the participants started discussing accessible design approaches independently after the first few interview results were presented.

The focus group was conducted face to face, although two participants joined online via Zoom, mainly to listen. Similar to choosing the interview participants, the technical director invited other employees in positions relevant to accessibility or with interest in the topic to join. Unfortunately, some of the employees who were interviewed could not join due to illness. In total, there were eight participants, four of whom were already interviewed, two trainees and one employee focused on accessibility who started

working for the company just after the interviews had been finished (WD09). All focus group participants had a gender distribution of 50/50.

#### Table 3

Focus Group Participants

ID	Job title	Sex	Online/in	Responsibilities
			-person	
WD01	Technical Director	male	in person	Technical & project manager,
				commercial functions, trainer
WD04	Web Development	male	in person	Content management systems,
				domains, forms
WD06	Web & Marketing	female	in person	Team leader, project manager
	Manager			online marketing, SEO, trainer
WD08	Sales Manager	male	in person	Sales, data protection (in semi-
				retirement)
WD09	Project Lead &	female	in person	Project lead, accessibility specialist
	Accessibility			(new employee)
WD10	Trainee IT	female	in person	No additional responsibilities
	specialist			
WD11	Trainee Marketing	female	online	No additional responsibilities
WD12	Head of IT	male	online	IT Security, software architecture &
				specification

# 3.3 Content Analysis

All audio recordings were transcribed according to Kuckarzt (Dresing & Pehl, 2018; Kuckartz & Rädiker, 2022). Hence, speech is transcribed verbatim and slightly adapted to written German and unintelligible passages are marked by 'unv.'. Speaker changes are indicated by sections. Subsequently, excerpts to be quoted in the thesis are translated into English as closely as possible.

After transcribing all interviews, a qualitative content analysis based on Mayring was chosen (Mayring & Fenzl, 2019; Mayring & Gläser-Zikuda, 2008; Weber & Wernitz,

2021). The qualitative content analysis allows for large amounts of text to be evaluated and interpreted without losing meaning (Mey & Mruck, 2010; Weber & Wernitz, 2021). Based on the research questions and the available interview material, the systematic categorization with inductive category formation is logical and appropriate (Mayring & Fenzel, 2019; Mey & Mruck, 2010). However, the first four research questions were used as the deductive main categories to facilitate the interview evaluation. The combination of both deductive and inductive approaches offers the possibility to adequately capture all the insights gained from the semi-structured interview within the context of the research questions (Mayring & Gläser-Zikuda, 2008; Weber & Wernitz, 2021).

The four main categories based on the research questions are: Project Flow & Implementation, Challenges & Opportunities, EAA, and Solutions, and in the focus group there was a fifth category called Design Approaches (Table 4). Within the scopes of the deductively formed main categories, sub-categories were formed inductively to enhance the open-endedness of the evaluation thus allowing for unexpected aspects (Mayring & Fenzl, 2019). Corresponding interview excerpts were sorted into those categories. New subcategories were formed if there were many content similarities between different excerpts. If there were still text excerpts in the subcategories, which in turn could be divided into different topics, further subcategories of the subcategory were formed. The categories and passages are re-iteratively evaluated while perusing the material (Mayring & Fenzel, 2019). The focus group did not include any further information on research question 1, since its focus was to discuss future implications and challenges. Instead, a fourth main category containing research question 5 was formed, including exclamations on different design approaches as discussed in chapter 2.2 (Table 4).

#### Table 4

#### Coding Agenda

Category	Definition	Example	Rule
Project Flow & Implementation	All passages where work and project processes or the implementation of accessibility are addressed.	<i>WD04, 00:35:23:</i> You don't always have to invent everything from scratch. Especially with JavaScript and something like that. Many websites already have such suggestions and sample files that you can also test online and something like that is adapted immediately. If this barrier-free aspect is not yet considered in these	Only passages that neither relate to design opportunities nor design challenges
		examples, but they would still fit well,	

		then I take that in and continue to	
		improve it. In my project.	
Challenges & Opportunity-	All text passages where the	<i>WD01, 00:38:14:</i> It's difficult, and above all, it's difficult	-
ties	implementation of	to calculate how much time you'll	
	commented on in	test it again. Because technology and	
	terms of problems	browsers change with the display, and	
	or opportunities.	possibly HTML changes again, where	
		easy.	
EAA	All text passages	WD03, 00:21:47:	Texts that
	describing the	But I think it's good that there is such	do not
	European	a legal requirement, because as I	exclusively
	the understanding	You forget, you just forget the people	content of
	of it, and its impact	who have limitations, are impaired.	the law
	on work processes		correctly
	general.		
Solutions	Any passages that	WD01_00:44:30:	
3010110115	suggest how	Technically, it would be good if there	-
	accessibility	were some automated tests where	
	implementation	you could have something checked.	
	or supported.		
Design		WD06_00:24:46:	
Approaches	that discuss,	I understand this approach: you want	-
	criticize, or	to have one site for everyone, but if	
	acknowledge	it's just 80% satisfactory for everyone,	
	approaches in the	versions that 100% listen to your	
	organizational	target audience or the user at any	
	context.	given time, I think it already raises this	
		from a different angle.	

The process was visualized using a mind map on Miro to re-iteratively adjust inductive categories and assign quotes to them. The mind map is attached in the appendix.

# 4 Findings

# 4.1 Interviews

In the following chapter, the findings of the interviews are summarized, and structured according to the four research questions, as addressed in the interviews, and main categories built in the content analysis.

# 4.1.1 Research Question 1

How do web design companies approach the design for accessibility?

### Figure 1

Code System RQ1



To investigate the first research question, it was first necessary to comprehend the project flow of the web design company. For this purpose, the interviewees were asked

to outline their daily project routine, so that a flow chart could be reconstructed based on these descriptions, as seen on the miro board (linked in the Appendix).

The project flow follows a waterfall model, separating the project into phases. In most cases, the first step is for a customer to approach the company. An initial meeting is then held to get to know each other and jointly determine requirements and wishes. If necessary, there is then a workshop to familiarize oneself with the customer's systems and infrastructure. Based on the customer's needs, a functional scope is determined and an offer is made. If the offer is successful, further workshops or research/competitor analyses are carried out if necessary. Subsequently, a first design mock-up is created, which is reviewed with the customer. After an agreement is reached, a full design is created on which basis the website is developed. In some cases, the website is tested before it goes to final approval. Then the content is added. This is usually done by the customer. Depending on the system and previous knowledge, the customer may receive training on how to create content in the respective system. The website then goes live. In some cases, individual functions are then adapted. Finally, either the customers themselves look after the website in the future or the web design company takes over the long-term content maintenance and/or technical support. This ranges from updates to marketing or SEO / SEA.

Projects are mostly worked on in small teams, consisting of one developer, one designer and a project lead. The project lead usually is the one to do research on special requirements, for instance on the topic of accessibility. The web implementation is ultimately mainly up to the programmers. WD02 pointed out how it can be challenging to find compromises between the interests of different parties:

"Of course, that's between the ambitious designer we have sitting here, our usability experts in this case, our editor, who has a high demand on the content, our SEA expert, who has a certain expectation regarding the friendliness for search optimization, it's already a constant discourse anyway. And if the topic of accessibility is now added to usability, so to speak, then the balance of power changes and shifts again." – WD02

The participants were asked about their expertise in the field. The agreement was that basic knowledge was available, but that there was a lack of current information. However, when asked in detail about the knowledge present, it was found that most participants already have a great deal of knowledge of current guidelines such as the WCAG. When asked where they got this knowledge, their years of project experience were often referenced. The company had some barrier-free projects in the early 2000s

in which even user tests with people with disabilities were carried out, which normally do not take place for budget reasons, according to the employees. Because the company has many long-time employees who need to access knowledge in accessibility from time to time, there is basic cross-company knowledge in the field. In addition, the company regularly goes to trainings and fairs to listen to talks on various current topics, according to WD03. Nevertheless, all employees emphasized that accessible design does not make up the everyday business and therefore it requires increased refreshing of knowledge. The BITV self-test is used as a source of information for concrete test steps. In addition, legal texts are sometimes consulted. Internally, new information is being documented in Confluence, a digital collaboration and management workspace.

When planning a website with a client, accessibility is not a default. Instead, during the first meeting, the company will ask: "How barrier-free does the offer have to be?' to define this for us. And then we plan accordingly, budget for it and implement it to the best of our knowledge and belief" (WD06). Yet, since the developers use responsive programming, as well as their individual content management system, a basic amount of accessibility is already given by default in most cases. The developers will implement new features needed by current clients to the content management system, this way continuously adding onto the stack of the content management system. The developer WD04 mentioned that they sometimes draw back on online templates and resources for their content management system and make small adaptations if necessary.

One of the developers mentioned how implementing the accessibility basics is quite easy, as long as considering it *"These basic things are actually so easy to install. You just have to think about it"* (WD05). Yet, the CEO mentioned that implementing accessibility is a lot of effort and thus it is sometimes hard to convince clients to pay extra for accessible websites. So far, the company implemented plain language and sign language with the help of external providers, or left this aspect to the clients themselves.

Accessibility testing for legal requirements is not a service the company offers (yet, according to WD03). However, the employees do conduct BITV accessibility tests to ensure the websites live up to the client's expectations on accessibility. Still, WD06 pointed out that the BITV guidelines are not infallible.

"It's good, but it's prone to error because it's based on human judgment. And of course, you can work through this checklist, which is what we do, [...] But it's up to the person who goes through this checklist whether it's checked off or not." – WD06

Similarly, some of the developers do additional tests through Chrome Lighthouse, other browser extensions or Visual Studio Code. However, there is no uniform course of action when it comes to testing the code.

The company once had accessibility testing done by people with disabilities through the Institute of Barrier-free Information Technology. They then got a checklist with aspects that still needed improvement. It was pointed out how helpful this way of testing was to ensure that the implemented solutions fulfilled their purpose:

"In practice, you may have implemented something that actually meets the written requirements, but possibly something where someone sits in front of it and says no, it doesn't work like that, it doesn't work." – WD01

Interviewees pointed out that the testing of websites consisting of many web pages requires going through a lot of content which makes it very time-consuming. On the same note, it was mentioned that achieving a base level of accessibility is easy while achieving 100% in testing can be very challenging.

In some cases, public websites needed some changes after a few years to still fulfill accessibility requirements. In one case, a user himself gave feedback on a contrast being too low for him to read. For those cases, each website the company manages has a contact form, allowing users to give feedback and developers to make immediate changes.

To conclude the first research question, web design companies approach the design for accessibility based on client requirements. If the clients do not require a website to be accessible, a base level of accessibility might still be implemented if client systems and processes are compatible with the web design company's content management system. When clients ask for an accessible website, the project lead will inform themselves of current guidelines, asking their team to consider them. Hence, the designer will test colour contrasts and refrain from using animations or other moving and unpredictable elements, while the developers might take extra measures if the current version of their content management system is not compatible with the guidelines yet. When it comes to testing the code, the company has no established way of doing it. They mostly test with BITV, but sometimes the developers test the code additionally.

## 4.1.2 Research Question 2

What are the opportunities and challenges in designing for accessibility in the context of web design?

### Figure 2

Code System RQ2



When asked about the opportunities in designing accessible websites, most interviewees felt like the answer was clear: including everyone in the services they design. Some mentioned their difficulties with some websites, especially not finding what they are looking for due to a "*stupid design*" (WD08) or more modern design approaches that older generations are not used to. One interviewee also criticized websites that have no clear user flow, for instance, large pictures and no indicators of click-ability. Another

interviewee mentioned how his parents usually call him to set up technical devices or explain software to him. He argued that accessible websites might help reduce anxiety for older generations. With the EAA entering into action, the employees see an opportunity to no longer have to convince clients of the necessity of accessibility. This aspect will be further discussed in research question 3.

The category challenges in designing for accessibility made up one of the biggest parts in most interviews and has the most codes by far, showing how accessibility is a topic that is worrying to most employees in the web design company.

The first challenge in designing for accessibility relates to unspecific and vague information on the topic. Interviewees mentioned that laws are formulated very vaguely and miss specific calls of action. Generally, some interviewees found contradicting information on the topic online. The designer mentioned how they tried to find some design tools to test colour contrasts and noticed how some tools used different contrast values as a basis. Thus, the interviewees had difficulties differentiating between information that is current and information that might not fulfill the present standards anymore. WD01 pointed out how he is missing one central access point. Currently, he needs to actively look if there are any new criteria instead of being informed by default. According to him, it is non-transparent from when which rules apply and to whom. Additionally, rules interpretation might vary depending on who is the one to test them. One employee mentioned how aspects that were successfully tested when publishing the website originally did not fulfill the same criteria later on, leading to confusion and frustration:

"And then we got another report one and a half years later and suddenly things were somehow no longer okay, as we had implemented them. I was like, why, is it another person who has now tested it again? So, it also makes it super difficult for us to somehow get a red thread into it." – WD06

The interviewees emphasized that the testing steps are very complex, and might be challenging, especially for someone with less digital expertise. One interviewee assumed that the European Accessibility Act might lead to small companies no longer offering online services such as online appointments because they lack expertise and resources to correspond to the legal requirements. Moreover, some of the requirements are difficult to comprehend. One interviewee described how they once got a notice that the whole sentence needs to be labelled as a link, not understanding why it is not sufficient to mark the website only. Some interviewees mentioned how accessibility guidelines undergo

many changes that are sometimes difficult to retrace. Meanwhile, one interviewee felt like there have not been a lot of changes compared to the early 2000s, although assuming that his perception might be different because he does not work with accessibility regularly.

The interviewees pointed out that it can be challenging to combine the needs of clients, for instance, budget and visual appeal, with the needs of users with disabilities, for instance, readability and accessibility. Moreover, some features necessary in an accessible website might be irritating to other users, for instance, plain language. Yet, creating an extra page for users that need plain language is not manageable for large pages, leads to more costs, needs to be updated with the web content and separating users with and without disabilities is ethically questionable, as discussed in the state of the art.

Not only managing needs between target groups and stakeholders can be challenging, but also needs of users with disabilities vary depending on the severity and kind of impairment. One employee questioned whether it is more sensible to try to consider all groups and thus compromise, or focus on one group of impaired users and completely consider their needs only. The interviewees emphasized how designing for the anonymous user is a very challenging task because it is almost impossible to consider everyone's needs all at once. WD02 thus calls the kind of accessibility they implement "technical accessibility", meaning that there could still be someone for whom a website is not accessible, even if it corresponds with standards: "*These are very different tasks that need to be performed. And you can only do it optimally if you know who is sitting in front of it.* Yes, and everything else we do is ultimately about creating technical accessibility".

When it comes to web development, most interviewees agreed that implementing accessibility according to given guidelines is manageable. They mentioned that there might be some cases that are more complex than others, for instance, complex user forms or features that are already difficult to implement in a non-accessible version, such as slide shows or visual effects. WD02 pointed out that the technical implementation is less of an issue than designing user flows that allow everyone to find what they are looking for and understand the content and calls to action.

Design is the aspect with the most challenges in terms of implementing accessibility. All interviewees agreed that accessibility puts some boundaries on design, disabling certain designs from being implemented, for instance, certain visual effects or variety. The

designer, WD07, pointed out how web accessibility often takes away from all things that invoke emotion, for instance, images or visual effects: *"It is down to imagination. One would have to write: There is a beautiful picture in the background*". The reduced nature of accessible design, especially when it comes to colours and versions of buttons or links is what the interviewees pointed out as most restricting. They argued that strong contrasts do not always look visually appealing and accessible design means for the design to be stripped down which can be boring to look at. A debate was brought up on whether an option would be to implement an accessibility lever enabling users to switch to an accessible mode of a website, instead of all websites being high-contrast and stripped down by default. Yet, again, some interviewees mentioned that differentiating between user groups with and without a disability was not in the interest of most disability organizations and that they sometimes find themselves to be in a dilemma.

Another challenging aspect is coordinating the accessibility of the content of a website. Mostly, the clients themselves or public relations departments are responsible for writing and managing texts and other content. Unfortunately, in some cases, such as ministerial conferences, those responsible for web content are substituted once per year. Since they are mostly not skilled in digital accessibility, the web design company offers training each year. Additionally, the company offers a support contract, allowing to be contacted eight hours a weekday with questions. According to WD03, that happens quite often. Since accessibility certificates have to be updated once a year, even websites that have been accessible might need readjustments. This calls for a big workload over time. WD06 considers the biggest challenge to implementing digital accessibility in daily, ongoing, processes:

"Above all, this implementation in everyday work, i.e. the time factor and the implementation in everyday work, that these simply become standardized processes, is what I actually see as the greatest challenge, because so much simply changes. It's not just some structural measure, then that's the way it is, but websites live from the fact that they develop further and are expanded [...]. [The editors] have even less time to deal with it and think about it when they are exchanging text, to put a link description for example." – WD06

Some interviewees emphasized that sometimes, implementing accessibility fails due to external dependencies. For instance, if a website is implemented using WordPress or TYPO3, some updates might be needed to correspond to current accessibility guidelines. Similarly, some external plugins might be crucial for the client but no longer barrier-free. Thus, the developers prefer using their own content management system to

be independent and able to make necessary changes themselves. Apart from dependencies in web development, one interviewee pointed out how in the early 2000s, there was only one person in Bremen offering translation into sign language and hence, it took two months for the content to be online. Since that website updated information regularly, the content almost immediately needed to be redone. Furthermore, the local information centre for accessibility supposedly only has two employees supporting local companies with accessibility questions. Generally, it seems like there are too few points of contact, support and digital accessibility services.

Another external factor are the ongoing changes in technology, software and browsers. These lead to incompatibilities between accessibility features and software versions. One interviewee described how public institutions often use old software versions or browsers, making it challenging to implement certain features. On the other hand, some new features or plugins might not have barrier-free versions yet.

On the same note, the interviewees mentioned the lack of support tools to implement accessibility. The designer, WD07, explained how the colour contrast tools are sometimes tedious to work with because they require you to enter each colour code separately to test the contrast. Moreover, the need for quality assurance tools was emphasized, since it is almost impossible to review every change or content addition a client makes to a website.

WD01 mentioned how the technical infrastructure in terms of reception in Germany could sometimes be a hindrance since some websites or apps might work offline while some accessibility plugins might not. However, this challenge was only mentioned once, and there was no concrete example given.

To summarize the findings regarding the research question 2, challenges were pointed out in regards to information vagueness and complexity, compromising between stakeholder and user needs, the conflict between usability and visually appealing design, dependencies on external providers, lack of tools, and the ongoing need for re-iteration and quality assurance while adding content. The interviewees emphasized that achieving technical accessibility according to the BITV or WCAG is manageable. However, design limitations long-term re-iteration and quality assurance of content have emerged as the biggest problems. Opportunities were seen mostly in reducing barriers, such as enabling a clearer user flow or better readability that might reduce anxiety, for instance for older generations or people with impairments in interacting with web technology. Moreover, the interviewees saw the EAA as an opportunity to no longer have to convince clients of the importance of accessible websites. This issue will be discussed in more detail in the next chapter.

## 4.1.3 Research Question 3

How does the European Accessibility Act impact the design of websites?

#### Figure 3

Code System RQ3



To answer the research question 3, codes from the European Accessibility Act category are considered. Most interviewees agreed that a legal act is necessary, especially to convince clients to invest in accessibility. Many clients argue that the target group of those who need accessible design is too small for its expense. Furthermore, it seems like clients are missing awareness and would prefer modern design over an accessible website (*"Especially regarding colours and contrasts, I believe the client finds it more important that the site looks good than it being especially readable"* – WD05). Thus, clients who are not from the public sector rarely specifically request an accessible website in the private sector, one interviewee argues it is mostly due to accessible websites having a better *"image"* (WD05). Meanwhile, another interviewee argued that accessibility is not enough of a figurehead yet for clients to consider its expense worth it.

WD06 assumes that 80% of all websites will be affected by the European Accessibility Act. Based on the upcoming large demand for accessible websites due to the EAA, most interviewees were worried about the upcoming workload. One employee argued that accessibility will be the most prominent topic in the upcoming years that will "occupy them with a lot of tummy ache" (WD06). The company is now trying to prepare for that case by planning to build an accessibility "task force" (WD06) and actively informing all

clients of the upcoming change beforehand. This way, they are hoping that clients will take on the changes as early as possible rather than waiting until the law comes into effect. Yet, most interviewees were worried that most clients will request changes to be implemented within a short period in the summer of 2025, seeing parallels to data privacy guidelines that were implemented a few years ago: "Very few people cared about it right away. No, it was, of course, that everybody wanted it in the end [...] where it becomes mandatory. And that's going to be the same with this accessibility thing" – WD04.

Client timing is not the only parallel that the interviewees saw to the enforcement of data privacy guidelines: One interviewee explained how some people made use of the data privacy changes by looking for non-conform websites to file lawsuits against them for financial reasons. That interviewee was particularly worried that enabling accessibility through law would again lead to people sending warning letters or filing law suites against websites that do not conform to the EAA, thus being a threat to mostly small companies that are not able to finance law suites and/or a relaunch of their website. Similarly, another employee assumed the law to be especially threatening to small companies due to missing expertise and resources to make changes to their websites.

None of the employees mentioned the law to be detrimental to their particular work practices. This can be traced back to the fact that none of the interviewees were familiar with the contents of the law in detail. When explaining the details to them, some mentioned that they already make use of WCAG AA standards and the BITV testing steps when implementing accessibility for public clients and thus they were not surprised by certain aspects of the EAA. One interviewee ironically asked whether the EAA is written in plain language, hence emphasizing the barrier already needed to access and understand the law properly.

Summarizing, while the EAA might not have strong consequences for the workflow of the web design company, it does have a huge impact on the workload. The interviewees agreed that the law is mostly positive since it leads to clients being forced to implement accessibility changes that would otherwise not be prioritized. Yet, some worries were voiced regarding the implementation of the law, especially regarding the vagueness of guidelines, upcoming workload and possible law suites.

## 4.1.4 Research Question 4

What can be done to facilitate the implementation of accessible design in web design processes?

#### Figure 4

Code System RQ4



Four categories were mentioned as possible facilitation of implementing accessibility. Firstly, interviewees explained how standards could help counteract the vagueness and complexity of information. By offering concrete visual or code standards as a practical example of laws and guidelines, the effort needed and inhibition to familiarize oneself with accessibility would be lowered. An accessible atomic design system for web developers to pick what they need was suggested. Another suggestion was a simplified building kit for guidelines where one can enter the requirements and get an accessibility checklist based on them. Moreover, one interviewee mentioned repeatedly how she would prefer checklists, guidelines or standards to be divided between necessary and nice to have, or structured based on importance.

One interviewee mentioned that instead of testing with several different tools and methods, as is currently the case, having one unified automated testing tool that does all those steps would be ideal. The designer suggested a plugin for Figma or AdobeXD that immediately tests the colour contrast, for instance in the form of a traffic light: green means the contrast is accessible, yellow means it's technically sufficient but could cause barriers, and red means the contrast is not sufficient. Artificial intelligence was mentioned as an opportunity in terms of both testing code, as well as creating and supervising content, for instance, related to plain language. Especially, when it is necessary to

translate a multitude of web pages into plain language, the artificial intelligence tool ChatGPT was perceived to be a possible help.

The need for external institutes was expressed as a solution for information seeking, ongoing changes and plain and sign language. A central point of contact for queries or to collect current information, guidelines, and standards in one place was suggested. Possibly, this info point could even contain a history of past developments in law so that it is easier to track changes. Moreover, according to WD01, it would be ideal if that institution informs anyone who has a website of current changes by default so that companies do not have to proactively look for new information. This institute could even offer training regularly and function as a support with questions of any kind. One interviewee explicitly addressed the chamber of commerce, demanding for it to raise awareness on the topic and educate website owners before the due date in 2025. As already discussed in the findings on research question 2, WD06 finds that the institutes responsible for digital accessibility in Bremen do not have enough resources and staff to handle the workload and support companies. Thus, another approach to facilitate the implementation of accessibility was to expand corresponding positions and funding.

A few interviewees mentioned how universal design is challenging to implement, especially trying to combine stakeholder and user needs with visually appealing designs. Thus, another approach to facilitating digital accessibility is to allow for individual user customization based on needs rather than creating one unified design, as would be the case in Ability-Based Design and End-User Development discussed in the State of the Art (see Chapter 2.2.2 & 2.2.3). The designer, WD07, mentioned how he would prefer for users to have a button to decide which presentation of a website most fulfills their needs, thus not losing the possibility for more complex designs. He expects to be designing for tools and individual device customization in the future, since according to him, accessibility tools are more optimized than browsers will ever be. WD05 considers it to be possible for a website to have a customization bar, allowing the users to turn features of a website on or off.

In summary, measures that could facilitate the implementation of digital accessibility could be further standards and guidelines that can be collected in a single point of contact. More or better equipped external institutes that support in educating and processing inquiries are wished for. Artificial Intelligence could be used to support content translation and testing in the future. Moreover, concepts that allow for individual customization, such as ability-based design, might facilitate the conflict of compromising between user and stakeholder needs.

# 4.2 Focus Group

### Figure 5

Code System Focus Group



In the focus group, the main interview findings were introduced and discussed among the employees. Since research question1 aims at understanding existing practices, project flow and implementation were not brought up in the focus group specifically. Instead, interviewees discussed the challenges and implications of the EAA. Moreover, the conflict of one design for everyone vs. a customizable design, as described in Chapter 2.2, was brought up. While the company is still in the middle of trying to find strategies, some of them were mentioned in the focus group.

Some of the challenges in implementing accessibility that were already mentioned during the interviews were discussed again. During the discussion, it was again obvious that information on the topic and laws was very vague. Most questions could not be answered by any of the interviewees, not even by the company's accessibility specialist who by their own account has been working on the topic for almost a year. Common questions were whether a contact form or booking tool requires a website to be accessible, and if

so, if only that part of the page needs to be accessible or the whole site. While the interviewees assumed it would only make sense to make the whole page accessible, they were not entirely sure whether that was the legal requirement.

The issue of testing for accessibility was also prominent. Interviewees mentioned how the company does not have the financial means to have websites tested by people with impairments. Similarly, it was pointed out how some requirements are interpreted differently depending on the observer and that there is not a clear right or wrong in some instances. Moreover, it is difficult for the company to estimate the expenses of testing, since they do not have clear project flows for testing yet and changes in law and software make expenses unpredictable. In general, the employees were wondering who would pay for implementing accessibility voluntarily, thus considering the European Accessibility Act to be necessary. The company itself decided to not implement accessibility for their own website in order to have no restrictions in terms of design. Now, they are trying to implement as much as compatible with the new design:

"Who are you doing the site for? We have also made this decision for ourselves and I stand by it. Our own new website is not accessible. For reasons. And we now have to look afterwards, how do we get to WCAG A. [...] We are not obliged to comply with AA, so we do A. Then we have at least a little bit. Not everything. But because our main target group is just not the person with impairments. It's just difficult." – WD06

As mentioned in the quote, target groups were another point of discussion. One interviewee pointed out how it is already difficult to combine search engine optimization with design, not even adding accessibility to it. In regards to research question number five, "*Which design approaches are most efficient to implement in a company setting?*", the interviewees discussed whether it is possible to design a website that works for every target group and reached an agreement that it is not possible. They mentioned plain language as an example of implementing an extra webpage for accessibility, enabling the user to switch between page versions. Talking about plain and sign language, it was also pointed out how there is little understanding of the relevance of sign language among non-impaired users, combined with high costs for signed content.

All employees agreed that the German term "Barrierefreiheit" can never be fulfilled, since no website will be completely free of barriers, while the English term accessibility is more fitting. Since all interviewees agreed that one website that fulfills every user's needs does not exist, they discussed whether universal design is the right approach. The accessibility specialist, WD09, was in favour of the universal design approach and emphasized that a compromise that includes everyone, if not ideally, is better than no inclusion at all, while the other interviewees wondered if personal customization would be a better approach to lose fewer design opportunities. WD09 underlined that creating alternative websites does not fulfill the requirements as stated in the EAA and Convention on the Rights of Persons with Disabilities (CRPD). While all employees understood the dilemma, WD06 pointed out that the conflict between target groups is exactly why they continue to get stuck on the same discussions, thus emphasizing the relevance of questioning whether design for all is the best approach to the topic. Hence, the interviewees discussed that customizations are already part of the accessibility requirement and what could happen if users were able to make adjustments to a website or use an adaptive system that saves previous user settings. Yet, WD09 pointed out how not all users might have the expertise to use these functions:

"WD04: [00:25:32] Maybe just one more click, on the icon at the top.

WD06: [00:25:34] Exactly and you have a page that just picks you up 100% and not one where you put any restrictions on whatever audience it is at that moment. WD08: [00:25:46] That problem would be solved if browsers could make a personal setting.

WD06: [00:25:53] You go right into the different modes.

WD08: [00:25:57] That is, I set the browser, so I can only use a keyboard. And when I access the browser, then the website is immediately there from the provider who has also just set that the same way.

WD09: [00:26:12] That's part of accessibility is that it's adaptable and that's exactly what it does. The problem is, I think, since the target group is wide between seniors who can hardly operate in the browser and others who know how they have to set in the browser so that they have their own pages or whatever."

While the interviewees agreed that the EAA is necessary to convince clients to implement accessibility, they connected the law to negative feelings such as fear and uncertainty. It was argued that the obligation to implement accessibility might be a hindrance to digitalization. For instance, companies with a focus apart from the web that might use it to implement booking tools might decide that the costs to implement accessibility exceed the convenience of digitalizing in the first place. The topic of warning notices that anyone could send was brought up again, yet mostly dismissed since according to WD09, they run through supervisory authorities, thus prohibiting private people from receiving financial benefits.

The interviewees brought up several occasions where they designed websites for clients in other federal states, noticing the differences between how German states are referencing the law. While the requirements differ from state to state, also the institute in which the centre for accessibility is located, differ. Thus, the centre for accessibility in Bremen has more resources since it is located with the senate, while other states assign it to institutes of less decision-making power instead. Thus, the interviewees hoped for a unified approach in all German states and more financial assistance for agencies that can be used for tools and support.

As a strategy to deal with the implementation of accessibility due to the EAA, the company hired an accessibility specialist, present in the focus group. WD09 took notes on any questions that arose, wanting to inform herself further. The time left until the enactment of the EAA was seen as a positive since it enabled the company to develop processes, especially for implementing and testing accessibility. Finally, all employees pointed out that many more discussions will be necessary. It was emphasized that implementing accessibility will be a challenge, however, most of the interviewees were confident that they could rise to the challenge.

In summary, the vagueness in information and inconsistency between federal states led to the interviewees feeling anxious and uncertain about the EAA. The company does not have the means to test for accessibility properly and cannot estimate how they will quantify the costs of implementing accessibility for clients due to the longevity of measures. To overcome those uncertainties, they hired an accessibility expert who will do research to implement project flows for the implementation of accessibility. Yet, even with the help of an accessibility expert, all agreed that the proper consideration of all target groups is impossible, thus opening the discussion of whether universal design is the best option. While they are implementing universal design according to the accessibility guidelines for now, as required by law, most employees are in favour of customizable options. They assume that having adaptable web services will solve the target group dilemma and help clients understand how all users profit from these options. However, one interviewee was worried about the implications for those, who do not have the ability to find and use given options. While the interviewer mentioned how data security might be an issue when systems adapt automatically given user abilities or presettings, it was mostly dismissed by the employees, and the global public infrastructure, a web service that allows users to adapt all websites based on one setting, was given as an example for a technology that offers a similar service.

# 5 Evaluation

This master thesis raised five research questions that were answered in a combined approach of literature research and case study, consisting of interviews and a focus group. The findings of these research questions will be summarized in the following.

# Research Question 1: How do web design companies approach the design for accessibility?

In the examined web design company, web accessibility projects are not the default. Instead, clients need to pay extra for the website to be accessible. This increased price is related to increasing costs on the production side: research is needed beforehand, to familiarize oneself with current guidelines. Furthermore, design and implementation processes take longer since additional aspects need to be considered. Finally, content creation and management require more effort to ensure new content fulfills all requirements and is still coherent with current guidelines.

The literature research and interviews showed that accessibility is a team effort. All roles are responsible for implementing accessibility (Zimmermann & Vanderheiden, 2008). The employees in the examined web design company described that there is no specialized workflow for accessibility, but that everyone needs to take extra caution. The project lead is responsible for negotiating with clients and doing research on current accessibility guidelines. The designer needs to design accessible layouts and visual content. The developers are required to implement all technical requirements. Accessible content also plays into search engine optimization and other stakeholder expectations. Sometimes, accessibility and SEO can complement each other, however, for instance, plain language can also be a hindrance to SEO. Thus, managing stakeholder expectations, team expectations and additionally, user expectations can be challenging.

Contrary to what one might expect, the technical implication turned out to be the least challenging aspect since HTML offers tags and responsive programming tools that are accessible (Yoon et al., 2016). The examined web design company often works with their own content management system, which is expanded throughout the projects. The developers try to keep it accessible so that it can be implemented in accessible web projects without needing further adaptation. Thus, even web projects that clients so far did not require to be accessible, are often accessible to a certain degree. However, the web designer of the company emphasized that he has to change his way of working

quite a lot to fulfill accessibility standards. Also, project managers found it challenging to estimate costs due to the longevity of accessibility support.

As shown in the State of the Art, many websites are compliant according to WCAG (Brajnik et al., 2012). Thus, user groups with cognitive impairments are often not considered by web design companies (Borg et al., 2015; Friedman & Bryen, 2008; Habil & Trescher, 2018; Kim et al., 2023; Mikulak et al., 2023; Sevilla et al., 2007; Small et al., 2005). Moreover, assistive technologies are often expensive and targeted at functioning best when used in combination with certain browsers or tools (Petz et al., 2022). Therefore, accessibility testing is very complex and costly, which is one reason why it is currently often not done in detail. Instead, tools such as Google Chrome Lighthouse or the WAVE toolbar are used to save costs. Yet, they evidently cannot recognize all accessibility errors. Thus, there is a large demand for accessibility testing tools.

### <u>Research Question 2: What are the opportunities and challenges in designing for</u> <u>accessibility in the context of web design?</u>

Regarding opportunities in designing accessible websites, interviewees unanimously emphasized the importance of inclusivity of online services. Designing accessible websites was seen as a way to address issues faced by various user groups, particularly older generations unfamiliar with modern design approaches. Moreover, accessibility was perceived as potentially reducing anxiety for those less familiar with technology. Hence, the European Accessibility Act (EAA) was viewed as a positive step, eliminating the need to persuade clients about the necessity of accessibility.

However, many challenges in designing accessible websites could be identified. Current studies show that universal design approaches that are implemented through guidelines such as the WCAG are unable to consider all user groups (Berget & MacFarlane, 2020; Harper, 2007 in Wobbrock, 2011; Mikulak et al., 2023; Murphy et al., 2022; Sevilla et al., 2007; Small et al., 2005; Treviranus, 2023). Disabilities can be extremely diverse, as shown in Chapter 2.1. Therefore, one checklist, implemented in one website, can never reflect all user needs. So far, there is no consensus on implementing web accessibility in HCI research (Persson et al., 2015). This lack of standards proved to be challenging, both in current studies on web accessibility as well as in the conducted interviews (Law et al., 2007; Persson et al., 2015; Treviranus, 2023).

Interviewees highlighted difficulties in finding clear and specific information about accessibility guidelines and standards. They faced contradictory or outdated information online, leading to confusion about compliance requirements. Furthermore, challenges

arose in reconciling the design preferences of clients (e.g. visual appeal) with the needs of users with disabilities (e.g. readability). Designing for users with disabilities presented challenges due to the diverse range of impairments, making it hard to cater perfectly to all groups simultaneously. While technical implementation according to guidelines (BITV or WCAG) was manageable, design limitations emerged as a significant issue. A study by Yoon et al. (2016) found that most accessibility problems arose from navigational and semantic design rather than technical implementation, confirming the impression of the interviewees. Ensuring ongoing accessibility in content creation posed a challenge, especially when content managers lacked digital accessibility skills. The need for continuous quality assurance and updates was highlighted. The interviewees also pointed out external dependencies, technology changes, and lack of support tools as hurdles in maintaining accessibility over time.

In summary, opportunities were seen in enhancing user experience by reducing barriers and clearer user flows, especially for older generations and users with impairments. Technical accessibility seemed realizable for web design professionals, but design limitations, ongoing content maintenance, and quality assurance emerged as major problems. Catering to all user groups proved to be a challenge, leading to services that are technically accessible but still not completely accessible to all user groups. The company acknowledged its inability to comprehensively test for accessibility and struggled to estimate the costs of implementing these measures for clients. Despite hiring an accessibility specialist and preparing for EAA compliance, the company did not feel like it had a solution for the ongoing debate of catering to all target groups. Overall, the team felt confident in their ability to meet the challenge but acknowledged the necessity for further discussions and innovative solutions.

# Research Question 3: How does the European Accessibility Act impact the design of web-based products and services?

Overall, the interviews underlined the findings of the state of the art (see Chapter 2). So far, websites are often not designed accessibly since clients do not consider users with impairments to be their target group and choose to save costs. Research shows that individuals with long-term or situational impairments regularly have difficulties accessing digital services (Aniyamuzaala, 2023; Ferati & Vogel, 2020; McCausland et al., 2021; Murphy et al., 2022, 2019). Standards and requirements vary internationally, which leads to little cooperation and control mechanisms (SWD/201570624 final, 2015a). The findings in this thesis confirm the need for a legal act on web accessibility.

The EAA will have a great impact on web infrastructure by obliging clients to choose an accessible website. The employees noted that clients will be more willing to pay for accessible websites if it is legally required, thus making up for the former lack of resources to implement accessibility. However, the EAA will greatly impact the workload of all companies that own a website. The EAA was perceived by focus group participants as potentially hindering digitalization efforts for companies focused on other areas if the costs of accessibility outweigh the benefits. So far, the web design company experienced little support from external institutes, leading to frustrations in terms of information gathering, questions and services such as sign language translations. Disparities between German federal states regarding accessibility requirements and resources were highlighted, emphasizing the need for a unified approach, and increased financial support. A need for action was assessed on a mostly organizational basis since project flows and estimation of costs need to be readdressed. Moreover, the interviewees were worried that the implementation of legal requirements would lead to very unified websites due to visual design restrictions. During the development phase, the EAA will have little impact since, according to the examined web design company, most of the implemented code is already accessible. Nevertheless, especially accessibility testing, long-term accessibility support and content creation require many resources.

# Research Question 4: What can be done to facilitate the implementation of accessible design in web design processes?

Many interviewees had no outright suggestions on what could help them since they found the challenges in implementing accessibility very complex. Others suggested tools, for instance for automatic testing of colour contrasts or code. The interviewees found artificial intelligence to be especially promising in supporting with plain language translations or code testing. In contrast to what was expected before conducting the interviews, most challenges do not lie in the technical implementation. Instead, the organizational infrastructure was criticized. Thus, the interviewees wished for unified standards and one unified institute that would support them with inquiries of all sorts. Individual user customizations were brought up as a facilitation to include all user groups. Hence, alternative design approaches to universal design should be considered to facilitate the implementation of accessible web design, as discussed in Chapter 2.2. and evaluated in research question 5.

# Research Question 5: Which design approaches are most efficient to implement in a company setting?

This thesis illustrated three different design approaches: universal design, ability-based design and end-user development. Universal design aims to create products and environments usable by everyone without specialized design (De Macedo & Ulbricht, 2013; Helvacioglu & Karamanoglu, 2012; University of Washington, 2004). However, it struggles with individual user needs, especially for people with cognitive disabilities, leading to separate web pages and potential exclusion (Law et al., 2007; Wobbrock et al., 2011). Ability-based design and end-user development enable the user to make individual adaptations and could thus prove promising to solve current accessibility issues that universal design brings. Ability-based design shifts focus from disabilities to abilities, advocating for adaptable and customizable interfaces that cater to individual needs and preferences (Wobbrock et al., 2011, 2018). End-user development empowers non-professionals to customize software, providing more personalized user experiences and addressing the ever-changing diversity in user requirements (Lieberman et al., 2006). However, while these approaches offer potential solutions, challenges regarding user privacy, cognitive skill requirements, and potential exclusion persist, warranting cautious implementation in the pursuit of enhanced accessibility (Baneres et al., 2020; Lieberman et al., 2006; Persson et al., 2015).

Employees debated the feasibility of creating one website that caters to all user needs, highlighting challenges in combining search engine optimization, design, and accessibility. Moreover, non-universal design approaches open discussions of ethics and privacy that further complicate the interplay between all these factors (Gooding, 2023). In the focus group, the notion of universal design versus personal customization approaches was discussed. While the accessibility specialist supported universal design, others contemplated whether customizable options might be more effective. Concerns were raised about individuals who might struggle to find or utilize customization options. However, the idea of a global public infrastructure allowing users to adapt websites based on individual settings was cited as a potential solution. The ongoing debate between universal design and customizable options reflected a company-wide search for an approach that balances compliance with user inclusivity.

There is no clear understanding of one ideal design approach, as all approaches raise some issues. In theory, allowing the users to make personal customizations, or enabling the websites to adapt to the users' needs automatically, seems promising. However, as the employees pointed out, a basic amount of accessibility needs to be given for all users to be able to access these options and use the website even if they decide to not make customizations. Moreover, users should never be forced to give away private information on their medical conditions or requirements when using digital services (Gooding, 2023). Thus, while resolving restrictive design issues, implementing customizable websites might lead to some extra workload, unless a global public infrastructure can be used to unify the technical implementation of websites in the European Union.

The employees pointed out that they are bound to legal requirements and hence have little space to try out whether customizable approaches would lead to the inclusion of more user groups. Similarly, there is little research on customizable web design options, as approaches such as ability-based design (see Chapter 2.2.2) and end-user development (see Chapter 2.2.3) have had little practical application and have been rarely replicated. Thus, it remains to be seen whether these approaches can actually solve the challenges in catering to all user and stakeholder needs.

Finally, the query for the most efficient and inclusive design approach cannot be answered. All design approaches presented in this thesis offer interesting viewpoints and might in combination be able to create more inclusive web applications. For now, however, all companies in Europe will have to adhere to legal requirements and thus mostly follow universal design approaches. Yet, there is a great need for discussions on other ways to ensure digital inclusivity while making use of digital infrastructure and adaptivity.

# 6 Discussion

This master's thesis aimed to shed light on how web design companies deal with the European Accessibility Act, which will come into force in 2025. Universal design, as required by the EAA, was critically examined in this context, as it does not always meet all the requirements of the various user groups. Accordingly, different design approaches were proposed as alternatives to universal design and their practical implementation was discussed.

First, a detailed literature research on web accessibility, existing design approaches, tools and guidelines as well as legal requirements was carried out. Then, interviews were conducted with eight employees of a web design company. In a focus group, the results of the interviews were discussed and deepened concerning alternative design approaches and future perspectives. Finally, suggestions for future implementation of web accessibility were evaluated based on current workflows, structures and challenges.

The literature shows that so far there is no common consensus on how to implement digital accessibility. Although there are many different design approaches, the most common resources are based on the idea of universal design. Accordingly, when designing digital content, a solution should be found that includes all user groups in one offer. Unfortunately, a solution that truly includes all users has been lacking up to now. Studies show that guidelines designed to support compliance with legal requirements often neglect user groups, for instance people with cognitive impairments. Furthermore, constant changes in the digital infrastructure as well as the legal situation mean that implemented content must be continuously checked about its barrier-free functionality. Especially the involved long-term costs lead to a negative attitude towards the topic in web design companies. In addition, many universal design requirements are accompanied by a restriction of visual design elements. Because of these challenges, the interviews highlighted a perplexity as to how the universal design approach should be implemented without ignoring some needs and requirements of both stakeholders and users.

The literature offers a solution for different requirements: adaptiveness, meaning web infrastructure that enables users to either manually or automatically adapt the content of a website based on their own needs. There are different approaches to this, such as ability-based design or end-user development. In the focus group, different design approaches were discussed. The interviewees agreed that universal design approaches

make it nearly impossible to consider all user needs. However, it was brought up that current accessibility laws require one solution for everyone to prevent further exclusion. Thus, the understanding of accessibility differs between different design approaches, legislation, and individual opinions. There should be an agreement on how accessibility can be best implemented in the digital realm, making use of the digital infrastructure that allows for adaptiveness which for instance barrier-free architecture cannot provide.

Due to the recent nature of the European Accessibility Act, there is little literature on the consequences and implications of it yet. The interview results suggest that it will lead to an increased workload for all companies that have a website and are legally required to adhere to the EAA, especially for web design companies. Moreover, organizations such as the Institute for Barrier-free Information Technology will be faced with more inquiries, thus needing more resources and support to cope with the upcoming requests.

The findings from current research as well as the case study showed a lack of studies on web design implementations that are not based on universal design and guidelines such as the WCAG. Thus, it is difficult to evaluate the impact other design approaches such as ability-based design or end-user development might have on organizational structures and the inclusion of all user groups. However, it became clear that merely adhering to already established guidelines and principles is not sufficient to implement fully accessible web design. Rather, it is highly relevant to deal with target groups. Designers and developers accordingly need an understanding of the usage patterns and requirements of the users to be able to adapt the individual web content to them. The users should furthermore be involved in the evaluation process, since analysis tools cannot detect all existing barriers. However, target group analyses and the explicit consideration of these in existing workflows are rarely integrated due to a lack of resources. The current legislation is bound to the universal design approach, requiring one solution for all users, which often does not seem possible as seen in both research and interviews. Therefore, fewer resources are put into offering individual adaptations to users, which further complicates the consideration of different target groups.

This thesis was limited to a small and specific research field: only eight employees were interviewed, four additional employees were part of the focus group, and the company that was the subject of this thesis, already has above-average knowledge on the topic due to past commissions. It should thus be treated as a small pre-study and needs to be repeated with larger numbers of participants. Moreover, the interviews and focus group were conducted in German which can lead to a loss of meaning during translation. Due to illnesses and home office contracts a hybrid format for the interviews was chosen that

in turn led to internet connection issues, and consequently the interruption and rescheduling of an interview. Also, in planning the focus group, the interviewer was unable to coordinate which employees would participate until the day it happened due to employee illnesses, vacations or other appointments. Moreover, employee changes happened while this study was conducted, thus leading to employees partaking in the focus group that had not been interviewed despite their relevance to web accessibility and vice versa.

In terms of research methodology, no linear research approach was followed due to unforeseen results in the interviews. While the first consideration was to conduct a complete design case study, developing a tool to support the company in its implementation of web accessibility, the interviews showed that external factors and target group conflicts are far more crucial. Moreover, doubts about the implementation of universal design were repeatedly brought up. This resulted in a focus shift, emphasizing the dilemma between different design approaches. Consequently, instead of designing a technical artifact, a fifth research question was formulated and a focus group was conducted to examine the topic in more depth. Due to this focus shift, iterative changes to the research goal were made, which should be critically considered.

This thesis serves as a first assessment of how web design companies can react to and implement upcoming legal changes. In addition, it provides suggestions for questioning current objectives and perspectives of accessible design. Thus, some of the existing gaps in the research could be closed. While this thesis does not answer the questions posed with certainty due to its limited research field, it provides starting points that can be used for further research.

Firstly, the combination of end-user development and accessible design seems promising and should be looked at in more detail. Moreover, a complete design case study on implementing accessibility in a web design company would be conceivable. The development of technical tools to create and test legally compliant websites would offer a great research opportunity. Since most tools are based on universal design approaches, the development of tools that support adaptation and automation of accessible web structures would be especially beneficial. Further qualitative interviews or observation studies in web design companies to further concretize the problem statements and compare existing workflows could also prove educational. Since the web design firm examined in this study already had very specific knowledge in the field of accessibility through past commissions and even won a web accessibility award, it would be particularly interesting to look at the workflows of a less experienced company.

This thesis hopes to draw attention to shortcomings in web accessibility, close research gaps, and offer a practical view on implementing accessibility to curb the fear of the topic, especially in a company context. The topic of web accessibility still needs more attention and detailed discussions to ensure that the legal requirements are both realistic to implement as well as include all users. Thus, it needs qualified experts and financial means to advance the realization of accessible web infrastructure. This thesis hopes to inspire the discussion of agreeing on one accessibility design approach, that is inclusive to all user groups as well as feasible to implement. Digital web infrastructure differs from other universal design sectors such as architecture due to its adaptivity. Therefore, digital accessibility should make use of these functions to properly cater to all user groups. One suggestion based on the findings of this thesis would be to create an infrastructure that offers the basic amount of accessibility as suggested by WCAG guidelines and additionally allows the user to make individual customizations based on preference and abilities. By allowing individual customizations, web companies would evade the conflict of having to target all user needs at once and have more freedom in visual elements. Moreover, an agreement on using the same web infrastructure would allow the users to save their settings and preferences. This would also eliminate the challenge of plugins and technical infrastructure no longer being updated and thus not fulfilling current accessibility requirements.

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