Assessing the Accessibility and Usability of Web Archives for Blind Users

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Abstract. Web archives play a crucial role in preserving the digital history of the internet, given the inherent volatility of websites that constantly undergo modifications, content updates, and migrations, or even cease to exist altogether. Web archives ensure that present and historical web information will be available in the future for researchers, historians, students, corporations, and general public. Given their importance, it is essential for web archives to be equally accessible to everyone, including those with visual disabilities. In the absence of a prior in-depth investigation in this regard, this paper examines the status-quo accessibility and usability of five popular web archives for people who are blind. Specifically, we analyzed reports generated by an automated accessibility checker tool and also collected feedback from a user study with 10 blind screen reader users. The analysis of accessibility reports revealed issues that were common across the different archives, including a lack of text alternatives for images and the absence of proper aria labels. The user study showed that blind users struggled to do even basic search tasks to locate desired mementos or snapshots of websites saved in the archives. The participants also explicitly indicated that they found it strenuous to interact with web archives. Informed by these findings, we provide accessibility design suggestions for archives' web developers and assistive technology developers.

Keywords: Web Archives · Accessibility · Usability · Screen Reader · Blind

1 Introduction

Web archives are digital repositories that use autonomous web crawlers [12] to collect various types of web content, such as web pages, videos, pictures, books,

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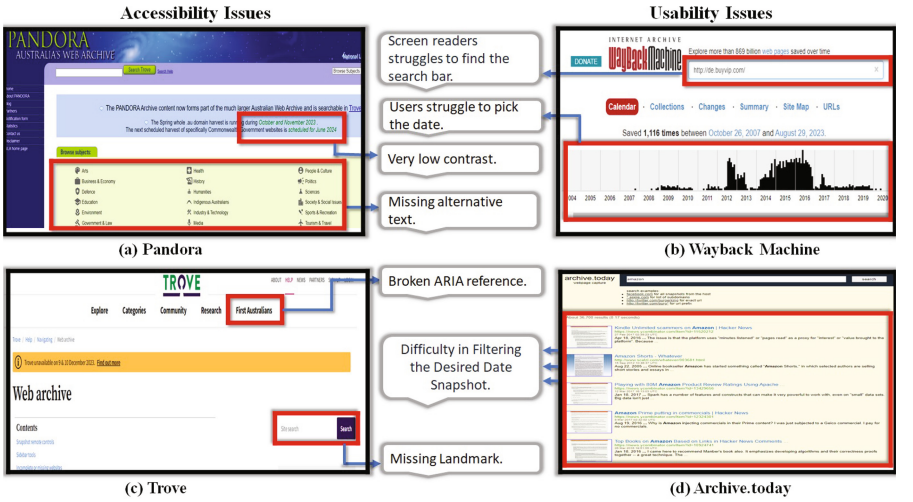


Fig. 1. Examples of accessibility and usability issues found in web archives.

and social media data, for long-term preservation [59]. Web archives such as the Wayback Machine [6] store the 'snapshots' of web pages at different time intervals, enabling users to access prior versions of web pages that may have been altered or even removed from the corresponding websites [29,48,53]. Therefore, web archives serve as an important resource for researchers, analysts, and the general public for a variety of tasks, including fact-checking [58,59], searching historical information [58], tracking public opinion changes [36], tracing the spread of false narratives [33], understanding patterns of misinformation propagation [56], and ultimately promoting information accuracy and credibility on the internet [8,27]. Given the importance of web archives, it is essential that they are equally accessible to people who are blind. However, little is known about how accessible and usable these web archives are for blind individuals.

People with severe visual impairments, including those who are blind, interact with web applications using a screen reader, a special-purpose assistive technology that makes content accessible by converting text and visual elements to speech. Moreover, a screen reader also enables users to navigate the content without the need for a conventional mouse by providing special keyboard shortcuts as alternatives (e.g., 'H' for the next 'heading' element on the webpage, TAB for the next link). This one-dimensional *press-and-listen* mode of interaction has been shown to cause significant usability barriers for blind users on the web [54], particularly in websites pertaining to e-commerce [14] and social media [38]. The usability of web archives, however, is still an uncharted research territory.

In this paper, we fill this accessibility and usability knowledge gaps regarding web archives by: (i) generating and analyzing the accessibility reports of the various web pages belonging to 5 popular web archives – The Wayback Machine [6], The UK Web Archive [5], Pandora [3], Trove [4], and Archive.today [2]; and (ii)

analyzing the data collected from an Institutional Review Board (IRB) approved user study, where blind participants performed representative tasks in the aforementioned 5 web archives using their preferred screen readers. To automatically generate accessibility reports, we leveraged IBM Equal Access Checker [1], which provided detailed feedback regarding the accessibility of the web archives. For usability data collection, we conducted a user study with 10 blind users who were proficient in web browsing using screen readers.

The analysis of accessibility reports illuminated various issues, many of which either directly or indirectly affected the users' ability to execute essential tasks with web archives. The notable issues included the absence of alternative text for photos, insufficient labeling of links, inconsistent usage of vocabulary and content layout across web pages, absent landmarks, incomplete preservation of web forms, and inadequate labeling of forms. The user study also revealed several usability barriers. Specifically, the participants who completed the assigned tasks needed to expend a significant amount of time (an average of 8.21 minutes per task) and effort (an average of 129 keyboard shortcuts per task). Figure 1 depicts some of the accessibility and usability issues uncovered in our investigation. Based on our findings, we finally developed accessibility design suggestions for both web archive developers and assistive technology developers to guide their development of more accessible and usable web archives. To summarize, our contributions are:

- Uncovering and analyzing the accessibility issues of web archives with the aid of an automatic accessibility checker tool.
- Discovering and understanding the usability concerns of blind individuals regarding web archives via a user study with 10 blind participants.
- Developing design suggestions for web archive developers and assistive technology developers to enhance the overall accessibility and usability of web archives for blind users.

2 Related Work

2.1 Web Accessibility

Web accessibility involves designing and developing digital content, websites, and applications in such a way that all users, including those with disabilities, are able to understand, navigate, and interact with the presented information in an efficient manner [9,64]. To promote web accessibility, several guidelines and design recommendations have been proposed in the literature [61], including the standard Web Content Accessibility Guidelines (WCAG) by the W3C [46]. There is also plenty of support available in the form of WAI-ARIA specifications [62] and accessibility evaluation tools [11,35,37] that web developers can leverage to make their web applications accessible. However, studies have shown that web developers often ignore the accessibility guidelines [19], and moreover, their use of ARIA in HTML source code is often inconsistent [45]. Consequently, the extent of accessibility enforcement has been shown to vary across different

websites, which in turn has spurred many research investigations into the accessibility of websites belonging to different domains [7,10,17,31,34,65], including government and university websites [43], and e-commerce websites [30]. However, none of the prior studies have investigated the accessibility of web archives.

2.2 Web Usability for Blind Users

While web accessibility has been extensively studied by researchers, web usability for people who are blind has received considerably less attention [15,16]. Accessibility in and of itself does not imply usability, i.e., the ease and efficiency with which users can do their tasks on websites. Prior studies have shown that, compared to sighted users, blind users typically need to expend significantly more time and effort to do simple web tasks even on the most accessible websites [20,52]. The conventional method of evaluating the non-visual usability of websites is by conducting user studies with blind people [13,21,23,44]. For instance, multiple prior studies [30,32,47,51] have investigated the usability of e-commerce websites and found that blind users typically need to invest significant time and effort to do basic tasks such as finding desired information on a page [47], navigating and comparing data items [26], and accessing basic controls, such as item filters and sort options [25]. Other than e-commerce websites, researchers have also examined the usability of social media websites and their content [28,40,57] as well as the usability of online collaborative tools such as Google Docs [22,39,42,50,60]. While there are many such prior works that have examined the usability of web applications belonging to different domains, to the best of our knowledge, no prior work has investigated the usability of web archives for blind users – a knowledge gap we will fill in this paper via a usability study with 10 eligible blind participants.

3 Materials and Methods

3.1 Accessibility Analysis of Web Archives

We assessed the accessibility of five distinct web archive websites: (1) *The Wayback Machine* [6]; (2) *The UK Web Archive* [5]; (3) *Pandora* [3]; (4) *Trove* [4]; and (5) *Archive.today* [2]. These web archives provide diverse means through which users can retrieve snapshots of archived web pages. The most common and easiest approach is to provide the URL of the web page in the search bar, followed by a selection of the date of interest. In addition to this, these web archive platforms offer filtering options that empower users to narrow down their search results according to time periods, web domains, or collections.

To evaluate the accessibility of web archives, we used the IBM Equal Accessibility Checker tool [1]. The tool assesses a provided website for accessibility compliance in accordance with the IBM Accessibility 7.2 [1], which encompasses the WCAG standards [63], the US Revised 508 requirements [24], and the EN 301–549 standards [55]. It then provides a comprehensive report that highlights

important accessibility issues on the website along with their frequency of occurrence. In addition, the tool suggests ways to address the issues captured to mitigate accessibility barriers. The issues are also categorized under different groups based on criticality, including *violations of accessibility guidelines*, *guidelines requiring review*, and *recommendations*. The reports are generated in both Excel and HTML formats for convenient subsequent analysis; for our analysis, we used the Excel format.

From each of the five web archives, we first manually scraped the home page along with all the web pages that were at most within a three-hop distance from the home page. The three-hop threshold was based on our manual observation that in all the five archives it took at most three hops from the home page to reach an archived memento or snapshot of a target web page. In total, we collected 223 web pages in this process (96 web pages from the Wayback Machine, 28 web pages from the UK Web Archive, 31 web pages from Pandora, 33 web pages from Trove, and 35 web pages from Archive.today). We subjected each of these pages to the accessibility checker to obtain the corresponding accessibility reports, generating 223 reports in total.

We qualitatively analyzed all the generated accessibility reports using an open coding technique [49]. First, an accessibility expert manually analyzed 50 randomly sampled reports and developed codes capturing the different kinds of accessibility issues. Two annotators then used these codes to annotate all the generated accessibility reports, and their inter-annotator agreement was 0.82, signaling excellent agreement. These annotators then met to discuss, hash out their disagreements, and finalize the annotations for the reports. In instances where the annotators could not reach an agreement, a third-party arbiter resolved the disagreement through simple majority voting. Specifically, the following codes or themes were used to annotate accessibility reports generated by the testing tools: (i) Structural Elements and Forms; (ii) Visual Content and Images; (iii) Interactive Controls and Keyboard Accessibility; (iv) ARIA Roles and Structural Guidelines; (v) Context and Warning Related Issues; and (vi) Miscellaneous Issues. These themes formed the basis for computing the various descriptive statistics, which we have reported later in Sect. 4.

3.2 Usability Analysis of Web Archives

We conducted an IRB-approved user study where proficient blind participants performed representative web archive-related tasks either in person or remotely via Zoom, depending on their preferences. The participants utilized their own computers and preferred screen readers to complete the overall study tasks. During the study, we collected usability-related performance data, such as task completion times and the number of shortcuts. After the study, we collected subjective feedback from the participants via an exit interview. We detail the study setup next.

Participants. We recruited 10 blind participants through email lists and word-of-mouth referrals[1]. All participants satisfied the following inclusion criteria: (i) severe visual disability such that the participant cannot use any other accessibility aid (e.g., screen magnifier) besides a screen reader to interact with computers; (ii) proficiency in using either JAWS or NVDA screen reader; (iii) proficiency in desktop/laptop web browsing; (iv) fluency in English; and (v) no additional disabilities such as hearing or motor control issues that might impede their ability to complete the study tasks. Candidates who did not meet all of these criteria were excluded from the study. Overall, we managed to recruit a demographically diverse set of participants for the study. The participants' gender distribution was nearly balanced, with 6 female and 4 male participants, and their average age was 49.7 years (with a median of 54, a minimum of 38, and a maximum of 69). All participants were advanced screen reader users, and they all had a web browsing experience of at least one year.

Study Design. In a within-subject design, the participants were asked to do the following task in each of the five web archives: *Find and open the memento of a given target webpage for a specified date; then find and open another snapshot for a different specified date.* The participants started the task from the home pages of the 5 web archives:

1. Archive.today: `https://archive.ph/`
2. Trove: `https://trove.nla.gov.au/`
3. Pandora: `http://pandora.nla.gov.au/`
4. UK Web Archive: `https://www.webarchive.org.uk/`
5. Wayback Machine: `https://web.archive.org/`

Note that the home pages differed significantly with respect to their user interfaces, which mitigated the learning effect. The ordering of web archives for the task was counterbalanced using the well-known Latin square method [18]. All participants performed the tasks in the Chrome browser using either the JAWS or NVDA screen reader. Further study details are available on GitHub[2].

Procedure. At the beginning of the study session, the experimenter explained the objectives of the study to a participant and obtained the participant's informed consent. This was followed by a 15-minute practice session where the participant was allowed to adjust screen reader settings (e.g., voice, speech rate, volume) according to their preferences and also refresh their memory about screen reader shortcuts by consulting the help manual. The participant was then asked to do the tasks one-by-one in the predetermined counterbalanced order. After completing the study, an exit interview was carried out to gather subjective feedback, including feature requests and ideas for improving the usability of web archives. Screen-sharing and recording features were enabled throughout

[1] A typical number of participants in studies with blind users is between 5 and 20.
[2] https://github.com/accessodu/Web_Archives.

the study with the participant's explicit permission. All conversations were in English, and the participants were compensated with an Amazon gift card.

Data Collection and Analysis. From the study, we collected performance metrics, including task completion times and the number of shortcut presses. These metrics were analyzed using both descriptive and inferential statistical methods as presented later in Sect. 4. Other than quantitative metrics, we also collected qualitative data, such as experimenter notes during the study and the subjective feedback from the participants during the exit interviews. This data was qualitatively analyzed using open coding and axial coding methods [49]. Specifically, the first annotator went over the data from the first five participants and developed the initial set of codes capturing different concepts in the data. Then, the first annotator discussed the codes with the second annotator to reach a consensus, following which both annotators independently coded the data from all participants. The annotators then met to resolve discrepancies and discuss how to group the codes into 'higher-level' categories/concepts. Then, both annotators revisited the data to sort out disagreements and finalize the annotations for the qualitative data. The corresponding inter-annotator agreement was 0.90, signaling excellent agreement. In scenarios where the two annotators could not come to a consensus regarding annotation, the third annotator served as the arbiter, i.e., the issues were resolved using simple majority voting. Next, we present our findings.

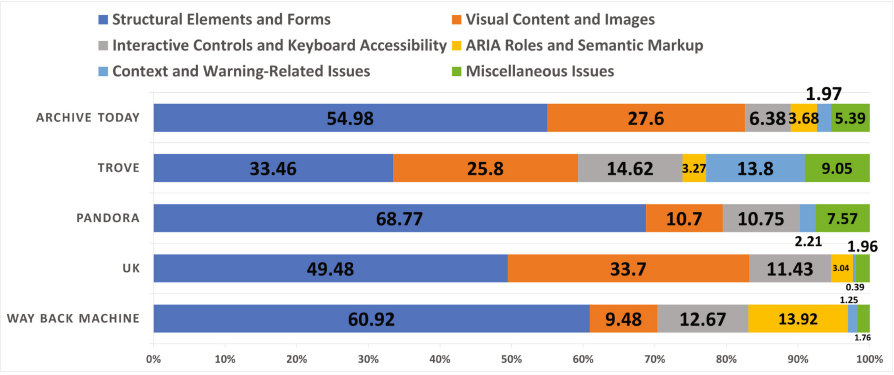


Fig. 2. Accessibility issues across web archives.

4 Results

4.1 Accessibility of Web Archives

As explained earlier, the accessibility issues uncovered in the reports were grouped into six categories or themes. The percentage distribution of these

themes based on their frequency of occurrence for each of the analyzed web archives is shown in Fig. 2. As seen in this figure, the accessibility issues pertaining to the *structural elements and forms* comprised the largest share in all five web archives. On the other hand, the *context and warning-related* issues accounted for the least share in all archives except Trove. Other salient findings included the absence of issues related to ARIA roles and semantic markup in the Pandora web archive, and the significant presence of all six themes in the Trove web archive. Notable observations within each theme are presented next.

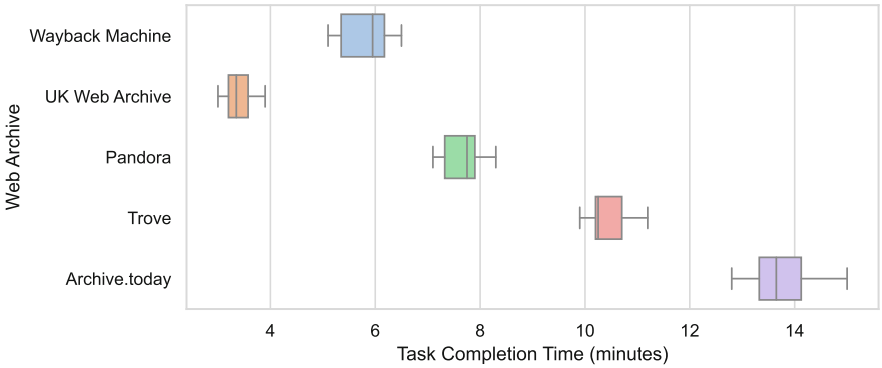
Structural Elements and Forms. Further breakdown of issues pertaining to structural elements and forms revealed disparities among the web archives. For the Wayback Machine, most of these issues were regarding *Headings* (11.15%), *Styles/Content* (13.5%), and *Forms* (22.43%), which indicates that screen reader users are highly likely to face challenges in navigating the content and understanding the page structure in the Wayback Machine website. On the other hand, Trove exhibited the lowest proportions for Headings (8.48%), Styles/Content (4.69%), and Forms (6.59%), which in turn suggests that Trove's website is more easily navigable due to a clearer and intuitive structure that can be easily perceived by blind users. The high proportion of Table-related issues (17.79%) in the Archive.today website also warrants attention, as it suggests potential accessibility issues concerning navigation of tabular data in this web archive.

Visual Content and Images. The UK Web Archive exhibited the highest percentage of accessibility issues related to images (33.7%). These issues included missing or inadequate alternative text descriptions for the visual content on this platform. Trove and Archive.today also exhibited high percentages of image-related issues (25.8% and 27.6%, respectively), suggesting that these web archives also have significant room for improvement.

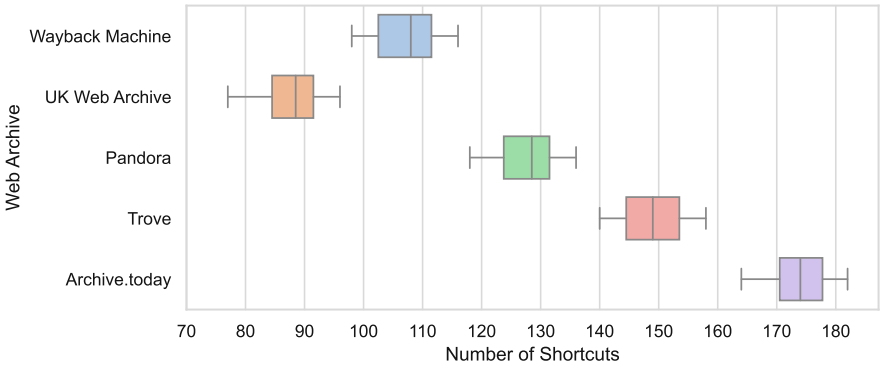
Interactive Controls and Keyboard Accessibility. Notable observations included: (i) The percentages of issues related to Links (1.86%), Widgets/Scripts (1.43%), and Time-sensitive content (1.86%) in the Wayback Machine were observed to be relatively low; and (ii) Percentage of issues related to time-sensitive content (6.23%) in case of the Trove archive were relatively high.

ARIA Roles and Semantic Markup. As seen in Fig. 2, the Wayback Machine had significantly higher percentages of ARIA-related issues compared to the other archives. The specific issues in the Wayback Machine included non-unique IDs used in ARIA and labels, as well as the ARIA property not updating dynamically when content changes. Pandora on the other hand, did not have any ARIA-related issues.

Context and Warning-Related Issues. Very few context and warning-related issues were discovered in all the web archives except Trove. The promi-



(a) Boxplot for task completion time.



(b) Boxplot for the number of shortcuts.

Fig. 3. User study results: (a) task completion time, and (b) number of shortcuts.

nent issue in this regard was the presence of content with a high tendency to cause seizures, especially in the Trove archive (13.8%).

Miscellaneous Issues. The miscellaneous issues included the use of scripts to emulate links, the absence of accessible names for the Select element, and the use of a placeholder attribute as a visible label replacement. These issues were mostly seen in the Trove (9.05%) and Pandora (7.57%) web archives, whereas very few such issues were discovered in the case of the other three web archives.

4.2 Usability Analysis of Web Archives

Task Completion Times. Fig. 3a shows a box plot for task completion time metric for all web archives. Overall, participants spent, on average, 5.81 min doing the tasks on the Wayback Machine website, 3.41 min on the UK Web Archive, 7.67 min on Pandora, 10.43 min on Trove, and 13.75 min on

Archive.today. An ANOVA test revealed a statistically significant difference in task completion times between the archives (F-Statistic: 757.94, p-value $<$ 0.001). Further, pairwise comparisons between archives using post-hoc Tukey's HSD tests showed significant differences between all the pairs (see Table 1).

Table 1. Tukey's HSD test for Task Completion Time.

Comparison	HSD Statistic	p-value
Wayback Machine vs. UK web archive	2.400	<0.001
Wayback Machine vs. Pandora	−1.860	<0.001
Wayback Machine vs. Trove	−4.620	<0.001
Wayback Machine vs. Archive.today	−7.940	<0.001
UK web archive vs. Pandora	−4.260	<0.001
UK web archive vs. Trove	−7.020	<0.001
UK web archive vs. Archive.today	−10.340	<0.001
Pandora vs. Trove	−2.760	<0.001
Pandora vs. Archive.today	−6.080	<0.001
Trove vs. Archive.today	−3.320	<0.001

A detailed examination of the study data revealed that certain interaction activities significantly influenced task completion time, particularly in the process of locating and filtering snapshots based on specific dates. Notably, the accessibility and usability of date-related filter elements emerged as key factors impacting task completion time. In the UK Web Archive, the selection of date-related elements was notably easy for blind users; the date selection was presented in the form of a list, which was easily navigable using a screen reader. Consequently, blind users could efficiently select a snapshot for the desired date, leading to lower task completion times. Conversely, when all snapshots of all dates were presented simultaneously on the screen, blind users faced challenges in locating and selecting the desired date. This difficulty in date selection contributed to higher task completion times in the Archive.today condition. In other web archives, while date filters were available to facilitate snapshot selection for different dates, using these filters was moderately challenging for the participants. As a result, the task completion times for these web archives lied between those for the UK web archive and Archive.today.

Number of Shortcuts. Figure 3b shows a box plot for the number of screen reader shortcuts pressed by the participants while doing the tasks in each web archive. The number of shortcut presses reflects the effort exerted by the participants in doing the tasks. Overall, participants spent, on average, 107.2 shortcuts on the Wayback Machine, 87.8 shortcuts on the UK Web Archive, 127.6 shortcuts on Pandora, 149.0 shortcuts on Trove, and 173.7 shortcuts on Archive.today.

An ANOVA test revealed a statistically significant difference in the number of shortcuts among the platforms (F-Statistic: 321.98, p-value < 0.001). Further, pairwise comparisons between archives using post-hoc Tukey's HSD tests showed significant differences between all the pairs (see Table 2).

Table 2. Tukey's HSD test for Number of Shortcuts.

Comparison	HSD Statistic	p-value
Wayback Machine vs. UK web archive	19.400	<0.001
Wayback Machine vs. Pandora	−20.400	<0.001
Wayback Machine vs. Trove	−41.800	<0.001
Wayback Machine vs. Archive.today	−66.500	<0.001
UK web archive vs. Pandora	−39.800	<0.001
UK web archive vs. Trove	−61.200	<0.001
UK web archive vs. Archive.today	−85.900	<0.001
Pandora vs. Trove	−21.400	<0.001
Pandora vs. Archive.today	−46.100	<0.001
Trove vs. Archive.today	−24.700	<0.001

The number of shortcuts metric was significantly influenced by the navigational effort spent in: (i) finding and accessing the archived snapshots or mementos of specific webpages at particular dates; and (ii) locating and accessing snapshots for different specific dates after retrieving the initial snapshots. This navigational effort varied across web archives, and it was the highest in Archive.today and the lowest in the UK web archive.

4.3 Qualitative Feedback

Some of the notable themes that emerged from the qualitative analysis of exit interview data collected from the participants are listed next.

Desire for Quicker and More Efficient Navigation. Eight out of ten participants expressed frustration with sluggish navigation and information retrieval process on the Wayback Machine website. One participant stated that "It's like trying to find a needle in a haystack. I need a quicker way to access content." Another participant echoed this sentiment, mentioning, "I feel like I'm going in circles. There has to be a faster way to find what I'm after."

Filter Options and Clear Explanation. Six out of ten participants pointed out the need for clearer explanations and more intuitive placement of filters in the Archive.today archive. One of the participants stated that "The filters are all over the place. It's like a scavenger hunt every time I want to use them." Another

participant emphasized that "I spend more time hunting for filters than actually using them. Grouping them logically and providing clear explanations would be a game-changer."

Enhanced Snapshot Recovery. Seven participants proposed integrating the date and target website name into a single command for snapshot recovery. Regarding this, a participant stated that "Entering date and website separately is tedious. Combining them into one command would save me a lot of hassle."

Difficulty Finding Specific Links. Eight out of ten participants reported significant challenges in locating specific links in Archive.today archive, e.g., FAQ link. Regarding this, one participant said that "Finding specific links feels like looking for a lost treasure. It shouldn't be this difficult."

Direct Access to Search Results Directly. Five participants suggested adding shortcuts in Pandora for instant access to search results, thereby streamlining the search process. One participant emphasized that "I feel like I'm on a click marathon just to get to the results. A shortcut button would be a lifesaver."

Simplifying the Layout Style. Six out of ten participants recommended simplifying the Pandora website's layout to improve the user experience. Regarding this, a participant remarked: "The layout feels like a maze. Simplifying it would make navigation a breeze."

Limited Exposure to Web Archives. The vast majority of participants (9 out of 10) reported having no prior exposure to the web archives. Only one participant mentioned limited past experience with the Internet Archive. However, 6 participants expressed a strong desire to learn more about web archives due to their curiosity after the study. The remaining 4 participants mentioned that it was difficult to use these archives and were not particularly enthusiastic about knowing more about these archives.

5 Discussion

The findings of this study underscore the need to reassess the design of web archive platforms to enhance their accessibility and usability for blind users.

5.1 Unique Issues of Web Archives

Temporal Navigation. Users of web archives often need to navigate through multiple versions of the same web page captured at different times, requiring a mechanism to easily switch between and compare different versions. For example, a screen reader user examining the evolution of a webpage's content over several years may struggle if the archive's user interface doesn't provide for quick and easy switching between mementos.

Archival Metadata Accessibility. Web archives include metadata such as capture dates, timestamps, and source information, which must be presented in an usable manner to a screen reader user. For example, a legal professional verifying the contents of a webpage potentially containing evidence, will require access to metadata such as exact capture date and time.

Broken Links. Archived webpages often contain broken links or missing elements due to incomplete captures or changes on the web, which can impede navigation and accessibility. A user trying to follow a link in an archived page may encounter a broken link, disrupting their ability to access the complete context and complete their task.

5.2 Limitations and Future Work

A limitation of our study is the small sample size of participants. Although these participants provided valuable insights into the accessibility and usability of web archives, it is crucial to acknowledge that user experiences and challenges can vary significantly across people. This is particularly true for individuals with vision impairments, whose experiences can differ widely based on their eye condition and computer skills. A larger and more diverse sample would enable a more thorough understanding of the issues and user needs across various platforms and contexts. Our study primarily addressed the experiences of screen-reader users. We aim to extend this study to fully understand the challenges faced by low-vision individuals who rely on screen magnifiers for web access.

The limitation in sample size also extends to our focus on five specific popular web archive platforms. It is important to acknowledge that other web archive platforms may vary in their structure and interaction patterns, necessitating exclusive assessment of their accessibility compliance and usability. Additionally, web archive platforms undergo continuous evolution, including regular changes to the user interface that can inadvertently affect accessibility and usability. Consequently, there is a pressing need to continuously reassess these platforms to ensure they remain accessible to blind users. Furthermore, the accessibility compliance of these platforms was assessed using the IBM Equal Access Accessibility Checker tool. Future studies could employ a range of advanced tools to gain additional insights into these websites, enhancing the comprehensiveness and accuracy of accessibility evaluations.

The time constraints imposed during the study also limited the comprehensiveness of the user data collected and the subsequent analysis. Participants' interactions with web archive platforms during the study may not have fully captured the experiences of users who engage with web archives over extended periods. Also, the varying levels of familiarity of our participants with screen readers may have influenced their perceptions of usability on these platforms. In future research, we will explore the impact of screen reader expertise on the usability of web archives.

The study was conducted exclusively with blind users. Although the observed user effort in terms of number of shortcuts and the total time taken per task were

very high, it would have been more informative to compare these performance values with those of sighted users, to analyze the present usability gap between sighted and blind users. This is scope of our future work.

Another limitation is that the tasks selected for our user study may not have covered the full range of possible interactions users can possibly have with web archives. Thus, our findings may have missed some of the accessibility and usability issues in web archives.

5.3 Suggestions for Web Archive Developers

Accessibility Enhancements. Web archive developers should prioritize adding more ARIA landmarks, labeling forms, providing text alternatives for visual content, adding more headings, making links discernible, using unique ID attributes, and creating frame titles. By avoiding obsolete features and reducing unnecessary information, developers can ensure compatibility with assistive technologies and provide a more accessible user experience. Additionally, implementing a feedback mechanism allows for continual enhancement based on user insights, ensuring that the archive remains accessible and user-friendly.

User Interface Optimization. Simplifying and optimizing the user interface is crucial for improving the overall user experience of web archives. Developers should streamline the interface, simplify the set of filters, and ensure that important links are prominently displayed at the top of the webpage within the interface, as this ensures they are among the first elements encountered by screen readers when navigating the page. Enhancing navigation by making it simpler to locate specific dates and content snippets is also essential. By optimizing the search bar, which involves improving its compatibility with screen readers, enhancing its efficiency in delivering search results audibly, and reducing navigational congestion, developers can create a more intuitive and user-friendly interface that enhances usability and accessibility for all users.

Uniformity in Navigation. A major usability issue identified by our participants is that they have to constantly adapt to the variations in the user interfaces across different web archive platforms. This inconsistency in navigational requirements induces an additional cognitive burden on screen reader users. To mitigate this issue, it is crucial for web archive developers to adhere to common design guidelines, aiming to streamline a simple user interface across various platforms. Specifically, it is essential that users be able to search for and retrieve snapshots of archived websites across different platforms following a similar navigational path, thus enhancing their overall user experience. Third party user-side solutions can also be designed which provide uniform proxy interfaces on top of the original web pages (e.g., [25,41,47]). We plan to explore third party solutions for web archives in future work.

Enhancements for Snapshot Comparisons. A common task on web archive platforms involves comparing snapshots of a website from different points in time. This process can be particularly overwhelming for screen reader users, who are required to navigate through multiple web pages repeatedly and retain information regarding the differences, which can cause significant cognitive burden. To

alleviate this issue, web archive developers should implement a more simplified method that allows users to easily retrieve and compare multiple snapshots of a webpage via a single accessible interface. Additionally, this interface should highlight major differences automatically in a way that is accessible to blind users. Such enhancements would substantially reduce the cognitive load and improve the usability of web archives for screen reader users.

5.4 Suggestions for Assistive Technologies Developers

Screen Reader Improvements. Assistive technology developers can play a vital role in improving the accessibility of web archives for users with disabilities. Enhancing screen reader functionality, particularly in detecting and interacting with elements like search bars and filters, is crucial. Providing contextual feedback and simplifying navigation commands can help users better understand and interact with archived content. Additionally, improving assistance for ARIA landmark roles and enhancing link descriptions can further aid blind users in navigating web archives effectively.

Accessibility Features. Developers of assistive technologies should focus on enhancing accessibility features to provide a more seamless experience for users with visual disabilities. This includes facilitating convenient navigation of date selection widgets, optimizing content navigation for a small set of well-known shortcuts, and simplifying narration and access to search filters. By providing feedback mechanisms and improving cross-platform compatibility, developers can ensure that assistive technologies work effectively across various platforms and environments, ultimately enhancing the accessibility and usability of web archives for all users.

6 Conclusion

Our study uncovered essential insights regarding the accessibility and usability of prominent web archiving services, such as the Wayback Machine, UK Web Archive, Trove, Pandora, and Archive.today. Through a rigorous evaluation process utilizing the IBM Equal Access accessibility checker tool, we identified accessibility issues common across archives. Furthermore, through a usability study, we uncovered interaction issues in the aforementioned web archive platforms with Archive.today ranking the least user-friendly, and the UK Web Archive emerging as the most user-friendly digital archive. User feedback highlighted the immediate need for improved navigation, clearer instructions on buttons and links, particularly in forms, directing users on how to complete each field, and specifying where each click will take users when interacting with any link or button across the entire website, among other issues. Our contributions also included suggestions for web archive service providers and assistive technology developers for enhancing the usability of online web archives.

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