



Current Challenges and Barriers in Sustainable Web Design: A Qualitative Study

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ABSTRACT

Sustainable web design plays a crucial role in mitigating the environmental impact of websites and digital services. However, there is still a long way to go in implementing sustainable web design practices. To understand current challenges and barriers in sustainable web design, we conducted a qualitative study gathering data from 27 participants, including practitioners, prospective practitioners, and academia in Norway. Our analysis revealed that a lack of knowledge and understanding of sustainable web design is the most frequently reported challenge. Participants expressed a need for more information and specific guidelines on how to implement sustainable practices. Other challenges included a lack of prioritization among customers, a lack of motivation, comprehension difficulties, and a lack of syllabi in academia. The majority of participants ranked sustainability as their lowest priority, with accessibility taking the top spot due to current regulations in Norway. However, similar challenges were reported in implementing web accessibility, where participants expressed dissatisfaction with the guidelines.

CCS CONCEPTS

• **Information systems** → **World Wide Web**; • **Human-centered computing** → *Accessibility*.

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Sustainable Web Design, Climate Change, Environmental Impact, Sustainability Challenges and Barriers, Web Accessibility, Digital Carbon Footprint

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1 INTRODUCTION

Although everyday online activities may seem harmless, they all contribute to the alarming rate of CO₂ emissions the Internet produces. The main contributors to internet-related CO₂ emissions are data centers, network infrastructure, Internet traffic, user devices, cloud computing, and content distribution [2]. For instance, sending a standard email emits around four grams of CO₂e [4], while one hour of video streaming emits approximately 100 grams of CO₂e [24]. Other examples of online activities, like cryptocurrency transactions [22], and search engine queries [2], also significantly contribute to emissions, further adding to the Internet's carbon footprint. The energy required to keep up with the exponential growth of the Internet has led it to become a leading contributor to the climate crisis and environmental pollution [26]. As communication technologies continue to rise, global electricity usage from these technologies is projected to increase dramatically, from 4% in 2020 to 14% by 2040 [23]. The magnitude of this energy consumption, primarily fueled by fossil fuels [2] is substantial enough that, if the data centers that make up the Internet were a country, it would rank as the sixth most polluting in the world, on par with Germany [11, 19]. In fact, current development trends suggest that by 2025, the Internet's environmental impact will worsen, and it is projected to climb even further on the list, essentially becoming the 4th most polluting country [23].

Efforts to reduce carbon emissions and achieve net zero by 2050 have been made since the Paris Agreement of 2015 [29]. Still, little focus has been placed on the environmental impact of digital technologies, despite their significant carbon footprint [31]. It is crucial to address the environmental impact of digital technologies to ensure a sustainable digital future and achieve the goals of the Paris Agreement. Sustainable web design, defined as an approach that prioritizes reducing carbon emissions and energy consumption [11], is web developers' way of contributing towards this goal.

Creating a sustainable solution requires embracing sustainability at every step of the development process. Awareness of stakeholders, including practitioners, managers, governments, and customers, is essential in sustainable web design [12]. Previous research [13] found that stakeholders within web design seem to be aware of some sustainable practices for the web; however, they are not practicing them. Similar research on awareness within the software industry has been conducted, with one study [20] stating that software practitioners have limited knowledge and implementation of green and sustainable practices, while another [3] highlighted that practitioners were aware of sustainable practices and were successfully practicing them.

To create a truly sustainable product, it must be desired, designed, and developed with sustainability in mind by each of the stakeholders. Practitioners need to understand the impact of their decisions on the environment and society. At the same time, managers and business owners can promote sustainability initiatives and encourage employees and customers to adopt sustainable practices. Despite being aware, developers and industry seem reluctant to embrace sustainable development [13]. By collaborating and prioritizing sustainability, all stakeholders can work towards creating a more environmentally responsible digital ecosystem.

Although sustainable web design is a newer and less established area compared to web accessibility, there is an opportunity to establish it as a recognized and regulated component of web development. Regulations within accessibility have previously been shown to positively impact the compliance of the guidelines [15]. These regulations regarding web accessibility are prevalent in numerous countries. Norway, for instance, has had such rules in place since 2013 [18]. Despite the existence of these regulations, several challenges persist in the implementation of web accessibility practices during the development process. One example is the considerable number of Norwegian municipality websites that have been evaluated yet to achieve complete accessibility [16]. Some of the challenges within web accessibility are setting and following standards and guidelines during design and development, raising user awareness and motivation through training, and conducting evaluations through both automated tools and user testing [1]. It is important to understand challenges within web accessibility to help us to understand potential challenges and solutions for creating a sustainable web.

To the best of our knowledge, the only study on challenges in sustainable development is by [12], where the authors discuss various definitions of sustainability, including those related to the environment, even though their primary focus is on economic sustainability. In an effort to expand knowledge in the field of sustainable design, this paper builds upon previous research on web developers' awareness and practices toward sustainable web

design [13]. To this end, we conducted interviews with practitioners, prospective practitioners, and academia to reveal the challenges and barriers that all stakeholders in web design must overcome in implementing sustainable web design. This paper contributes to the emerging field of sustainable web design by clearly defining some of the challenges web developers face when creating sustainable solutions and exploring how to overcome these challenges.

2 METHODS

A series of semi-structured interviews were carried out from February to March 2023. The participants were all from Norway and connected to design and development. The participants included practitioners, prospective practitioners, and academia. Interview data were analyzed for patterns and themes by the researchers. Thematic analysis [5] was employed to interpret the qualitative data.

Interviews were conducted with 27 participants categorized into three groups: practitioners (n=14), prospective practitioners (n=8), and academia (n=5). Altogether, there were 15 male and 12 female participants. A total of eight were in the age group of 18 to 24, ten between 25 to 34, and nine above 35 years old. Work experience distribution was fairly evenly split between those with less than five years (n=14) and those with over five years (n=13) of experience. In terms of roles, the participants identified as developers (n=19) and designers (n=8).

We developed two semi-structured interview guidelines. One for the practitioners and prospective practitioners and another for academia with different universities represented. Our two interview guidelines aimed to identify and understand challenges within sustainable web design without emphasizing any specific challenges. The interview guideline for practitioners and prospective practitioners consisted of four parts containing 32 questions. The first part asked about the participant's demographic information. The second part delved into the development process of the participant's current project, including team organization, development methodologies, and decision-making processes. In the third part, we inquired about the participant's familiarity with accessibility concerns and the Web Content Accessibility Guidelines (WCAG). This was done because of the strong link between digital accessibility and sustainability [6], and for us to learn about existing practices and potential issues regarding existing web design guidelines. The fourth part focused on sustainable web design, with questions about the participant's understanding of sustainability in web design and their company or study program's focus on sustainability.

The interview guideline for academia consisted of ten questions. They were asked about how sustainability is currently integrated into the curriculum, methods of promoting sustainability among students for application in society and working life, academic content and challenges related to sustainability, and plans for including more sustainability in the future. Additionally, there were questions about how the curriculum addresses accessibility.

Online and in-person interviews were conducted with one participant and two researchers at a time. Semi-structured interviews were employed because of their flexibility, in-depth exploration, and ability to gain a comprehensive understanding of participants' perspectives [7]. Before conducting each interview, the participants

received information about the study and gave written consent. The average interview time was 35 minutes. During these sessions, one researcher led the discussion while the other took notes. Directly after each interview, both researchers reviewed and cross-checked the notes. For analysis, we organized each question and its respective answers into columns in a spreadsheet. We then utilized a combined approach of thematic analysis and card sorting [27] to reveal the participants' challenges of sustainable web design. Thematic analysis was used to identify patterns and themes in the textual data summarized in the spreadsheet. These themes were then used to create a set of cards representing the different challenges of sustainable web design. Card sorting was then used to classify and prioritize these challenges based on their perceived importance within the development process, accessibility, and sustainability.

3 RESULTS

Thematic analysis and card sorting of interview data identified significant barriers to sustainable web design practices, including knowledge gaps, customer-oriented prioritizing, lack of industry motivation, and comprehension challenges.

3.1 Knowledge Gap

The most frequently encountered challenge among the participants was the knowledge gap. When asked what the participants needed to consider sustainable web design, all practitioners (P.) and prospective practitioners (P.P.) answered either lack of information, knowledge, or guidelines as significant challenges to implementing sustainable design practices. One participant expressed this as "We don't know enough to be sure of how to implement it as part of our solutions, so I crave more knowledge" (P.), and another said, "I would need more information because there are not many resources about it" (P.P.). A group of participants (n=6) emphasized the importance of clear and structured guidelines for sustainable web design, with one participant having stated that "Structured and readable guidelines like WCAG would be helpful" (P.P.). To effectively convey the guidelines, a participant suggested, "A website with information such as encyclopedias, where you can find guidelines explained in a simple way would be a step in the right direction" (P.P.). The industry also seemed to be on board with this idea, where a participant expressed that "A guideline could help to make it easier for my company to start implementing sustainable design" (P.).

3.2 Customer-Oriented Prioritization

According to the practitioners, sustainable practices are often not prioritized in their development processes due to customer attitudes and priorities. Most practitioners (n=10) reported that they need to follow the requirements set by customers, which caused problems for some practitioners interested in advocating sustainable web design. One participant stated that "Whenever I try to advocate sustainable design for a project, I always face resistance from the customer" (P.). Others noted that customers might not be aware of or interested in sustainable design and its benefits. Instead, they focus on existing laws and regulations for the universal design of ICT solutions. In an exercise to prioritize categories in their organization's development processes, practitioners were asked to rank

six categories in order of importance. The average results showed that accessibility was ranked as the most crucial category, followed by code maintainability, scalability, code efficiency, Search Engine Optimization (SEO), and sustainability, which ranked last. Several practitioners recognized the importance of educating customers on the benefits of sustainable design to increase their awareness and encourage them to prioritize sustainability higher.

3.3 Lack of Motivation in the Industry

Most participants (n=21) expressed an interest in implementing sustainability in their projects. However, these participants found it difficult to convince their colleagues of sustainable web design's importance and impact. One participant explained that sustainability-related tasks are "Swept under the carpet and placed at the bottom of the backlog" (P.). In addition to identifying inexperience with digital sustainability among team members as a core barrier to open-mindedness, the participant noted that their programming choices seemed to be made without awareness of their potential effects. Notably, participants in our study reported prioritizing accessibility as their top concern, citing regulatory requirements as a significant motivator. Sustainability ranked second to last for six participants and last for seven participants, with one participant not including it in their list of priorities. This indicates that over 63% of the participants did not give priority to sustainability in their decision-making process. In order to gain insight into the motivations that drive practitioners to produce sustainable products, we examined their top priority: accessibility. Here the participants work extensively with WCAG. Therefore, we asked the practitioners (n=14) why they followed these guidelines. While regulations and fines were reported as the primary motivator by most participants (n=10), many (n=9) also acknowledged the benefits of designing for everyone. One participant stated, "First and foremost, it is regulated by law and very important for us to be able to reach out to everyone. (...) We wish for anyone to be able to use what we create" (P.).

3.4 Comprehension Challenge

When asked to describe sustainability within the context of development, the majority of participants demonstrated some level of familiarity with sustainable development methods. However, a limited understanding of sustainability within web development was apparent, where only four participants demonstrated knowledge of how the Internet affects the environment, including carbon footprint and CO2 emissions. To address this challenge, participants were asked to identify necessary measures for implementing sustainability in the development process. Of the 22 practitioners (P.) and prospective practitioners (P.P.), over half (n=14) suggested that a guideline or informative resource would be beneficial for improving sustainability, with some participants citing WCAG as a similar alternative. This underscores the importance of implementing a guideline or informative resource to improve sustainable development in the future. To better understand how existing web guidelines are utilized and the possible difficulties encountered in doing so, we asked them about how they relate to working with current web accessibility guidelines. The responses reflected a common theme that, while accessibility guidelines exist, they can be difficult and tedious to use, leading to frustration and demotivation among

practitioners. One participant likened the experience to "reading Norwegian law" (P.). Over half of the participants (n=15) reported using tools or simplifications instead of the official WCAG website due to its low legibility and difficulty in navigating.

3.5 Lack of Sustainability in Academia

Regarding sustainability within the educational context, prospective practitioners and academia (A.) answered there is room for improvement regarding how sustainability is integrated into university curricula. A participant from academia reported that they are improving their curriculum and increasing their focus on sustainable development. However, sustainable web design is indirectly introduced to students as "code efficiency" or "web design methodology", not as a curriculum specifically promoting sustainability. This is confirmed by the prospective practitioners, where most of them (n=6) could define specific sustainable measures but lacked an understanding of the overall concept of sustainability. Several interviewees shared similar views, such as the comment made by one participant that "(...) It is not a lot. We had some about accessibility, which we might relate to sustainability. We also had UN's sustainability goals but did not have any subject that specifically covers sustainability" (P.P.). This may indicate that universities need to do more to prioritize and integrate sustainability into their courses to better prepare students for the challenges of a rapidly changing world, resulting in a new generation of developers with a better understanding and knowledge of the environmental impact of the development industry.

4 DISCUSSION AND CONCLUSION

The purpose of this study was to identify and analyze the challenges and barriers that exist in sustainable web design. The knowledge gap challenge was revealed as the most frequently encountered challenge among the participants, which refers to the lack of information, knowledge, and guidelines on sustainable design practices experienced by practitioners and prospective practitioners. Overcoming this challenge is key to equipping stakeholders with the necessary knowledge and skills to prioritize sustainability in their work. This, in turn, enables them to implement sustainable solutions and contribute to a more sustainable web environment. The knowledge gap could potentially impact the implementation of sustainable development practices, as supported by a study [8], which found that practitioners generally understood sustainability but lacked specific knowledge of sustainable software engineering. A case study by [10], found that providing clear instructions, such as a guideline, could be a way to lower the application barriers of sustainability within software engineering. To address this challenge, we propose developing easy-to-use guidelines that provide the industry with the necessary information to create sustainable solutions. Such guidelines have already proven to positively impact other areas of web design, such as web accessibility. For instance, research [25] has demonstrated that high compliance with WCAG has numerous benefits. Therefore, establishing web sustainability guidelines could yield similar benefits, lowering the barriers to implementing sustainability in web design.

The majority of participants showed familiarity with sustainable development methods in the context of development, aligning with

previous studies [3, 13]. However, our study revealed a limited understanding of sustainability in web development. To address the comprehension challenge, implementing standardized guidelines for sustainable design could be beneficial. Still, it is important to note that guidelines alone may not guarantee resolution, as seen with WCAG. Our study uncovered a significant challenge to achieving web accessibility: the comprehension challenge faced by the participants when attempting to understand existing web accessibility guidelines. Participants reported that the guidelines were tedious and difficult to implement, in line with previous research by [28] and [21]. While guidelines can serve as a starting point, they should be supplemented by other actions, such as awareness-raising campaigns, training programs, and legal regulations. A combined top-down and bottom-up approach, as proposed for web accessibility [17], may enhance guideline effectiveness and promote a deeper understanding and implementation of sustainable design practices.

Another challenge of incorporating sustainable practices in web design is the lack of customer prioritization and motivation within the industry. Low customer prioritization can be attributed to a lack of awareness and knowledge, leading to a prioritization of customer-oriented requirements over sustainable practices in development. Furthermore, some customers may view sustainability as an additional expense rather than a cost-saving measure, despite its potential to reduce energy consumption and save money, in the long run [9, 11]. Earlier research has identified time constraints, lack of training, and cost constraints as the main barriers to prioritizing web accessibility [14]. Our interviews revealed a different trend, where it became evident that accessibility was given the highest priority, while sustainability was found to be the least prioritized area. A potential solution to increase prioritization and motivation is to enforce sustainable web design guidelines through legal regulations, similar to how accessibility guidelines are enforced in some countries, which has significantly increased accessibility in the industry [14]. This would give practitioners a stronger case to convince their colleagues and customers about the importance of sustainability and help promote sustainable practices in web development by increasing the motivation within the industry to accomplish sustainable solutions.

The lack of digital sustainability content in academia, except for the UN's goals, and insufficient coverage in student education implies a poor understanding of sustainability among students. Academia should integrate more digital design content into their courses and provide practitioners with the necessary knowledge and skills to implement sustainable design practices to prepare the next generation of web designers and developers to prioritize sustainability in their work [30]. Introducing guidelines to prospective practitioners would ensure their ability to implement sustainable web design practices throughout their careers.

Sustainable web design combined with web accessibility practices promotes justice and equality for everyone, regardless of ability or Internet access. Therefore, developing accessible and user-friendly guidelines that promote sustainable web design practices for all stakeholders involved in the web design process is imperative. Through collaborative efforts and a commitment to sustainability, we can create a web environment that is both inclusive and sustainable for current and future generations.

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