From Automation to User Empowerment: Investigating the Role of a Semi-automatic Tool in Social Media Accessibility

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This article focuses on evaluating SONAAR (Social Networks Accessible Authoring), a tool that combines automation and end-user empowerment to enhance the accessibility of social media content. SONAAR aims to increase user engagement in creating accessible content and expanding the availability of accessible media online. Additionally, SONAAR provides supplementary information to support the authoring of accessible media content. To assess SONAAR's effectiveness, we conducted three distinct studies. First, we analyzed user patterns and behaviors through log analysis. Next, we evaluated the clarity, helpfulness, and efficiency of the additional documentation and its potential to improve engagement in accessible practices. Finally, we explored user perceptions and challenges when interacting with SONAAR. The obtained findings indicate positive user feedback and provide valuable insights for improvement. These results underscore the importance of raising awareness and offering support for accessible practices, as well as the necessity for enhanced platform backing. Our study contributes to advancing accessible content authoring, promoting inclusivity and accessibility in online social media. We suggest future research directions to facilitate broader adoption of accessible practices and address user engagement challenges, ultimately enhancing the accessibility of social media content.

CCS Concepts: • **Human-centered computing** → **Accessibility;** • **Information systems** → **Social networks**;

Additional Key Words and Phrases: Accessibility, social media, visual content, user-generated content, artificial intelligence

ACM Reference Format:
Letícia Seixas Pereira, João Guerreiro, André Rodrigues, Tiago Guerreiro, and Carlos Duarte. 2024. From Automation to User Empowerment: Investigating the Role of a Semi-automatic Tool in Social Media Accessibility. *ACM Trans. Access. Comput.* 17, 3, Article 13 (September 2024), 25 pages. https://doi.org/10.1145/3647643

This work was supported by the European Commission through project SONAAR (grant agreement LC-01409741), and by FCT through the LASIGE Research Unit, ref. UIDB/00408/2020 (https://doi.org/10.54499/UIDB/00408/2020) and ref. UIDP/00408/2020 (https://doi.org/10.54499/UIDP/00408/2020) and the Scientific Employment Stimulus – Institutional Call – CEECINST/00032/2018/CP1523/CT0003 (https://doi.org/10.54499/CEECINST/00032/2018/CP1523/CT0003).
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ACM 1936-7228/2024/09-ART13
https://doi.org/10.1145/3647643

1 INTRODUCTION

Social media platforms have become dynamic spaces for advocacy and community, especially for individuals with disabilities. However, their potential for true inclusivity is often hindered by persistent accessibility challenges that limit the full participation of users with disabilities [12, 32, 35].

The complexity of social media, characterized by its extensive user-generated content, demands a comprehensive approach to accessibility that goes beyond the platforms merely providing accessible native content. In addition to making content accessible, these platforms must also actively support and ensure that users generate content that is accessible. Although major social networks have introduced features like automatic textual alternatives to enhance accessibility, these improvements have not yielded satisfactory results. Blind and visually impaired users still face significant barriers when attempting to access visual content [6, 11, 18, 22, 35], underscoring the need for a more robust approach to promoting and ensuring the creation of accessible content by users themselves.

Our initial exploration of this context, presented at the 2022 ACM SIGACCESS Conference on Computers and Accessibility (ASSETS'22) [25], sought to further investigate the barriers and opportunities for accessible media content on social networks. We identified that, despite a strong interest from sighted users in participating in accessible content creation, there is a clear lack of guidance and support from the major platforms to facilitate this process. Many people are either unaware of the existence of current accessibility features or, even if they are aware, lack clarity on how to effectively utilize them. This initial study suggested that a hybrid approach could help bridge this gap by combining the capabilities of automatic image recognition and machine-generated descriptions to empower and guide users in providing alternative text with sufficient context and personal intent for their media content.

In response to these findings, we developed SONAAR (Social Networks Accessible Authoring) [9], presented at the 2021 ACM Web Science Conference (WebSci'21). SONAAR is a tool designed to assist users in creating accessible content on social media. By integrating manual and automated methods, SONAAR offers a user-friendly authoring process for creating accessible content, enhancing the overall experience for both content creators and consumers.

This article represents then an expanded version of a paper originally presented at ASSETS'22 [25] and presents the results of a new study conducted to evaluate the proposed approaches of SONAAR. The primary aim of this research was to explore the potential benefits of employing a semi-automatic approach that combines automatic techniques with user empowerment. The final goal was to improve the accessibility of online media content and increase its availability to all users, including those with visual impairments.

The structure of this article is as follows: Section 2 provides a comprehensive background on media accessibility, incorporating relevant prior research in the field. It explores key topics crucial to our research, such as media accessibility on social networks and existing tools for enhancing media accessibility. Section 3 offers a summary of Study 1, initially presented at ASSETS'22. Building upon this, Section 4 briefly introduces the SONAAR prototypes, initially presented at WebSci'21. Section 5 outlines the new study conducted to evaluate SONAAR and discusses how such an approach can enhance the authoring and consumption of media accessibility. Section 6 presents conclusions drawn from this study. Finally, in Section 7, we outline the limitations encountered during our research and discuss potential future directions for improving the availability of accessible media content online.

2 RELATED WORK

Our research is related to prior work on (1) media accessibility on social networks, (2) using tools to enhance media accessibility.

2.1 Media Accessibility on Social Networks

Social networking services such as Facebook and Twitter have gained popularity among blind users, despite the increasing presence of multimedia content that poses accessibility challenges [5, 36]. To address this issue, various efforts have been made, including user-initiated alternative descriptions for images on Twitter [30]. Although Twitter made this feature default in 2020 [31], its impact remains unassessed. In contrast, Facebook employs automatic descriptions generated through image recognition algorithms, allowing users to edit them [10]. Despite these initiatives, recent studies indicate that blind and visually impaired users still face significant difficulties in accessing visual content [11, 18, 22, 35].

Gleason et al. [11] found that a small percentage of images on Twitter had alternative text, even when the feature was enabled. Currently, visually impaired users rely on workarounds or assistance from sighted individuals for photo-related activities [2, 19, 32, 36]. Previous research also indicated that friends and family members of visually impaired users often engage in accessible practices [19], and user motivations for providing alternative descriptions include personal connections to disabilities and inclusion [11, 26].

The complexity of addressing the accessibility of online media content has been a long-standing challenge. Established guidelines from WebAIM [34], W3C WAI [33], and the DIAGRAM Center [7] offer valuable insights, yet their reach to everyday social network users is limited. Furthermore, the emergence of unique media types such as GIFs and memes in these platforms presents new challenges not fully covered by current guidelines, further complicating accessibility efforts.

In this new social media landscape, it is important to acknowledge that media creators are often the users themselves, not just technically skilled developers. Therefore, new approaches must consider this user-centric perspective, while also addressing this dynamic nature, as well as new types of content [14], and identity factors [23] that characterize social networks. This shift towards a more user-driven content creation process underscores the importance of design elements in user interaction, as discussed in Bellscheidt et al. [1]. They draw attention to how these design elements critically shape the production of alt text by social network users, signaling a shift towards more responsible user behavior. As such, current strategies are evolving to encompass a variety of methods: from direct human input and automated solutions to hybrid models that combine the strengths of both approaches [28].

Incorporating human participation generally yields more precise and high-quality descriptions. This can be achieved through crowdsourcing, which is effective but often results in higher expenses and longer wait times. Alternatively, Friendsourcing where people request alternative descriptions from friends, is usually deemed higher in quality and more trustworthy, as well as being less costly [5]. However, involving friends can create social tension, as users may hesitate to reveal their challenges.

From a speed and cost-efficiency standpoint, automated solutions present an attractive option. These methods have the benefit of scalability [8, 17]. However, this comes at the cost of decreased accuracy in the descriptions provided, despite advancements in automated captioning technology. One significant downside is that users, particularly those who are blind or visually impaired, may make choices based on incorrect information due to this inaccuracy [18, 27]. In the context of social media, the effectiveness of automated methods is also limited due to the diverse range of personal photos [27].

Last, hybrid methods aim to combine the high-quality descriptions generated by humans with the cost and time efficiency of automated systems. These integrated approaches seek to optimize the advantages of both human and automated methods [16, 17, 21, 27].

2.2 Using Tools to Enhance Media Accessibility

Previous literature has explored approaches to enhance the accessibility of media content through automated tools that combine various techniques. WebInSight [4], for instance, was the pioneering system to automatically generate alternative text for web images and dynamically add it to web pages. The system retrieves existing alternative text from its database and calculates alternative text for images not yet stored. While many images can be handled by this automated process, WebInSight also allows image submission to human labelling services. The authors raise concerns regarding reliance on private companies for human labelling and the potential impact of incorrect alternative text.

Social Accessibility [29] and VizWiz [3] tackle this issue through a collaborative approach. Social Accessibility harnesses collaborative efforts for authoring accessibility metadata, while VizWiz leverages real people to answer questions in near real-time, offering an alternative for addressing visual queries. Salisbury et al. [27] focus on human-in-the-loop workflows that incorporate different levels of automation and human involvement, specifically within the context of alt text on social media. The authors conclude that this approach is particularly valuable, as it facilitates real-time crowdsourcing to quickly address unanswered questions and enables the reuse of answers for similar inquiries.

Wu et al. introduce Automatic Alt-Text [37], a system that employs computer vision technology to generate photo alt-text for screen reader users on Facebook. This system stands out as the first real-time, large-scale, machine-generated image-to-text description system integrated into a popular social networking site. The authors highlight the challenges inherent in this context, particularly in striking a balance between descriptive quality and algorithmic accuracy. They also address the concept of agency, as the AI system acts on behalf of photo owners to provide image descriptions for blind individuals. Training algorithms to accurately interpret identity, emotion, and appearance poses further difficulties, as they require more detailed personal data, raising privacy concerns that add complexity to the discussion.

While not specifically focused on social media, Caption Crawler [16] makes a significant contribution to media accessibility. Guinness et al. develop a system that employs reverse image search to locate existing captions on the internet, enabling users to browse websites while dynamically loading relevant image captions from other web pages featuring the same image in the background. Users can access a caption queue to retrieve additional details from various retrieved captions associated with an image. While this approach proves advantageous for widely used images across multiple web locations, it may face limitations when dealing with unique images that are not extensively hosted, such as personal photos. In such cases, the system's performance may be hindered due to the scarcity of available captions.

Finally, Twitter A11y [15, 17] incorporates multiple strategies to enhance media accessibility on the platform. By employing a hybrid approach, the system follows a sequence of methods when encountering images without alt text, including URL Following, Text Recognition, Tweet Matching, Scene Description, Caption Crawler, and Crowdsourcing. By incorporating a diverse range of techniques, there is a higher likelihood of providing alt text for images. However, the authors stress the importance of carefully selecting and prioritizing these techniques, considering factors such as quality, response time, and financial cost.

In conclusion, despite these advancements on automated solutions, it is evident that human-generated descriptions offer superior quality, particularly in the context of social media and personal photos. Furthermore, it is widely recognized that the primary challenge in accessibility is awareness. Therefore, our approach aims to leverage some of the techniques provided in the literature to not only enhance the accessibility of media content but also encourage and motivate content creators to publish accessible media right from the beginning.

3 EXPLORING CURRENT ACCESSIBLE AUTHORING PRACTICES

This first study aimed to explore the current context of the accessibility of visual content in social networks. We further analyzed the factors hindering the creation of accessible content by end-users, considering people with and without a visual impairment, on major social media platforms. Furthermore, we also aimed to uncover what does or can motivate people to create accessible content. For this study, we set the following research questions:

- —RQ1: What are the motivations for social network users to create accessible media content?
- —RQ2: Which barriers social network users encounter to share and author accessible media content?
- —RQ3: What are the requirements for social network users to create accessible media content?

To gain a comprehensive understanding of the barriers faced by end-users in authoring accessible media content and to explore the motivational factors driving their engagement, this study was divided into two distinct phases. We first conducted an online survey, followed by in-depth user interviews, as detailed in the following sections.

Please note that this article presents a summary version of the study, and for more in-depth information and additional details, we refer readers to the original paper [25]. In this article, we aim to present the most significant details of this first study, focusing on the discussion of the findings that provide the rationale for subsequent research.

3.1 Online Survey

To gather insights into social platform user behaviors, as well as the challenges and motivations behind generating accessible media content, an online survey was conducted. This survey, available in multiple languages, took approximately 15 minutes to complete. It consisted of three sections: demographics, social network usage, and social network accessibility practices. Pilot interviews were conducted with seven participants, including three blind individuals, to improve the survey design. Participants from diverse backgrounds, including accessibility practitioners and high school teachers, provided feedback on the questionnaire. The interviews lasted 30 to 40 minutes, and their responses were used to refine the questionnaire. The final questionnaire was distributed through social media channels and received 258 responses over a three-month period. Participants ranged in age from 17 to 73 years, with 25% reporting disabilities. Among them, 34 were blind, 12 had low vision, and 1 was colorblind. Participants were also given the opportunity to share additional insights and express willingness to be contacted for future research phases.

3.2 User Interviews

Initially, we conducted follow-up semi-structured interviews with 20 participants who had expressed their availability in the previous phase. All participants were frequent social network users according to the questionnaire. Among them, 7 were blind, and the remaining 13 were sighted users without disabilities. Half of the participants mentioned not frequently engaging in accessible practices. More detailed information about the participants can be found in the supplemental material.[1] Before the interviews, participants were asked to post accessible media content on their regular social networks. They were instructed to post at least three different media items and take notes on their activities, opinions, and challenges encountered during the process. Participants had a two-week period to complete these activities, integrating accessible practices into their routine.

[1] https://osf.io/anmd7/files/osfstorage/6495783f38091106a53c2bf6

After two weeks, the semi-structured interviews were conducted remotely via phone, Skype, or Zoom. The interviews lasted between 20 to 30 minutes and covered participants' experiences with accessible practices, motivations for creating accessible content, and suggestions for enhancing the process and promoting greater commitment to accessibility among end-users. All interviews were recorded with participants' consent.

3.3 Data Analysis

In the initial phase of our data analysis, we carried out a quantitative analysis of the responses to the questionnaire's closed-ended questions. A preliminary validation was carried out to ensure that all submitted responses were genuine and not arbitrary entries. Moreover, as the questionnaire allowed for optional participation in each question, all entries were considered valid for analysis. It should be noted that many of the questions permitted participants to select from multiple answers from a predefined list. Next, we generated transcripts for all interviews conducted and subjected them, along with the answers to open-ended questions, to an inductive coding approach [20]. In the initial round, a pair of researchers independently reviewed a sample of the dataset and formulated a preliminary set of codes. These codes were then cross-referenced, harmonized, and refined into a unified coding framework, encompassing a total of 150 individual codes. These were further classified into two tiers, comprising 21 primary codes and 129 sub-codes. Following this, we proceeded to apply this coding framework across the entirety of the dataset. For a comprehensive list of codes and sub-codes, a codebook is available online.[2]

3.4 Findings

In this section, we first present key findings identified through the quantitative analysis of the data gathered through the questionnaire. Next, we present the findings obtained from the qualitative analysis of the information gathered during the user interviews. This information was divided by the following topics: (1) accessibility unawareness, (2) lack of know-how, (3) the cost of the additional effort, (4) complying with and without guidelines or features, (5) inaccessibility, (6) and accessibility motivations and concerns.

3.4.1 Online Survey. We examined device access for social networks among both sighted and visually impaired participants. Both groups preferred mobile devices for accessing and posting on social networks. However, visually impaired participants showed a stronger preference for desktop or laptop devices, especially for posting activities.

In terms of social network usage, Facebook was the most popular platform, followed closely by Twitter. Notably, visually impaired participants used Instagram less (2%) compared to sighted participants (25%), who favored it as their main platform. For content posting, sighted participants preferred Instagram, followed by Facebook and Twitter, while visually impaired participants mainly used Facebook and Twitter. Other platforms such as LinkedIn, WhatsApp, and TikTok were mentioned by participants in both groups, but with lower levels of engagement.

Regarding the type of content posted, there were no significant differences in text, audio, and video content. However, sighted participants posted more visual-only content (5%) compared to visually impaired participants (2%). Visually impaired users face challenges on image-centric platforms like Instagram [2], which may explain their lower participation in visual content sharing. They also showed less interest in sharing GIFs and Memes, which aligns with accessibility issues related to these formats [13, 14, 26].

In terms of accessible practices, most visually impaired participants provided alternative descriptions for their media content, while most sighted participants did not. Among those who

[2] https://osf.io/anmd7/files/osfstorage/6255bd7a28f940063ca24876

provided alternative descriptions, 25% used the social network's functionality, and 23% integrated descriptions within the text of the post. Participants who did not provide alternative descriptions cited reasons such as unawareness of the option and uncertainty about where to include descriptions. We also identified a correlation between adopting accessible practices and awareness of disability needs.

Regarding why social network users in general do not provide alternative text descriptions, the most common belief was that others are unaware of this option, followed by the perception that it does not have a significant impact.

3.4.2 Interviews with Social Network Users. In this section, we present the main findings obtained during the interviews conducted with 20 social network users. We asked participants about their experience with accessible practices in social networks, further motivations for accessible content authoring, and potential suggestions or additional thoughts on how to improve this process.

Accessibility unawareness: Sighted participants generally lacked awareness about accessibility, especially concerning how blind people interact with visual content. Interviews revealed that this lack of knowledge hindered their understanding of the importance of making content accessible. Some participants only learned about the topic during the study, indicating a first level of unawareness. Others felt that creating accessible content was unnecessary, primarily because they did not personally know anyone with a disability. Such scenarios not only perpetuate existing stigmas but also contribute to neglecting accessibility, an issue especially noticeable on platforms like Instagram. Blind participants reported feeling excluded and emphasized that accessibility often is not a priority for many people. The absence of personal connections to people with disabilities, combined with a focus on broader reach, were identified as contributing factors to this neglect. Overall, the study underscores the need for increased awareness and the adoption of inclusive practices to meet the needs of all users.

Lack of know-how: Some participants reported learning to add alternative descriptions by seeing other users' examples, consistent with Gleason et al. [11]. However, sighted participants mainly did so because they were not aware of the platform's built-in accessibility features. The unclear platform design made it hard to know where to input these descriptions. Participants also struggled with knowing what a good alternative description should be and called for more guidance. They highlighted the need for making this a standard part of the posting process, suggesting mandatory fields. They also recommended features to suggest suitable descriptions and provide quality feedback, to better align with accessibility goals. Overall, the interviews emphasized the need to address know-how gaps, improve feature discoverability, and integrate accessibility into the posting process.

The cost of the additional effort: Time constraints were a common issue among participants when providing alternative image descriptions. Sighted participants noted that adding accessibility features disrupted their usual publishing routine, especially on social media where posts are often spontaneous. Describing complex images felt exhausting and time-consuming. Blind participants felt burdened by often having to advocate for accessible content, making them feel somewhat annoying to others. Current platform-provided alternatives were noted to lack enough context for visually impaired users, a point backed by prior studies [18, 21, 28, 32, 35, 38]. Participants highlighted the need for user involvement to add context and individual intent to human-generated descriptions.

Lack of standardization: Lack of standardization creates challenges for users trying to navigate accessibility features on different platforms. For instance, participants had to search extensively for Facebook's accessibility options, while Twitter's feature was easier to find but still not intuitive. Participants found Instagram's accessibility especially hard to discover. Variations across

platforms and interfaces further confuse users, echoing findings by Sacramento et al. [26]. Participants also felt that platforms should bear significant responsibility for making their services accessible, given their large user bases and the specific needs of those with disabilities. Interviewees also emphasized the role of individuals and legal frameworks in advancing digital accessibility. In summary, there is a strong demand for standardized, easy-to-use accessibility features and a call for commitment from both platforms and users for more inclusive practices.

Inaccessibility: The difficulty of using accessibility features on major platforms affects both sighted and blind users. Blind users often struggle to find and use these features, and platform updates make this even harder, as also highlighted by Voykinska et al. [32]. While many blind survey respondents said they post accessible content, interviews showed they mostly relied on help from sighted people, rather than platform tools. There is a clear demand for features that help them add their own image descriptions. This gap not only isolates blind users but also limits their social network engagement. The rise of new media such as GIFs and memes adds to their challenges. Many are unsure how to make such content. This misalignment between content variety and existing tools calls for better accessibility features, enabling visually impaired users to fully participate in social platforms.

Accessibility motivations & concerns: Participants who publish accessible content are often driven by personal disabilities or knowing someone with a disability. Sighted participants who do not typically share accessible content indicated they would be more inclined if they had a personal connection to someone with a disability. Those who do share accessible content do so because they believe it is the right thing, aiming to be inclusive and reach a broader audience. Platform features supporting accessibility were highlighted as essential for user engagement. However, some users find implementing accessibility challenging and may even be discouraged from trying. Some sighted participants saw accessibility features as hindering their experience, revealing a general lack of awareness. Embedding alternative text within posts was viewed by some as good but criticized by others for making posts lengthy. Concerns were also raised about slower loading and scrolling speeds due to extra accessibility information. Overall, the challenge lies in creating social platforms that are both dynamic and accessible, catering to the needs of all users.

3.5 Discussion

In what follows, we first discuss how these findings can be used to answer our research questions followed by further contributions provided by this work.

• RQ1: What are the motivations for social network users to create accessible media content?

Some participants mentioned only sharing media with a small circle of people, such as family and close friends. However, many also expressed interest in making the information they share on social media accessible to a wider audience. These participants emphasized that doing so **is the right thing to do**. Combined with the need to **promote inclusion** for individuals with disabilities, these factors can be seen as significant motivators.

We also observed that awareness was often linked to individuals who either have connections with people with disabilities or have encountered some form of accessibility approach. These participants were curious about understanding not only the general topic of accessibility but also specific details. For example, they were interested in how individuals with disabilities consume the content they produce.

Given this inclination towards inclusivity that we observed in the participants, we were able to outline strategies to increase people's motivation to engage in accessible practices. Increasing people's knowledge about the topic can be an effective strategy. **Involving end-users more**

closely in the process and **making accessibility features more prominent** could be effective strategies for motivating engagement. **Educating people** more broadly about how individuals with disabilities interact with technologies may also be beneficial. Providing real-world examples and practical tutorials can not only raise awareness but also keep people informed about why and how to engage in accessible practices. This aligns with data from previous studies [11, 26], which highlight the need for better tools and more training for social media users on popular platforms.

• RQ2: Which barriers do social network users encounter to share and author accessible media content?

The lack of awareness among participants about accessibility issues appears strongly connected to their limited familiarity to people with disabilities or assistive technologies. This highlights the pressing need for comprehensive educational initiatives that focus on how the different disabilities impact interaction with technologies as well on the steps needed to create inclusive digital content.

Moreover, there is **no guidance on major platforms** to help bridge this gap. Most participants who are sighted were **not aware** of how to make their content more inclusive, leaving them unsure of what steps to take. This lack of guidance contributes to the perception that adopting accessible practices **requires a significant additional effort**, potentially discouraging them from taking those extra steps.

Furthermore, our findings indicate a **stigma associated with accessibility**. Some sighted participants regard it as optional, or even as a potential detriment to their own online experience. This viewpoint is mainly perpetuated by the absence of mandatory accessibility guidelines or clear prompts from social media platforms.

From a different perspective, a set of challenges arises from the **lack of support for blind users** in creating accessible media content. While participants acknowledged some improvements in recent platform updates, longstanding accessibility issues persist. This issue compels them to rely on third-party help for social media activities, building on the social challenges they already face.

• RQ3: What are the requirements for social network users to create accessible media content?

The need for a **more user-friendly and accessible interface** is paramount. This would facilitate **greater visibility and ease of use for accessibility features**. A uniform approach across various platforms can further streamline the user experience, promoting an **easily recognized pattern** for accessible content sharing.

Furthermore, while some platforms employ machine-generated descriptions, these often fall short in delivering adequate context, a point supported by existing literature [18, 21, 28, 32, 35, 38]. A possible direction to consider is the development of **hybrid solutions**. These would combine the advantages of leveraging automated image recognition technologies with the quality and accuracy of descriptions provided by humans. Such a strategy could also serve a dual purpose: It could act as a guide for users in creating their own detailed descriptions, thus alleviating some of the effort and time they associate with the task. At the same time, it would support blind users who are in the process of creating accessible content, mitigating some of the social costs previously discussed.

4 SONAAR: SOCIAL NETWORKS ACCESSIBLE AUTHORING

Based on the findings obtained, we developed SONAAR, a semi-automatic mechanism that leverages a combination of manual and automated approaches to create a user-friendly mechanism that (1) empowers visually impaired users to engage with media content more easily and (2) facilitates and motivates all end-users to actively engage in creating accessible media content on social networks.

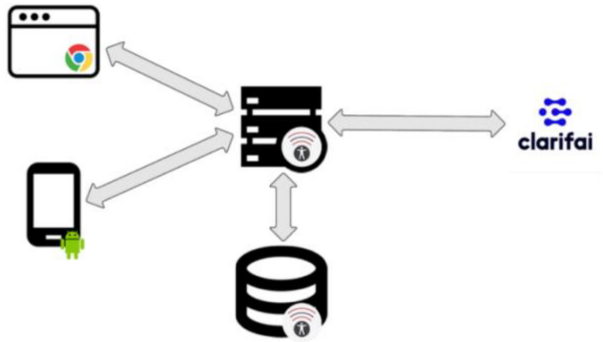


Fig. 1. SONAAR system architecture.

SONAAR prototypes are accessible through both a Google Chrome extension and an Android mobile application, enabling users to engage with its two primary workflows. In the first scenario, SONAAR assists users in creating accessible media content. It specifically aids in the input and generation of suitable alternative descriptions for media uploaded on popular social platforms such as Facebook and Twitter. When a user uploads media content, SONAAR offers a visual prompt, reminding the user to include an alternative description. Additionally, SONAAR presents a range of suggested alternative descriptions for the image, including those generated automatically through image analysis and text recognized within the image itself. Furthermore, if the image has previously been described by other users, then a selection of user-generated descriptions is also provided. The second scenario supported by SONAAR pertains to a consumption scenario. In this context, users can request alternative descriptions from SONAAR when encountering an image in various contexts, not limited to social networks. In such cases, SONAAR offers users the same set of alternative descriptions. SONAAR structure is represented in Figure 1.

For a more comprehensive and detailed information about the deployment of SONAAR prototypes, we refer readers to our previous publication [9], where we also discuss its contributions and challenges, in more depth. In the following sections, we will present a concise overview of the prototypes developed, emphasizing its significant features and contributions that provide the rationale for subsequent studies.

4.1 Backend

The SONAAR backend server stores alternative descriptions from various sources, including those generated by users, through image concepts, and through text found within the images. To support the interactions and functionalities provided by SONAAR, each image in the backend is assigned a unique identifier, linked to a set of descriptions. Each description is tagged with its respective language and the frequency of its usage in prior posts and tweets.

To ensure the effective operation of all features proposed, especially those related to image comparison and identification, SONAAR relies on some functionalities offered by Clarifai.[3] One such function involves image comparison, where Clarifai's service is used to compare a specific image with all images stored in the database for retrieval. Clarifai calculates a similarity index between two images, and if this index exceeds a specific threshold, the images are considered identical. This comparison remains efficient even in cases of minor image modifications, such as cropping or the addition/removal of watermarks. Another important Clarifai feature embedded in

[3] https://www.clarifai.com/

Fig. 2. Example of a message sent by SONAAR informing that a description was found for that image and where to include the description in the tweet.

SONAAR is the identification of textual content, particularly relevant within the context of social networks. This feature provides an initial source of alternative text suggestions from SONAAR, consisting in text present in the images.

Additionally, another source of alternative descriptions consists of those generated by other users for the same image. Given the prevalence of viral media and images on social networks, this feature can be also a valuable one. To facilitate this, when a SONAAR user creates a new alternative description for a fresh image, this new entry is stored in the database. SONAAR also includes a counter to track the frequency of use of a particular alternative description for the same image. It is worth noting that all these entries are labeled with the language of the respective descriptions, determined using the Franc Natural Language Detection library.[4]

In summary, to effectively address client requests, the SONAAR backend relies on three key pieces of information: the language associated with the client's device or browser, usage frequency, and a quality metric derived from semantic similarity between the image and each description, as detailed in Duarte et al. [8]. These three pieces of information guide the selection of alternative descriptions for users.

4.2 Supporting Authoring Accessible Content on Social Networks

In this section, we provide a brief overview of our Android application and Chrome extension, which function in a similar manner. The findings obtained in Study 1 identified two primary reasons why social network users do not create accessible media posts: lack of awareness about accessibility and the additional effort required.

Our prototypes address these issues by suggesting text descriptions for images in posts, raising awareness of accessible authoring practices, and simplifying the process for content creators to include descriptions. The prototypes automatically detect when users are authoring content with images on Twitter and Facebook. When an image is uploaded, SONNAR suggests descriptions. On Android, a notification is used to present the highest-rated description to the user. In Chrome, the description is displayed as an overlay window next to the description input field, as illustrated in Figure 2.

On both platforms, users have the option to copy the description to the clipboard and paste it into the corresponding field in the authoring interface. If multiple descriptions are available, then

[4]https://github.com/wooorm/franc

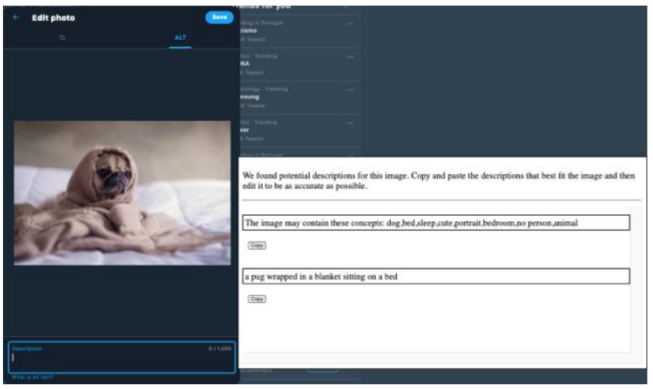


Fig. 3. Example of a message sent by SONAAR informing that potential descriptions were found and asking the user to select one of the descriptions to be copied to the clipboard.

there is an additional option to view and use them. Figure 3 provides an example of this interaction on the Chrome prototype.

Finally, we automatically detect when the user completes the tweet or post (i.e., activates the corresponding button on the interface). At this point, the description is stored as either a new description, or the usage count for the selected description is incremented.

4.3 Supporting Consuming Accessible Media Content

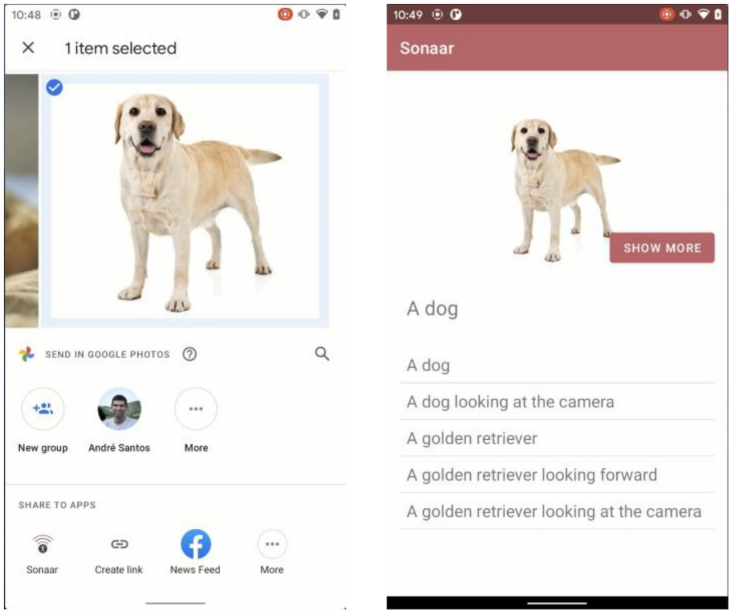
We have expanded the functionality of our prototypes to provide support for screen-reader users who need access to image descriptions across web pages and mobile applications. The Android application has been designed to register itself as an application that can receive shared images. When a user encounters a shareable image within any Android application that lacks a description or has an inadequate description (such as the image filename), the user can request a description (Figure 4(a)).

The prototype then presents a list of stored descriptions or descriptions generated based on the image's concept, as shown in Figure 4(b). Similarly, the Chrome extension operates with a slightly different approach. Since images are not inherently focusable elements on a web page, when a blind user comes across an image without a description or desires a description, activating the prototype on that web page triggers the sending of all images on the page to the backend. Upon receiving a response, the prototype modifies the **Document Object Model (DOM)** of the page. It makes all images focusable and inserts the descriptions into the alt attribute of the respective images. As a result, the user can browse through the images on the page and listen to the descriptions associated with each image.

In conclusion, the SONAAR prototypes explore the integration of AI-powered image recognition, text recognition in images, semantic similarity measures for text descriptions and image concepts, and language identification. These features enable us to provide image description suggestions during the content creation process on selected social networks. Additionally, users can request image descriptions while browsing the web or using any mobile application.

4.4 Documentation for Authoring Accessible Media Content

SONAAR aims to actively involve users in creating accessible content and, according to our first user study, most social network users lack awareness of accessible content practices and struggle to find proper guidance for improving accessibility. To address this issue, SONAAR also provides support documentation to offer users valuable information on accessibility practices **within** social



(a) (b)

Fig. 4. (a) Example of a request for an alt text using the Android prototype. (b) Example of a list of alt text retrieved by SONAAR.

networks. The SONAAR documentation follows two core principles: (1) Plain and simple language: We avoid using technical terms and jargon, ensuring that even users without prior knowledge of accessibility and technologies can easily grasp the concepts; (2) Short and objective texts: the messages and texts provided contain only essential information, enabling users to quickly navigate through them. Our approach encompasses two distinct strategies: (1) In-context tutorials: These tutorials offer a guided authoring process for creating accessible media content, seamlessly integrated into the frontend prototypes; (2) Website documentation: We provide an informative guide that sheds light on how individuals with disabilities consume media content and emphasizes the importance of engaging in accessible practices. This additional documentation is publicly available on the SONAAR website.[5]

5 EVALUATING SONAAR

In the following sections, we describe the activities conducted to evaluate the effectiveness of the additional documentation provided and integrated into our prototypes, as well as the interaction flows provided by SONAAR. To achieve this, we established the following research questions:

—RQ1: Does a semi-automatic mechanism for supporting user-authored alternative image descriptions increase the availability of online accessible media content?
—RQ2: Can a semi-automatic mechanism for supporting user-authored alternative image descriptions provide a satisfactory user experience in social media accessible content authoring?
—RQ3: Does providing additional information about digital accessibility improve users' motivation and engagement?

[5]http://www.di.fc.ul.pt/~cad/SONAAR/documentation/doc.html

To address these questions, our methodology involved three different steps. First, we performed an analysis of the archived logs to gain deeper insights into the utilization patterns and user behavior during interactions with SONAAR. This quantitative analysis provided an important understanding of how SONAAR was being used, as well as the most popular features and functionalities.

Next, we conducted a user study to evaluate the documentation provided on the SONAAR website. This study aimed to assess how clear, helpful, and efficient this documentation was in supporting users' comprehension and use of SONAAR.

Finally, we conducted another user study focused on the use of SONAAR prototypes. This study allowed us to gather qualitative data and explore the experiences, perceptions, and challenges faced by users when interacting with the prototypes. Through this study, we gained deeper insights into the usability and effectiveness of SONAAR in real-world scenarios.

In the following sections, we provide more details about the methodology used for each step, outline the procedures followed, present key findings from each study, and discuss the data analysis. All studies were conducted with approval from our University's Ethics Committee.

5.1 Usage Log

During the study period, we collected a set of information aimed to gather insights on how people were using SONAAR. This included tracking metrics such as the number of suggestion requests, authored descriptions, and the platforms and social networks where these interactions occurred. To collect this data, we stored the following information in the SONAAR database:

- —User identifier: A unique, randomly generated number assigned to each user. This number serves to differentiate actions within a specific SONAAR setup (this information was not linked to any personal details such as name, email, or store account).
- —Platform: Chrome extension or Android application.
- —Social network: Facebook, Twitter, or none (in the case of websites using the Chrome extension or shareable images on the Android application).
- —Request type:
  - Suggestion: Requests during content authoring on Facebook or Twitter.
  - Authoring: Requests containing user-authored alternative descriptions.
  - Consumption: Requests for descriptions made outside the authoring context.
- —Alternative description contribution: Whether the user provided a new alternative description in the request.

Taking into consideration the dataset retrieved from this log, we performed a descriptive data analysis aimed to gather insights into how people were using SONAAR prototypes. This included investigating the use of the browser extension and the mobile application, as well as categorizing the tasks performed, whether they were related to consumption or authorship, across various social media platforms.

We collected a total of 197 requests for alternative descriptions, including 43 suggestions for content authoring on social media and 154 for the consumption scenario. We observed a total of 17 unique user IDs, representing users who submitted at least one request to our backend. On average, each user made 11 requests. Most requests (174) were made using the Chrome extension, while Facebook was the most frequently used social network with 27 requests, followed by Twitter with 16 requests.

5.1.1 Authoring Accessible Content. We had a total of 13 unique users who requested descriptions for authoring accessible content using our prototypes. Six of them used the Android app, while seven opted for the Google Chrome extension. The most common scenario involved users

authoring descriptions on Twitter using the Google Chrome extension, followed by those using the Android application. Out of the 43 unique requests, the majority were made via the extension on Facebook. Moreover, only two extension users accessed both social networks, Twitter and Facebook.

5.1.2 Consuming Accessible Media Content. In the consumption scenario, eight unique users requested descriptions for web pages or screens using SONAAR. On average, each user made 19 requests, primarily through the Google Chrome extension. Although more people used the Android application, about 93% of requests came from Google Chrome extension users. This is not surprising, as the prototypes operate differently: The Android service generates a single request when the user asks for a description of an image, while the extension generates multiple requests for each image on the page when SONAAR is triggered.

5.2 Documentation for Authoring Accessible Media Content

To assess the effectiveness of the documentation for creating accessible content and its support for SONAAR users, we carried out an online survey. In the following sections, we outline the method employed and present the main findings obtained.

5.2.1 Method. The online survey was available in both Portuguese and English, and it gathered responses from 24 participants. Among these participants, 6 identified themselves as low-vision users, with 2 using a screen reader and 4 employing a screen magnifier. It is worth noting that all 6 of these users reported actively engaging in accessibility practices. Among the remaining 18 participants, 11 confirmed their involvement in accessible practices, while 7 reported not engaging in such practices.

Following the data collection phase, we used descriptive statistics to derive quantitative insights from the responses to closed-ended questions. Simultaneously, for open-ended questions, we adopted a content analysis approach [24] to identify recurring themes and patterns within the responses. This dual-method analysis was aimed at providing a comprehensive understanding of participants' perspectives and experiences concerning the effectiveness of documentation for authoring accessible content.

5.2.2 Findings. In this section, we present an overview of the data gathered from the user study focused on evaluating the effectiveness of documentation for authoring accessible content. We received a total of 24 valid answers, including 6 from participants self-reporting as having low vision.

Social media usage: Among participants with visual impairments, Facebook was the most popular social network, used by 5 participants. Instagram was the second-most-common platform, utilized by 1 participant. Two visually impaired participants reported using Twitter. Among sighted participants, Facebook and Instagram emerged as the most frequently utilized social networks, with 11 participants mentioning their use. Twitter was used by 7 sighted participants, while 2 used WhatsApp, and 1 person mentioned TikTok. Both visually impaired and sighted participants reported that they usually share images several times a month.

Accessible practices: Among the 24 participants, 7 sighted users mentioned that they do not provide alternative descriptions for the images they share. The reasons for this varied. Specifically, 3 participants were unaware that it was an option, 2 lacked knowledge on what would constitute suitable descriptions, and 1 participant indicated that they did not have any contacts who required such descriptions. Among the 17 participants who indicated providing alternative descriptions, visually impaired participants typically included the description within the text of the post, a comment, or a reply. They often relied on automated services for this purpose. In contrast, sighted participants predominantly placed descriptions in the designated field provided by

the social network or within the text of the post. We also explored participants' perceptions of the level of challenge in providing alternative descriptions. Two participants found it somewhat easy, while 6 participants neither found it difficult nor easy.

We also investigated participants' perception of the importance of providing alternative descriptions. Among visually impaired participants, 1 participant considered it very important, 2 participants regarded it as important, 1 participant found it moderately important, and 2 participants considered it slightly important. None of the visually impaired participants rated it as not important. Among sighted participants, 5 participants viewed it as very important, 4 participants considered it important, 3 participants rated it as moderately important, and 4 participants found it slightly important. One sighted participant expressed that it was not important.

Documentation for authoring accessible content: The survey also aimed to assess the effectiveness of the documentation provided by SONAAR. Participants expressed positive perceptions of the clarity of the information. Among visually impaired participants, 2 individuals rated the information as very clear, while 2 participants rated it as clear. Additionally, 2 participants found the information to be barely clear. For sighted participants, 4 individuals rated the information as very clear, and 9 participants found it clear. Two participants indicated that the information was barely clear. Overall, most participants perceived the information as clear or very clear, indicating a positive assessment.

We also asked if participants found the documentation to be comprehensive. Among visually impaired participants, 1 participant found it very complete, while 3 individuals rated the information as complete. Additionally, 1 participant considered the information to be barely complete. For sighted participants, 2 individuals found it very complete with a substantial number of participants (18 in total) rating the information as complete. Three participants expressed that the information was neither complete nor incomplete, and 2 participants considered it barely complete.

Regarding helpfulness, among visually impaired participants, 3 individuals rated the information as helpful, 1 participant found it very helpful, and 2 participants expressed that it was neither helpful nor unhelpful. Among sighted participants, a significant number (11 in total) considered the information helpful, with 5 individuals finding it very helpful. Two participants rated the information as neither helpful nor unhelpful.

When asked if they gained any new insights from the SONAAR documentation, 13 participants acknowledged a positive learning experience. Four visually impaired participants and 9 sighted participants reported gaining new knowledge about digital accessibility. Topics varied, including effective utilization of SONAAR and techniques for describing image content based on context for better support of visually impaired users.

We also looked at how the SONAAR documentation affected users' motivation. The survey showed that 2 visually impaired participants and 11 sighted participants thought it would probably encourage others to use accessible practices. Nine participants did not have a strong opinion on the matter, and 2 participants thought it probably would not.

Regarding personal engagement in accessible practices, among visually impaired participants, 2 individuals expressed a high likelihood, 1 participant stated a moderate likelihood, and 2 participants considered it unlikely that the SONAAR documentation would increase their motivation. Among sighted participants, 10 individuals reported a high likelihood, 6 participants expressed a neutral perspective, and only 1 participant mentioned it unlikely to be more engaged.

Finally, we evaluated the participants' interaction with the SONAAR prototypes. All 6 visually impaired participants and 4 sighted participants confirmed their use of SONAAR. Looking ahead, the majority expressed a strong inclination to continue using SONAAR. Among sighted participants who had not yet used it, 6 indicated they were likely to try it in the future, 5 remained neutral, and 3 considered it unlikely.

Open answers and further comments: Some closed questions also included an open field for respondents to provide additional details about their answers. Among the 13 participants who shared they gained new insights, 10 elaborated on the subject. They discussed various aspects like the range of abilities and digital content accessibility. Additionally, they emphasized the importance of adopting accessible practices and providing better image descriptions, appropriate use of emojis, and offered specific perspectives regarding SONAAR. Participants also provided suggestions for further improving this documentation, including incorporating personal experiences from people with disabilities, offering additional accessibility tips, including a thorough, step-by-step guide for utilizing SONAAR. They also suggested the inclusion of business-related data and providing more guidance on the use of emojis. Overall, the study findings reflect positive perceptions of the provided documentation's clarity and effectiveness, as well as the potential impact on motivation and engagement in accessible practices.

5.3 Interacting with SONAAR

In the last study conducted, we examined how users interact with SONAAR prototypes. Specifically, we investigated user experiences, perceptions, and challenges while using these prototypes. Additionally, we sought to gain a better understanding of SONAAR's usability and effectiveness in practical situations.

5.3.1 Method. The recruitment for this study involved multiple methods. We reached out to communities focused on visual impairments, shared information through our research team's social media accounts, and invited participants from previous studies. Additionally, we included a recruitment message in our prototypes to attract potential users of SONAAR who may have learned about the project from other sources.

Nine participants responded to our call, including four sighted users and five users with self-reported visual disabilities. Initially, participants filled out an online questionnaire about their social media habits and the accessibility features they use. Next, they were instructed to integrate one or both SONAAR prototypes into their daily social media activities for a span of two weeks. At the end of this period, they were asked to complete a follow-up questionnaire to provide insights into their experience. Three participants (VIP1, VIP2, and VIP5) completed the final questionnaire, and two participants (VP1 and VP5) agreed to participate in more in-depth interviews. Demographic information about the participants can be found in Table 1.

We conducted the analysis in two main phases. First, we examined the responses to the survey's multiple-choice questions through descriptive quantitative analysis, which helped us understand and summarize participants' views and behaviors regarding the prototypes. Second, we looked at the answers to open-ended questions and the transcripts from interviews. This enabled us to organize and categorize the feedback according to the topics addressed in the questions.

5.3.2 Findings. In this section, we discuss key findings from our user study, which examined user perceptions and usage of SONAAR. For each thematic area, we also specify the corresponding sample, as the number of participants varied across the different stages of our research.

Social media usage: Regarding the social media usage patterns among all *nine initial study participants*, Instagram emerged as the preferred primary social network, selected by five visually impaired participants, followed by Facebook and Twitter, which were selected by four and two participants, respectively. Among sighted users, Instagram and Twitter were the most popular platforms, chosen by three participants each, followed by Facebook and YouTube. Additionally, a few sighted participants mentioned using other social networks such as LinkedIn, Slack, and Xing. Concerning their posting frequency, three participants reported posting images several times per

Table 1. Demographics and Technology Use of Questionnaire Respondents

ID	Type of disability	Assistive technology	Accessible practices	Operating system used	Form language
VP1	Blindness	Screen reader	Yes	Windows, Android	Portuguese
VP2	Blindness	Screen reader, braille display	Yes	Windows, iOS	Portuguese
VP3	Myopia, astigmatism	–	No	Windows, iOS	Portuguese
VP4	Blindness	Screen reader, Braille display	Yes	Windows, Android, Chrome OS	English
VP5	Low vision	Screen reader	Yes	Android	Portuguese
SP1	–	–	Yes	Windows, iOS	English
SP2	–	–	Yes	Windows, Android	English
SP3	–	–	No	Windows, Android	Portuguese
SP4	–	–	Yes	Windows, Android	Portuguese

month, one participant indicated several times per day, and another participant less than once a month. Among sighted participants, three reported posting several times per day, one reported once a month, and one less than once a month.

Accessible practices: We also inquired all *nine initial study participants* about practices in ensuring accessibility and creating accessible content. In relation to offering alternative descriptions for their images on social media, our findings revealed that out of the nine participants, two admitted to not including alternative descriptions with their posted images. One sighted participant mentioned being unaware that it was possible to provide alternative descriptions, while one visually impaired participant expressed uncertainty about where to write them. However, among those who do provide alternative descriptions, the most employed approach is writing the description in the text field provided by the social network service itself. This approach was employed by five participants, including three visually impaired participants and two sighted participants. Additionally, two participants, one from each user group, reported utilizing an automatic service for generating alternative text.

We also examined the participants' perception of effort and difficulty involved in providing alternative descriptions. We asked them about the time it takes them to provide a description and whether they considered it to be a significant or minimal amount of time, using a 5-point Likert scale. Most users indicated that it takes them very little time, with an average response ranging from 1 to 3 minutes. Two participants mentioned spending some time, with one citing 5 minutes and another citing 1 minute. One participant shared requiring assistance from a sighted family member to ensure the quality of the description, taking her 10 to 15 minutes, considered to be a significant amount of time. Concerning their perceived difficulty in providing an alternative description, most participants consider this task somewhat easy.

Regarding the accessibility of images in their social media streams, four participants provided their insights on this matter. Most participants expressed that very few, or even none, of their social media contacts actively post images with alternative descriptions. Similarly, most participants reported encountering images with alternative descriptions on rare occasions. However, when alternative descriptions were available, participants generally perceived them to be of good quality.

Using SONAAR: We also investigated the features of SONAAR that the *three participants who concluded the study* used during the two-week period, how often they used them, and any challenges they encountered when interacting with the prototypes. Among the three participants,

two reported using SONAAR to create accessible content on Facebook. One of them employed the Android application, while the other used the Chrome extension. Additionally, one participant mentioned using SONAAR solely for testing purposes and did not publish any images during the study. We also asked participants how many of the suggested descriptions by SONAAR they included in their image posts and how many of those suggestions they modified. One participant indicated that they included a SONAAR-generated description for most of the images posted during the study period but modified the original content for half of them. Two participants reported posting a similar number of images when using SONAAR compared to their usual practice. Regarding the perceived difficulty, both participants found it neither challenging nor easy to create descriptions using SONAAR. Last, one participant did not share any images but mentioned that they would have modified the descriptions originally provided by SONAAR if they had done so.

Open answers and interviews: Regarding the open-ended questions in the initial survey, *two sighted participants shared additional comments and thoughts.* One participant mentioned being more mindful of accessibility when posting on professional networks due to his work in a disability-related institution, but sometimes forgetting to prioritize accessibility on his personal account. The other participant expressed the challenge of creating engaging and creative descriptions while still effectively conveying the message.

In addition, both participants agreed that the current descriptions available on Facebook are lacking in quality. One participant mentioned constantly requesting his contacts to include descriptions in their images but often being ignored, expressing frustration with the lack of understanding. The other participant shared that he tends to skip images on Facebook as he expects poor, mostly automatically generated descriptions. He emphasized the importance of context in creating a good alternative description, such as describing the landscape and people's attire in an outdoor picture.

Concerning the use of SONAAR, both interviewees primarily used the Android application to request descriptions on Facebook. The first participant did not encounter any difficulties while using SONAAR except the limited number of available descriptions in Portuguese, his native language. The second participant experienced an issue where they could not use SONAAR for some time due to a Facebook interface change, which is one of the current limitations of our prototypes. As mentioned in more detail in Duarte et al. [9], modifications in the interfaces of Twitter and Facebook can disrupt our prototypes' ability to detect specific attributes related to content authoring actions.

Regarding the accessibility of our prototypes, both users considered them to be quite accessible. We also explored participants' suggestions for improving SONAAR. One participant emphasized the need to go beyond simply embedding alternative descriptions and instead provide a brief explanation to authors on how to access these features and the suggested descriptions. This feature is currently implemented in SONAAR prototypes, and conducting further user trials with sighted individuals would help assess its effectiveness in raising awareness of accessibility features. The second participant suggested expanding SONAAR's capabilities to support other social networks, such as Instagram. Finally, one participant shared his thoughts on the documentation provided. He shared finding the information clear and believes it has the potential to help people understand the importance of engaging in accessible practices.

5.4 Discussion

In the following sections, we discuss the findings obtained through the analysis of the usage logs, as well as those obtained through the user studies conducted. Next, we discuss how these results can support us in answering the research questions established for this work.

5.4.1 Usage Log. The analysis of the log data from SONAAR provided us with insights into how the tool is being used and possible user preferences. The dissemination efforts for user participation led to new SONAAR users who were not directly involved in the previous user studies. In total, we identified 17 individual users in our database, compared to the 9 participants in our studies.

Most users were found to be using SONAAR in the consumption scenario, which involves requesting image descriptions on various websites or applications, including those outside the scope of social networks. Considering the higher engagement of visually impaired users in our studies, it is likely that most of these requests were made by them. This suggests that the current user base of SONAAR consists primarily of visually impaired users. Another indicator of user reach and engagement is the number of authorships during this period, with no new descriptions submitted by SONAAR users. It is worth noting that one study participant reported posting an image using the suggestion provided by SONAAR, but this information was not logged in our database. This may be due to the participant starting to use SONAAR between the study dissemination and the update of our prototypes with the logging feature.

Another important observation is the difference in the number of requests made through the extension and the application, with 88% of the requests originating from the extension, considering both authoring and consuming scenarios. Although there were more users of the Android application, this discrepancy in requests is expected. When the SONAAR browser extension is activated, the entire page is scanned, and, for each image available, a new request is sent to the backend. In contrast, the Android application requires the user to share a specific image with the SONAAR service.

Overall, the log data offers valuable information on user behavior and usage patterns. The log data shows that visually impaired users are a significant portion of the user base and reveals higher use of the SONAAR extension compared to the mobile application.

5.4.2 Interacting with SONAAR. In contrast to the study described in the original paper, in this second study, visually impaired participants predominantly used Instagram, while Twitter and Facebook were the preferred choices among sighted participants. However, when asked about their posting frequency, visually impaired participants reported posting only a few times per month, whereas sighted participants typically posted several times per day.

In terms of making content accessible, most participants—both sighted and with visual impairments–said they include alternative text for images when posting on social media. Most users find it relatively straightforward to use the designated fields for image descriptions provided by social media platforms, completing the task quickly. However, visually impaired users frequently encounter a lack of alternative text for images in their social media feeds. This observation is corroborated by most participants, who report that their contacts rarely implement accessibility features when posting or sharing content. This apparent contradiction can be attributed to the fact that participants who volunteered for an accessibility study are already aware of the importance and steps involved in publishing accessible content, representing a small subset of individuals who do provide alternative descriptions. However, there seems to be a limit to this engagement, as only three out of the initial nine participants completed the study, all of whom were visually impaired. In the initial user study, we found that a substantial proportion of participants were not aware of the feature that allows the addition of alternative descriptions, nor did they know where to find this option. Those who are aware may find the activity too time-consuming, further emphasizing the limitation on the time and effort people are willing to invest in this task. This low level of engagement also affected the interaction of the few participants who shared their experience using SONAAR. The number of descriptions suggested by SONAAR is directly influenced by the number of users creating new descriptions. Therefore, our interviewees, who were visually impaired users, often received suggestions containing concepts automatically

extracted from the images by Clarifai. Overall, the participants responded positively to SONAAR. They identified a few minor issues and offered suggestions for its future development. These included broadening SONAAR's compatibility with other platforms and browsers and improving language support. While SONAAR currently has interfaces in both English and Portuguese, the absence of a diverse dataset of user-generated descriptions means that suggestions are predominantly based on English image concepts identified by Clarifai.

5.4.3 Research Questions. Based on these results, we explore their implications for our research questions while identifying potential areas of improvement in the SONAAR prototypes.

• RQ1: Does a semi-automatic mechanism for supporting user-authored alternative image descriptions increase the availability of accessible media content?

Participants who have visual impairments indicated that they seldom come across images that include descriptions on social media platforms. Furthermore, most of their contacts do not engage in accessible practices. Although the specific impact of SONAAR on the availability of image descriptions within the context of social networks cannot be conclusively determined, the analysis of the log data reveals a significant number of requests in the consumption scenario. Consequently, it can be inferred that such mechanism has the potential to assist a subset of users by automatically extracting image concepts through Clarifai, even beyond the context of social networks.

• RQ2: Can a semi-automatic mechanism for supporting user-authored alternative image descriptions provide a satisfactory user experience in social media accessible content authoring?

During the study period, participants using SONAAR generally gave positive reviews about their experience. They did note some minor drawbacks, like limited language support—a known issue with SONAAR. Despite this, participants were satisfied with the system's accessibility and indicated a willingness to keep using it. These observations suggest that such mechanism could effectively improve user experience in generating accessible content on social media platforms.

• RQ3: Does providing additional information about digital accessibility improve users' motivation and engagement?

The findings of our study underscore the positive impact of additional documentation on users' understanding and engagement with digital accessibility. Participants reported significant learning how to enhance image descriptions through the provided materials. Additionally, most participants expressed a stronger inclination to actively engage in accessible practices. Participants also showed a strong interest in gaining a better understanding of how people with disabilities navigate the web as well as in employing methods to improve content accessibility. While we cannot definitively conclude that participants' expressed interest will directly translate into improved accessibility of their published content, the majority indicated an increased motivation to adopt accessible practices after reviewing the documentation provided. These findings align with prior research, highlighting the substantial barrier of awareness in adopting accessible practices.

6 LIMITATIONS AND FUTURE WORK

It is essential to acknowledge that our study had a relatively small number of participants. In one of the studies, which focused on collecting user feedback on the tool, only three out of the initial nine participants completed the study. This limited scale means that the ability to draw broad conclusions from these findings is restricted. While the insights gained are valuable, they may not fully capture the diverse experiences of the broader community, nor provide extensive conclusions about the overall effectiveness of the tool. Another key limitation to discuss is the methodology

used in evaluating SONAAR. Our approach relied mainly on feedback gathered through questionnaires, which lacks an in-depth analysis of user interactions. Therefore, future research could explore more comprehensive methods, such as detailed observational studies or interactive feedback sessions, to better capture the nuanced details of user interactions and experiences.

Acknowledging these limitations, we now turn to the potential enhancements that could further the development and effectiveness of SONAAR. Our study's results offer valuable insights for enhancing future developments of SONAAR and similar mechanisms. One suggested improvement is to provide a clearer message on the Android application's main screen, informing users of its purpose. Currently, this screen serves no further utility, as SONAAR operates in the background. By enhancing this screen with instructions on how to use SONAAR and offering tips to improve the accessibility of digital content, we can enhance the user experience. Participants emphasized the importance of expanding SONAAR's capabilities to include accessible content authoring on Instagram, given the significant number of participants using this social network. Providing support to Instagram would expand its reach and increase awareness about accessibility. Additionally, participants suggested supporting other browsers like Mozilla Firefox, which should be considered for future enhancements.

Another potential recommendation is to integrate a language translation feature using Natural Language Processing, making it possible for people with limited proficiency in English or those who primarily speak other languages to access translated descriptions. Although automated translations may not be of the highest quality, they would still enhance the usability and accessibility of such mechanisms for a broader user base.

In this regard, it is important to inform users about the quality of each description to improve user experience. Currently, SONAAR presents descriptions based on a quality algorithm, but there is no distinction between low-quality and high-quality descriptions. Implementing a rating system for each description, such as a star scale, can encourage users to refine and improve low-quality descriptions. This would facilitate better communication and enable users to make more informed decisions regarding the descriptions provided.

Addressing interface changes, particularly on platforms like Facebook, is crucial. Several participants reported difficulties using the Android application due to interface updates on Facebook. To address this issue, we propose implementing a feature that allows users to report problems and identify important interface elements, such as publish buttons. This feedback mechanism would help in adapting to new interface updates and improving the overall user experience.

7 CONCLUSIONS

This article presents an expanded version of our previous work [25], focusing on the development and evaluation of **SONAAR (Social Networks Accessible Authoring)** [9], a tool aimed at investigating how a hybrid approach can enhance the accessibility of social media content. The main goal was to empower end-users through automation, enhancing content accessibility.

In this article, we provide detailed insights into the usage logs of the SONAAR mechanism, shedding light on the patterns and behaviors of users engaging with the tool. Additionally, we conducted two user studies to further investigate the impacts of providing users with more information about digital accessibility and the experiences of users with disabilities. The initial study aimed to evaluate how raising awareness impacts users' motivation to improve the accessibility of online content. The second study focused on evaluating the effectiveness and usability of the SONAAR prototypes. Through these studies, we sought to gain a comprehensive understanding of how a semi-automatic tool can facilitate the creation of accessible content. By exploring the user experiences and motivations, we aimed to identify areas of improvement and assess the impact of the prototypes on users' authoring practices.

The results obtained from participant feedback indicate a positive reception of the SONAAR concept, with participants providing valuable suggestions for improving our services. The documentation provided was also well-received, with participants stating that it is clear, comprehensive, and helpful. Furthermore, participants expressed that the documentation has the potential to motivate users to engage in accessible practices by providing insights into how people with disabilities utilize the web and the positive impact of improving content accessibility on others' lives.

It is essential to emphasize the limited level of participant engagement in this research, especially among those with normal vision, despite our similar recruitment efforts. Even when considering the differing levels of commitment involved in both studies, the conversion rate remains consistently low. Our findings support previous conclusions that most individuals are not well-informed about the possibility of offering alternative descriptions and the essential steps required for this. Moreover, people tend to view accessibility practices as time-consuming and labor-intensive. While we were able to develop a technically feasible solution, native and improved support from major platforms could effectively reduce the perceived effort for users and increase their awareness of accessible practices.

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Received 1 July 2023; revised 15 November 2023; accepted 18 January 2024