Evaluating automatically adapted public e-services: first insights from users with low vision

Myriam Arrue, Aritz Sala and Xabier Gardeazabal

EGOKITUZ, Faculty of Informatics, University of the Basque Country (UPV/EHU), Spain

Abstract

As e-government services become increasingly fundamental to public administration, ensuring their accessibility is both a legal and ethical imperative. Web forms are a ubiquitous feature of public e-services, but they frequently present interaction challenges, particularly for users with disabilities. This paper presents an experimental study involving ten participants with low vision who interacted with four Spanish public e-services in both their original and automatically adapted versions. These adaptations were generated in real-time using an adaptation system based on a previously established model including annotation ontologies for web forms. The study focuses on subjective user feedback collected through post-task questionnaires and final interviews. Findings indicate that the adapted interfaces were well accepted. Participants reported greater ease of use and high levels of satisfaction. The results underscore the value of dynamic, personalized adaptations in improving accessibility-in-use for public digital services.

Keywords

Web accessibility, public e-Services, low vision, adapted interfaces, user experience

1. Introduction

The use of information and communication technologies (ICT) in public administration—commonly referred to as e-government—has continued to expand across the globe in recent years. The United Nations E-Government Survey 2024, published by the UN Department of Economic and Social Affairs [1], is the latest edition of the biennial report assessing the development of digital government across the 193 UN Member States. This thirteenth edition highlights a continued global upward trend in e-government development, with significant investments in resilient digital infrastructure and emerging technologies. The global average value of the E-Government Development Index (EGDI) has improved notably, and the share of the global population living in countries with low e-government development fell from 45% in 2022 to 22.4% in 2024. The Web Accessibility Directive [2] was launched in 2016 and remains in force and states that all public sector websites are required to be accessible. Moreover, its application has been expanded through complementary legislation such as the European Accessibility Act [3]. The objective of the latest is to extend accessibility requirements to a wider range of products and services, including e-commerce platforms, banking services, and more. These developments reflect the EU's ongoing commitment to ensuring digital accessibility for all citizens. Among the most common digital interactions with public administrations is the completion of online forms, which are essential for accessing services such as employment assistance, healthcare, and administrative appointments [4, 5]. However, unless these forms are fully accessible, they can exclude users with disabilities from crucial services. People with low vision, in particular, often encounter barriers when interacting with visually demanding elements such as date selection elements, captchas, or form validation feedback messages [6]. This highlights the importance of "accessibility-in-use" evaluations, which reveal practical obstacles that may not be identified through automated or guideline-based assessments alone [7, 8]. In addition, techniques such as personalization, automatic adaptations and transcoding applied for informational web pages [8] may also improve the user experience of people with low vision in such public e-services. This paper presents an experimental study comparing the interaction of ten people with low vision

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myriam.arrue@ehu.eus (M. Arrue); asala020@ikasle.ehu.eus (A. Sala); xabier.gardeazabal@ehu.eus (X. Gardeazabal)

0001-8859-8964 (M. Arrue); 0002-9945-0161 (A. Sala); 0002-9703-9782 (X. Gardeazabal)

with four original public Spanish e-services with their adapted versions. The adapted versions were dynamically generated at run-time by an automated adaptation system, developed based on the model introduced in [9]. The results discussed in this paper focus on subjective data collected through standard post-task questionnaires and a final user interview. The initial analysis reveals promising outcomes for the proposed system, with participants expressing a positive reception and high acceptance of the adapted interfaces.

2. Related work

To assess the accessibility of e-government services, numerous studies have been conducted over the past decade based on the standards mentioned earlier. These studies consistently reveal that many government websites still fail to comply with current accessibility regulations. Notable examples include evaluations of government websites in Slovenia [10], Alabama [11], Italy [12], and several African countries [13]. Although these works commonly employed automated accessibility evaluation tools, most were limited to analyzing homepage compliance with WCAG guidelines [14], and few incorporated users with disabilities in the evaluation process. As highlighted in [15], special attention must be paid when assessing the accessibility of web forms. These components play a crucial role in e-government services, yet very few studies evaluate the complete interaction flow of web forms. The design of forms significantly impacts both accessibility and usability. Despite their importance, there is currently no international standard for accessible form design patterns. In the absence of such standards, national guidelines are often used—for example, the United Kingdom's design system [16] and Norway's ELMER guidelines [17]. In the United States, a similar initiative seeks to standardize the design of public e-service forms across federal agencies to ensure consistent and inclusive access [18]. These efforts aim to simplify interaction and enhance communication between citizens and public administrations. For users with low vision, completing online forms can pose significant challenges. When using assistive technologies such as screen magnifiers, users often need to shift their field of vision frequently, which can result in a loss of context. Many magnification techniques also require horizontal scrolling, which negatively impacts usability. A study presented in [19] compared the effectiveness of screen magnifiers with responsive web designs, concluding that responsive layouts requiring less horizontal scrolling were more user-friendly. The Accessibility Requirements for People with Low Vision working draft published by the W3C [20] outlines key visual presentation needs (e.g., font, size, and text style), but it lacks guidance on interactive components commonly found in web forms, such as input fields, labels, action buttons, and feedback messages. One promising direction to improve accessibility is the use of adaptive interfaces. Adapted versions of web interfaces can offer more accessible and usable experiences tailored to the needs of specific users. Several transcoding systems have been proposed in this regard [21, 22, 23], but these approaches typically target isolated pages or specific impairments and lack a comprehensive model for adapting full e-service systems, particularly those involving complex forms. The present study aims to address this gap by comparing user interactions with original, officially compliant public e-service interfaces and with adapted versions generated at runtime by an automated system. This system builds on the authors' previous work [9] and is designed to improve accessibility and usability for users with low vision through dynamic interface adaptation.

3. Automated adaptation system

3.1. Architecture of the system

Figure 1 shows the general architecture of the automated adaptation tool implemented. It is based on a client/server model. The model of the system was thoroughly described in [9]. The client was developed as an add-on for the Firefox browser, whereas the server is composed of the adaptation engine and several repositories: annotations repository and knowledge base. The annotations repository contains the annotations of the public e-services to be adapted and the knowledge base holds the adaptation

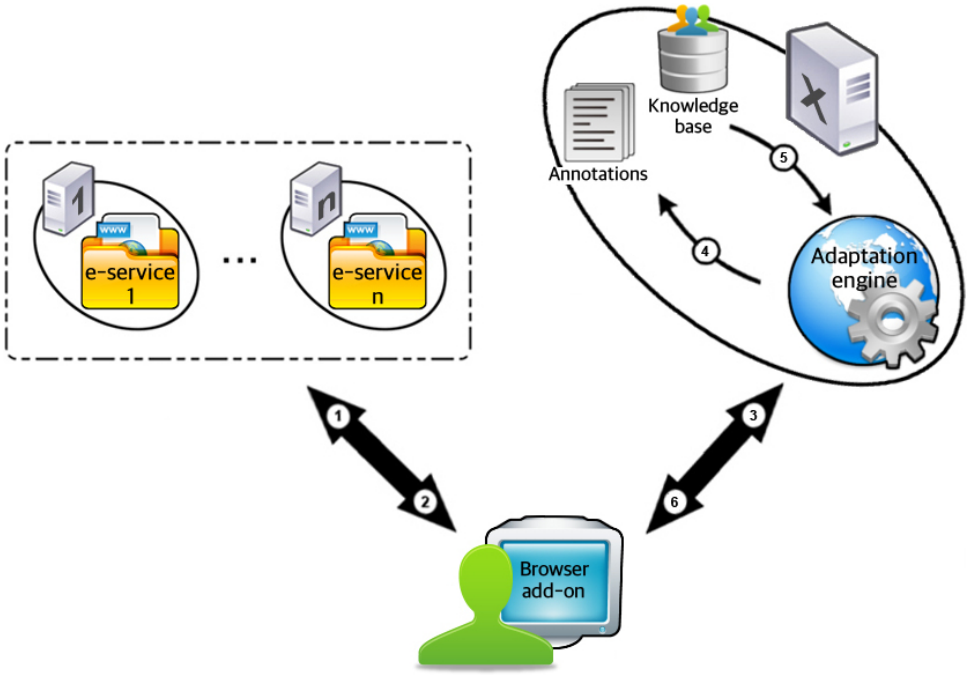

Figure 1: Architecture of the automatic adaptation system.

techniques to be applied. The process for generating an adapted version of an e-service is as follows:

1. The user accesses the e-service via Firefox with the add-on activated.
2. The add-on retrieves the web interface of the e-service.
3. The add-on establishes communication with the system's server.
4. The server checks the annotations repository and retrieves the relevant annotations for the e-service.
5. The necessary adaptations are fetched from the knowledge base.
6. The adapted interfaces are generated by applying the specified adaptation techniques to the respective components of the e-service.

3.2. Annotations of e-services

Each e-service to be adapted must have an associated annotation file stored in the annotations repository. This study focuses specifically on public e-services that require users to complete online forms. Typically, these processes involve multiple steps—many of which are common across different e-services—and users are often required to provide similar data. These shared characteristics led us to develop an annotation model capable of covering the overall process, individual steps, and the specific data required from users. The primary goal of these annotations is to extract valuable information to facilitate the automatic application of selected adaptation techniques, tailored to user features and preferences. Figure 2 illustrates the ontology designed for annotating the e-services. Currently, the annotation process is entirely manual, as described in [9].

3.3. Adaptation techniques

The adaptation techniques are stored in the knowledge base. In the case of this experimental study, they are oriented to improve the navigation experience of people with low vision by:

1. Providing uniform style for e-services
2. Structuring the process in steps
3. Ordering steps and grouping components in steps

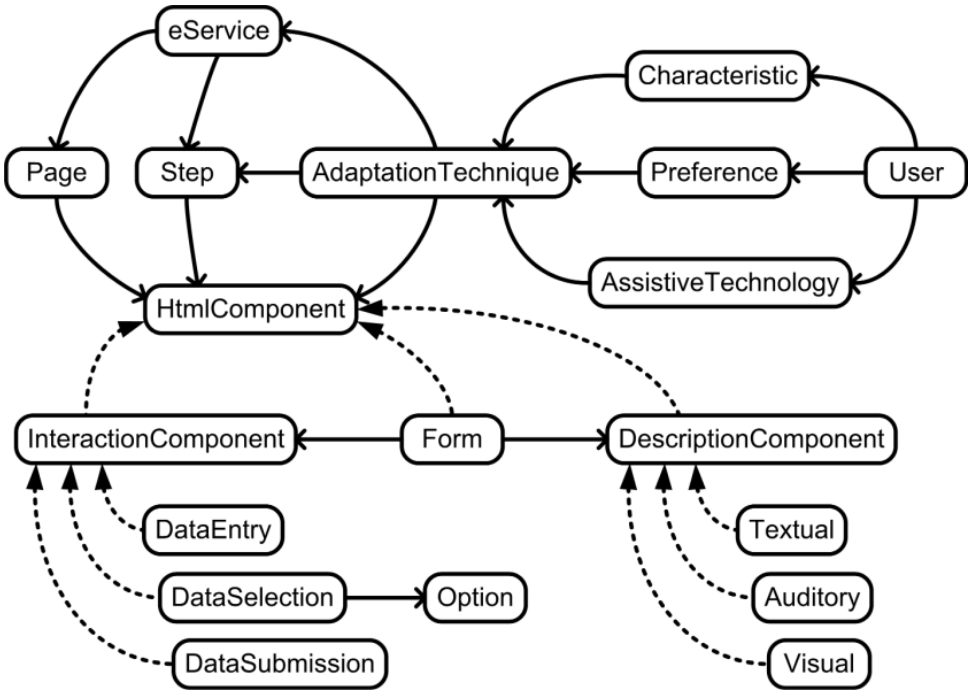

Figure 2: Graphical schema of the ontology defined for annotating the e-services.

4. Identifying steps and overall progress of the process
5. Changing the presentation to high contrast colours
6. Resizing components
7. Replacing the selection components (DataSelection)

These adaptation techniques were selected based on previous work. The first four techniques (1–4) are aimed at improving user orientation during the fulfillment process and were developed as a result of the ELMER project [17]. Adaptations 5 and 6 are defined according to the Accessibility Requirements for People with Low Vision [20]. The final adaptation (7) was proposed based on earlier authors' studies involving people with low vision [6, 24, 25] which indicated that participants felt more comfortable when options were presented as links rather than through radio buttons or select components.

3.4. Example of adapted e-service

The adaptation system automatically generates adapted versions of e-services at run-time. It segments the form into its components and presents the user with a step-by-step process, showing simplified interfaces that facilitate data entry. Figure 3 illustrates the original interface of the OSA e-service initial form page alongside the adapted versions created by the system, based on the defined annotations and adaptation techniques.

4. Experimental study

4.1. Participants

Participants were recruited with the help of two associations for people with visual impairments: Begiris Elkartea in Gipuzkoa and Itxaropena Elkartea in Araba. The inclusion criteria required participants to be adult users with visual disabilities who regularly use screen magnifiers and have experience browsing the web. A total of ten participants (P1–P10) took part in the study, with an average age of 41 years (SD = 12.2). Among them, three were men (P3, P5, and P10) and seven were women. One participant (P9) was legally blind, while the remaining participants had low vision. The experiment

Figure 3: The original interface of OSA e-service (top left) and the automatically generated adapted versions.

Table 1
Information about the participants of the study.

Participant ID	Gender	Age	Assistive Technology
1	F	31	windows magnifier
2	F	57	browser zoom
3	M	23	windows magnifier
4	F	51	browser zoom
5	M	35	dragnifier magnifier
6	F	31	dragnifier magnifier
7	F	34	windows magnifier
8	F	44	browser zoom
9	F	44	browser zoom
10	M	60	browser zoom

was conducted in a single session lasting approximately one and a half hours. Participants used their usual assistive technologies during the session, with browser zoom being the most common tool. All participants reported high levels of computer literacy and web browsing experience (more than twice a week). The experimental sessions were held at two locations: a laboratory at the Faculty of Informatics in Donostia and a laboratory at the School of Engineering in Gasteiz (both locations within University of the Basque Country). Table 1 presents detailed information about the participants.

The same desktop computer was used in all sessions, a Dell computer running a 64-bit version of Windows 10 Enterprise LTSC. A widescreen LCD monitor (aspect ratio 16:10) with a 24-inch diagonal and a resolution of 1920×1200 pixels was employed to display the public e-services. Assistive technologies used varied among participants: Windows Magnifier (P1, P3, P7), standard browser zoom (P2, P4, P8, P9, P10), and Dragnifier (P5, P6). All sessions were video-recorded, and each participant received compensation in the form of a €50 gift ticket for a department store. The study received ethical approval from the Ethics Committee for Human Research at the University of the Basque Country (CEISH-UPV/EHU, M10_2019_037).

4.2. Stimuli

Four public Spanish administration websites were selected as stimuli for this exploratory study: OSA, the public website of the public health service in the Basque Country; SGS, the public website of Social Security; DNI, the public website of the Ministry of Home Affairs; and DON the public website of the

City Hall of Donostia-San Sebastián. All of these websites comply with web accessibility standards. Although each website features distinct content and design, they all offer users the service of scheduling an appointment, which is provided through a multi-step web form. Users are required to enter personal data and select an appointment date. The process involves interacting with various elements such as text inputs, radio buttons, selection areas, captchas, and buttons. To streamline the experiment, we developed an initial web page (INIw) that contains direct links to the first step of each web form. Participants began all tasks on this page, selecting the corresponding link to complete the tasks outlined in the study.

4.3. Methodology

A within-subjects design was used in this study, where each participant completed the same tasks—scheduling an appointment through a web form—using two different interface versions: the original and an adapted version.

The independent variable was the interface version (original vs. adapted). The dependent variables were post-task satisfaction, measured using the After Scenario Questionnaire (ASQ) and user emotions, assessed after each task using the Self-Assessment Manikin (SAM).

The defined null hypothesis was the following: "There are no significant differences in user satisfaction (ASQ scores) or emotional responses (SAM dimensions) between the original and adapted interface."

4.4. Procedure and tasks

First, participants were briefed on the purpose of the experiment and signed a consent form. Demographic and expertise information was collected through a brief pre-session interview. Prior to starting the session, participants were encouraged and assisted to adjust the system to meet their preferences. The required assistive technology for each participant had been pre-configured and installed correctly on the system. All sessions were video-recorded, and interaction data—including page loads, task start and end times, visited links, scroll actions, and clicks—was captured via a locally implemented application developed by the research group. Next, participants were asked to complete a set of tasks, consisting of two tasks on each website: one using the original design and one using the adapted interface. The order of presentation was counterbalanced. For each task, participants were required to complete the web form to schedule an appointment with the service. All tasks began from the initial webpage (INIw), where the experimenter instructed participants to select the corresponding direct link based on the assigned task. At the start of each task, participants were provided with both an oral explanation and a printed explanation. For example, in the DNI task the instructions were: "Please get an appointment to renew your ID card by selecting this link," with the experimenter clearly indicating the correct link. To address concerns about entering personal data, detailed sample information was provided—printed in large format—for each task, which participants were instructed to use when filling out the forms. Each task had a completion time limit of 10 minutes. Upon task completion, participants participated in an interview and completed the After-Scenario Questionnaire (ASQ) [26] to rate their satisfaction with the e-service. The ASQ included three closed-ended Likert-scale (1–7) questions assessing satisfaction regarding the ease of task completion, the time required, and the support information provided by the system. Additionally, participants rated their subjective experience of using the e-service via the Self-Assessment Manikin (SAM) [27] and answered two extra questions related specifically to their experience inputting the required information into the forms. Comments and feedback regarding the experience and any barriers encountered were annotated by the experimenter throughout the sessions. Finally, at the end of the experiment, participants were interviewed to evaluate the adaptation system, the automatically generated adapted interfaces, and to discuss their overall preferences between the original and adapted versions.

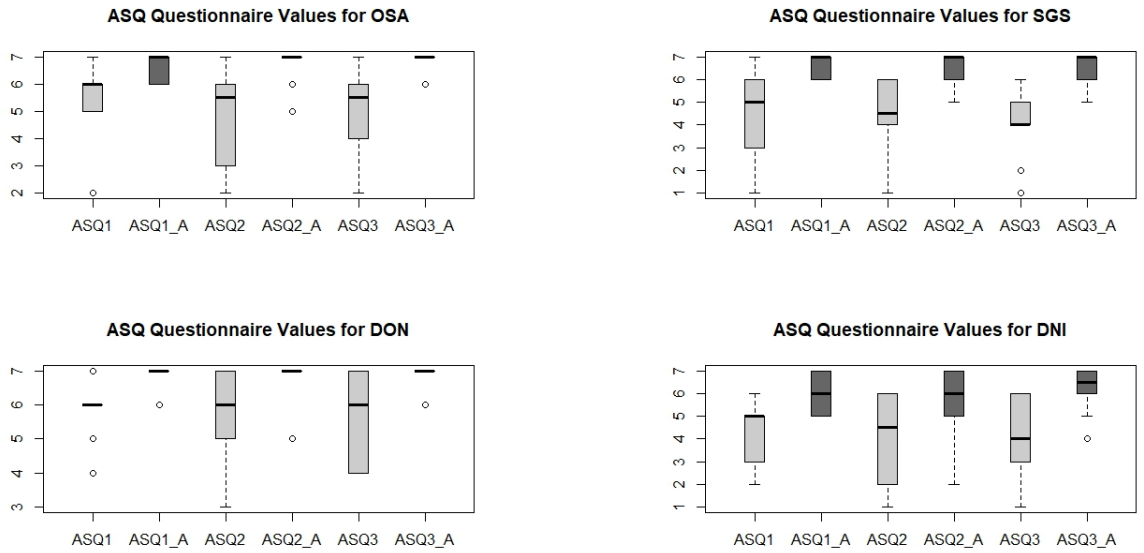

Figure 4: Values gathered for questions in ASQ questionnaire for each task in OSA, SGS, DON and DNI e-services.

5. Results

5.1. ASQ questionnaire results

Participants were required to complete the After-Scenario Questionnaire (ASQ) at the end of each task to gather their subjective perceptions regarding their experience with the public e-service. This questionnaire includes three items, each rated on a 7-point Likert scale (1 indicating the lowest satisfaction and 7 the highest): the first one rating the easiness for completing the task (ASQ1), the second one rating the appropriateness of the required time for completing the task (ASQ2) and the third one rating the convenience of the feedback provided by the e-service (ASQ3). Figure 4 presents the values provided by participants for each e-service, comparing the original version (ASQ1, ASQ2, ASQ3) and the adapted version (ASQ1_A, ASQ2_A, ASQ3_A). The overall average score for ASQ1 across all e-services was 5.02 (SD = 1.59). The DONe- service received the highest average score (5.9, SD = 0.87), while SGS and DNI had the lowest (4.5 on average, with SD = 1.9 for SGS and SD = 1.35 for DNI). In the adapted versions, the scores for ASQ1_A improved for all e-services, with an overall average of 6.57 (SD = 0.63). DON again received the highest rating (6.8, SD = 0.42), and SGS showed the greatest improvement, with a 2.2 point increase (from 4.5 to 6.7, SD = 0.48). All e-services obtained higher ratings in the adapted version, with the smallest improvement being 0.9 points in the case of DON. The average ASQ2 score for all e-services in the original version was 4.7 (SD = 1.85). DON scored the highest (5.8, SD = 1.39), while DNI scored the lowest (3.9, SD = 2.02). For the adapted versions, the average ASQ2_A score increased by 1.72 points, reaching 6.42 (SD = 1.05). Again, DON scored the highest (6.8, SD = 0.63), while DNI, although having the lowest among the adapted versions, improved by 1.5 points (from 3.9 to 5.6, SD = 1.57). The original version of the e-services had an average ASQ3 score of 4.77 (SD = 1.73). DON received the highest score (5.8, SD = 1.31), while SGS had the lowest (4.1, SD = 1.59). In the adapted versions, the overall average for ASQ3_A increased to 6.6 (SD = 0.7). Notably, OSA showed a 1.9-point improvement, rising from 5.0 (SD = 1.82) to 6.9 (SD = 0.31). SGS also saw a significant increase, reaching 6.5 (SD = 0.7), and DNI had the lowest ASQ3_A score, though still relatively high at 6.2 (SD = 1.03). We performed the Wilcoxon signed-rank test for analyzing the differences between values gathered in both versions the original and the adapted interfaces. The results showed the differences were statistically significant for all ASQ questions ($V = 552.5$, p-value < 0.01 for ASQ1 and ASQ1_A; $V = 488$, p-value < 0.01 for ASQ2 and ASQ2_A; $V = 521.5$, p-value < 0.01 for ASQ3 and ASQ3_A).

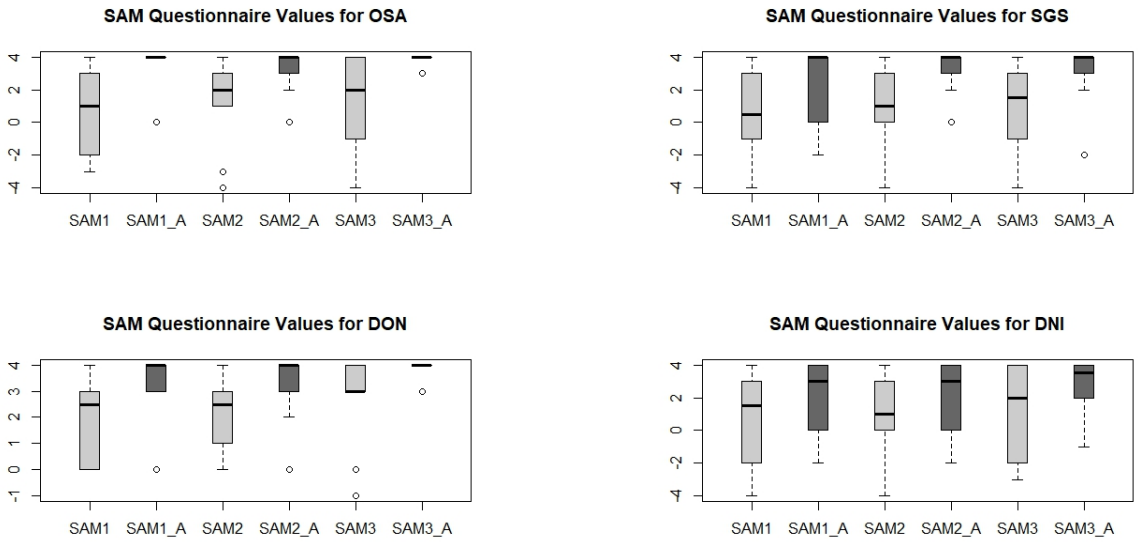

Figure 5: Values gathered for questions in SAM questionnaire for each task in OSA, SGS, DON and DNI e-services.

5.2. SAM questionnaire result

Participants completed a questionnaire based on the Self-Assessment Manikin (SAM) after each task to assess their emotional responses during their interaction with the public e-service. This instrument includes three items rated on a Likert scale ranging from -4 to 4 (where -4 indicates the lowest and 4 the highest intensity): the first item (SAM1) assesses the level of pleasure experienced during the task, the second (SAM2) evaluates the motivation to engage in the task, and the third (SAM3) measures the perceived sense of control or dominance over the situation. Figure 5 presents the values reported by participants for each e-service, both for the original version (SAM1, SAM2, SAM3) and for the adapted version (SAM1_A, SAM2_A, SAM3_A). For SAM1, the overall average score across all e-services was 1.02 (SD = 2.53). The highest value was obtained by DON (2.1, SD = 1.59), while OSA and SGS showed the lowest scores (0.6, SD = 2.75 for OSA; 0.6, SD = 2.71 for SGS). In the adapted versions, all e-services reported higher average values for SAM1_A, with an overall mean of 2.77 (SD = 1.94). The OSA e-service stood out with the highest increase, reaching 3.2 (SD = 1.68), which represents a 2.6 point improvement. Even in the case of DON, which initially had the highest score, an increase to 3.1 (sd = 1.66) was observed. Regarding SAM2, the overall average score was 1.3 (sd = 2.4), with DON again obtaining the highest mean (2.2, SD = 1.47) and DNI the lowest (0.7, SD = 2.86). The adapted versions improved considerably, with an overall average score of 2.95 (SD = 1.69). DON saw the smallest increase (from 2.2 to 3.3, SD = 1.33), while OSA, SGS, and DNI showed more substantial improvements: 2.0, 2.2, and 1.3 points respectively. For SAM3, the overall average score was 1.45 (SD = 2.65). DON once again reported the highest score (2.7, SD = 1.76), and SGS the lowest (0.7, SD = 2.83). In the adapted interfaces, the overall mean for SAM3_A rose to 3.3 (SD = 1.47). SGS improved by 2.3 points (to 3.0, SD = 1.88), and OSA experienced the greatest increase of all e-services (from 1.4 to 3.8). DON, which already scored relatively high, still showed a notable improvement to 3.9 (SD = 0.31), representing a 1.2 point increase. Statistical analysis using the Wilcoxon signed-rank test confirmed that the differences between the original and adapted interfaces were significant for all SAM dimensions ($V = 338$, p-value < 0.01 for SAM1 and SAM1_A; $V = 439.5$, p-value < 0.01 for SAM2 and SAM2_A; $V = 370$, p-value < 0.01 for SAM3 and SAM3_A).

5.3. Acceptance of adapted versions

At the end of the experiment, participants were interviewed regarding their acceptance of the adaptation system. Specifically, two questions were asked: QUE1, concerning their preference between the original and the adapted versions of the e-services, and QUE2, regarding their willingness to use the adapted versions on a daily basis. All participants expressed a preference for the adapted versions and stated they would use them in their daily life, except for participant P6. This participant was reluctant to trust the adapted versions, expressing concern about potentially missing information due to the simplified nature of the interfaces and the fact that they were not the official ones. As a result, she was uncertain about her preference and her willingness to use the adapted versions in her daily routine. Several participants highlighted positive aspects of the adapted versions during the interview. These are some of the comments they shared: P1: "I liked the contrast and the bigger format of text. I did not need to use the magnifier with the adapted versions." P4: "The adapted versions are simplified containing only the main content and avoiding distractors. I liked them and I was more efficient." P7: "I liked the step by step format of the adapted version of DNI to select the location." P8: "I do not like long forms and prefer the reduced step by step forms of the adapted versions." P9: "I like the colors, contrast and simplified interfaces." P10: "The adapted version is better. I appreciate that it's simpler."

6. Discussion

All the evaluated e-services are legally accessible according to WCAG guidelines. Although participants were able to complete the tasks using the original versions, the ASQ questionnaire results showed a clear preference for the adapted versions across all aspects. Even the DON e-service, which already obtained the highest ratings among the original versions, saw an improvement in average scores in terms of ease of use, perceived efficiency, and quality of feedback. From an emotional perspective, participants also responded more positively to the adapted interfaces. According to the SAM questionnaire results, these versions elicited higher levels of pleasure, motivation, and a greater sense of control. The adaptation system was well accepted. Most participants preferred the adapted interfaces and appreciated the applied modifications, such as simplified layouts, step-by-step data entry, improved contrast, and larger font sizes. Several participants explicitly stated they would like to use the adapted versions in their daily interactions with public e-services. Notably, participant P1 mentioned that she did not need to use a screen magnifier when using the adapted interfaces. The adaptations focused primarily on enhancing the usability of interactive form components. However, some official elements, such as institutional logos, were not retained. Based on participant P6's concerns regarding trust and perceived legitimacy, future versions could consider including visual cues or annotations to reinforce the official appearance of the adapted interfaces. These findings are consistent with previous research that emphasizes the challenges users with low vision encounter when interacting with web forms. For instance, studies such as [6] and [24] have highlighted the limitations of standard accessibility approaches and the need for interface simplification and enhanced visual contrast. The improvements observed in participant satisfaction and emotional response in the present study align with earlier work that advocates for adaptive and personalized interfaces [21, 23]. Furthermore, the positive reception of the step-by-step structure and high-contrast designs reflects principles recommended by national guidelines, such as ELMER [17] and the UK Government Design System [16]. Additionally, the e-services that applied the adaptation system achieved a consistent structure and design across interfaces, in line with the standardized templates described in [18], which provide uniform layouts for home pages, identification pages, and web forms to facilitate user navigation. Therefore, this study not only confirms previous knowledge but also extends it by demonstrating the effectiveness of real-time adaptation systems in public e-services.

7. Limitations of the study

Despite the promising findings, this study presents several limitations. First, the number of e-services analyzed was limited to only four, all focused on appointment-scheduling tasks within Spanish public administration platforms. However, the studied e-services included a variety of interaction components that may be representative of a broader range of public e-services. Second, the study involved a relatively small group of participants—ten individuals with low vision. While participants reported similar experiences and perceptions, the small sample size limits the statistical power and generalizability of the findings.

8. Conclusions and future work

This study analysed dynamically adapted interfaces in enhancing the accessibility and usability of web forms within public e-services for individuals with low vision. The experimental evaluation, conducted with ten participants, revealed that the adapted versions were not only well received but also led to a noticeable improvement in ease of use and overall user satisfaction. These findings underscore the potential of real-time, personalized adaptations to mitigate interaction challenges and promote digital inclusivity in public e-service platforms. Despite these promising results, further research is needed to verify the scalability and long-term benefits of such adaptive systems across a broader spectrum of public digital services and user groups. Future studies should consider larger sample sizes and include users with diverse accessibility needs to develop a more comprehensive understanding of adaptive interventions. Moreover, exploring objective performance metrics could provide deeper insights into user experience and system efficiency.

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Declaration on generative AI

During the preparation of this work, the authors used GPT-4 in order to: Grammar and spelling check and Improve writing style. After using this tool, the authors reviewed and edited the content as needed and take full responsibility for the publication's content.

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