

NAVEGO: Design and Formative Evaluation of an Accessible Web Extension to Support Safe Browsing for Older Adults

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ABSTRACT

Older adults are increasingly exposed to digital services for communication, access to information, online payments, and social participation. However, this growing dependence on web technologies may also increase their vulnerability to intrusive advertising, misleading interfaces, fraudulent forms, phishing attempts, and social engineering attacks. This paper presents NAVEGO, a web extension designed to support safer browsing experiences for older adults by combining ad and pop-up blocking, detection of potentially malicious forms, accessible interface resources, and preventive guidance. The development process was grounded in Human-Computer Interaction principles. It included benchmarking of existing ad-blocking tools, persona-based design, low- and medium-fidelity prototyping, analytical usability inspection, heuristic evaluation, automated accessibility assessment, and a formative accessibility evaluation conducted by three of the authors acting as expert evaluators in persona-based scenarios. No older adults took part in the evaluations reported here; the findings therefore characterize barriers anticipated by evaluators, and not the effectiveness of the extension for its target population. The evaluations revealed usability and accessibility issues, including limited visibility of controls, ambiguous terminology, screen reader announcements based on internal variable names, insufficient feedback for critical actions, and unclear communication of protection states. These findings yield concrete design recommendations for accessible and usable security tools aimed at older adults, and define the corrections required before an evaluation with older participants can be undertaken.

KEYWORDS

Web accessibility, older adults, usable security, browser extension, human-computer interaction, digital fraud prevention.

1 INTRODUCTION

Population aging is taking place in a context of increasing digital mediation of everyday activities. For older adults, connected technologies expand opportunities for communication, information, payments, and social participation; however, they may also intensify vulnerabilities when there is low familiarity with interfaces, insecurity in the use of devices, or difficulty in recognizing risk situations [2, 6, 8, 15]. Among the most relevant risks are misleading advertisements, misinformation, communicational manipulation, improper requests for data, and digital scams, which may cause financial, social, and emotional harm. The cybersecurity literature emphasizes that prevention does not depend solely on technical mechanisms, but also on digital education, critical capacity, and safe browsing practices [26, 28].

Digital literacy is not merely the operational ability to use devices and applications; it also involves locating, understanding, and critically assessing information in the context of autonomous and safe use [8, 15, 20]. Levels of digital literacy among older adults are consequently heterogeneous, influenced by education, previous experience with technology, and opportunities for digital inclusion [28]. These differences directly affect the identification of risks, the interpretation of suspicious messages, and decision-making during browsing [17].

Suspicion of fraud is typically constructed from combined signs such as urgency, requests for secrecy, requests for passwords or banking data, promises of advantage, suspicious links, and unverified pages. These elements are characteristic of social engineering, exploiting trust, curiosity, distraction, or lack of knowledge to induce harmful actions [17, 26]. Intrusive advertising and pop-ups that interrupt browsing or redirect users to external pages compound the problem, increasing exposure to behavioral tracking and to malicious practices [26].

Given this scenario, digital protection strategies aimed at the population aged 60 and over should consider not only technological blocking mechanisms, but also resources that promote the understanding of risks and support the development of digital competencies. This article presents NAVEGO, a web application designed to support safe browsing for older adults, focusing on reducing risks associated with digital

fraud, improper collection of sensitive data, and potentially malicious interactions.

1.1 Contributions

The central contribution of this work is the design and formative evaluation of an accessible security tool for older adults: a set of design requirements and redesign recommendations that emerge from applying accessibility criteria and usable security criteria jointly, rather than separately, to a browser extension. Three elements support this contribution: (i) NAVEGO itself, a browser extension that combines intrusive content blocking, suspicious form detection, accessibility resources, and preventive guidance; (ii) the requirements elicitation process, grounded in benchmarking, persona construction, and analytical and heuristic inspection; and (iii) a functional prototype combining declarative network request rules with DOM-based heuristics, which made the accessibility barriers concrete enough to be inspected with a screen reader. We claim no evidence of technical effectiveness against digital scams, nor of usability for older adults; both require the studies outlined in Section 7.1.

2 RELATED WORK

The protection of web browsing has been addressed through ad blockers, cybersecurity tools, and strategies adopted by digital platforms. Ad blockers monitor browser requests and restrict advertising content through blocklists, which can reduce intrusive ads, loading time, data consumption, behavioral tracking, and malicious advertising [1, 21].

Such solutions are nevertheless designed for broad Internet audiences rather than for older adults. They focus on the technical filtering of advertising, trackers, and intrusive content, but tend not to guide users regarding communicational risks, data requests, suspicious forms, or the consequences of their actions [11, 26]; and their technical terms, small text, and complex settings may hinder use by people with lower digital literacy, low technological confidence, or sensory and motor limitations [9, 12].

Studies on programmatic advertising show that profile-based personalization increases concerns about privacy, and that variables such as age influence perceptions of online advertising and of ad blockers [25]. A further line of work analyzes the economic impact of ad blockers on advertisers, publishers, and platforms, focusing on the advertising ecosystem rather than on the direct protection of vulnerable groups [1, 7].

Traditional cybersecurity tools, such as antivirus software, firewalls, multifactor authentication, encryption, backups, and system updates, preserve the confidentiality, integrity, availability, and authenticity of information. However, digital scams also involve social and behavioral dimensions, such as social engineering, phishing, smishing, spoofing, and fake profiles, requiring understandable guidance, contextual prevention, and support for decision-making [26].

In this space, NAVEGO is positioned as a complementary proposal: it is not limited to blocking ads, nor does it operate

merely as a generic security tool. Its contribution lies in combining protection, accessibility, preventive guidance, and risk mediation for older adults, bringing the solution closer to the principles of Human-Computer Interaction by considering autonomy, trust, communicational clarity, and the reduction of cognitive load during browsing.

3 NAVEGO DESIGN PROCESS

The conception of NAVEGO originated from an ideation stage carried out within the scope of the Human-Computer Interaction (HCI) course, offered in the graduate program of the Institute of Mathematics and Computer Sciences of the University of São Paulo (ICMC-USP). After analyzing different proposals for web and mobile applications, the development of a web tool was defined, aimed at supporting safe browsing for older adults and reducing risks related to the theft of sensitive data, online financial scams, and unwanted transactions.

Development took place gradually throughout the course, articulating concepts of interface conception, design, and evaluation with practical activities. This dynamic made it possible to transform design decisions into progressive artifacts, guided by the profile of the target audience and by the evidence collected during the stages of benchmarking, persona construction, prototyping, and evaluation.

The process was organized into seven sequential stages, each producing an artifact that fed the next: (S1) benchmarking of three existing tools, producing an initial requirements list; (S2) construction of two personas from secondary demographic data, which prioritized those requirements; (S3) low- and medium-fidelity prototyping; (S4) analytical inspection of the medium-fidelity screens against website design patterns and design guidelines; (S5) heuristic evaluation of the same screens; (S6) implementation of a functional extension for the Firefox browser; and (S7) accessibility evaluation of the implemented extension, combining screen reader inspection under persona-based scenarios with automated and semi-automated checking. Stages S1–S5 concern design and are reported in this section; stages S6 and S7 are reported in Sections 4 and 5, respectively. All inspections and task executions were carried out by three of the authors of this paper, who were students enrolled in the course. No older adult participated at any stage, a limitation whose consequences are discussed in Section 5.7.

3.1 Benchmarking

After the ideation stage, benchmarking was carried out as a qualitative technique for the comparative analysis of existing solutions for the protection of web browsing, following the notion originally defined by Camp (1995) as the search for best practices capable of leading organizations to superior performance. Three tools were analyzed — AdGuard AdBlocker, Ghostery: Privacy Ad Blocker, and AdBlock Plus — against criteria of target audience, platforms, features, visual organization, aesthetic characteristics, accessibility resources, and usage limitations. All three offer ad blocking, tracker blocking,

customized lists, and protection control, but present limitations for older users: technical language, complex settings, reduced interactive elements, and the absence of accessible guidance on risks.

Based on this comparison, initial requirements for NAVEGO were defined: an interface centered on older adults, simple language, alerts about potentially malicious forms, blocking of ads and pop-ups, visual security indicators, enlarged clickable areas, high contrast, font enlargement, responsiveness, alternative texts, and clear feedback. These requirements guided the subsequent stages of interface conception, personas, and functionalities.

3.2 Personas

Based on the requirements identified, two personas were developed to represent potential user profiles. According to Pruitt and Adlin [19], personas are fictional, specific, and concrete representations of target users, useful for making explicit their characteristics, needs, limitations, and goals during the development of interactive products.

The characterization of the personas used secondary data from the ICT Households survey by Cetic.br [5], scientific studies, population data from IBGE [13], and information from SEADE [10]. The profiles are fictional and have an exclusively academic and illustrative purpose; the associated images were generated with the support of generative artificial intelligence to avoid the use of real people and to produce representations consistent with the defined attributes. Table 1 presents a comparative synthesis of the two personas, relating profile, relevant conditions, and direct implications for the design of the solution.

Two decisions guided the definition of these profiles. First, the personas were built to contrast rather than to average: among the dimensions described in the secondary sources, two that the benchmarking stage had shown to be decisive for the use of protection tools — level of digital proficiency and type of device predominantly used — were instantiated at opposite ends of the observed distribution, so that requirements derived from one profile would not silently absorb those of the other. Second, the sensory and motor conditions attributed to each persona were restricted to conditions with high prevalence in the 60 and over age range, rather than selected for illustrative effect. It must be stressed, however, that two personas cannot represent the heterogeneity of the older population, which varies widely in education, digital literacy, and functional conditions. Profiles that are equally plausible and were not covered — older adults with cognitive decline, without family support, or without previous experience with the Internet — constitute a known gap in the requirements elicited here.

3.3 Interface design focused on usability

With the benchmarking and personas defined, interface prototyping began based on user-centered design, usability, and the active participation of potential users. Students from

the HCI course participated in a simulated exercise of embodying the personas, discussing the needs, limitations, and expectations of the target audience.

Initially, low-fidelity prototypes were developed, understood as quick and partial models of the final product, useful for exploring alternatives for interface organization and interaction flows before computational implementation [22]. In NAVEGO, this stage made it possible to discuss the arrangement of elements, clarity of alerts, size of components, organization of information, and suitability of the language for the older audience. Figure 1 summarizes the first interfaces conceived.

Figure 1 shows, respectively, the initial interface of the extension, the settings page, and the signaling of a potentially malicious form aimed at capturing sensitive data. Medium-fidelity prototypes were then produced, with greater visual and interactional proximity to the final product; according to Dantas et al. (2012), this type of prototyping balances speed of construction with sufficient realism to anticipate evaluations, reduce redesigns, and support adjustments before final coding. Figure 2 presents, respectively, the activation panel, the security warning displayed in response to a suspicious form, and the settings area.

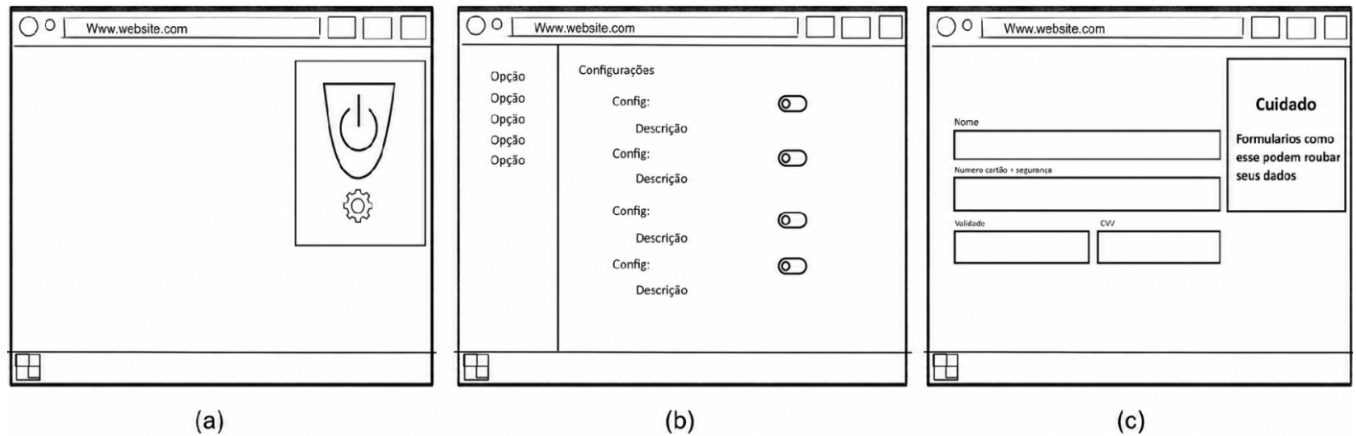
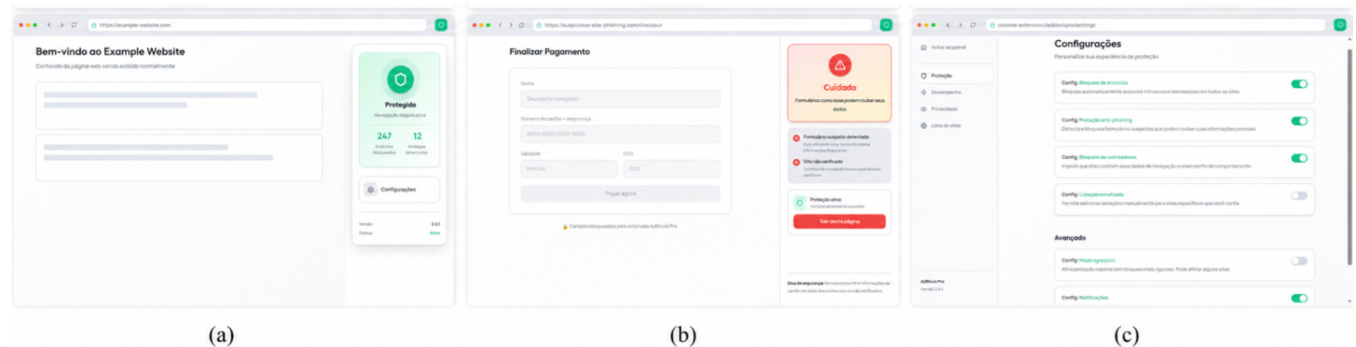
3.4 Analytical usability evaluation of NAVEGO

The analytical evaluation examined the communicational, structural, and interactional quality of the medium-fidelity screens, considering NAVEGO's purpose of supporting safe browsing for older adults. The qualitative inspection focused on the Activation, Security Warning, and Settings screens, adopting website design patterns from Montero et al. [16] and selected guidelines from Nielsen [18].

Four patterns were employed: Indication, guiding the analysis of clarity regarding location, available actions, and consequences; Similarity, addressing visual and functional continuity across screens; Ready, addressing ease of initial use without technical knowledge; and Polite, addressing the adequacy of the language for older adults. The analysis indicated visual consistency, informative cards, icons with a communicational function, and objective messages, but pointed to the need to refine terms such as “Aggressive mode” and “Custom list”. Nielsen's guidelines, applied to task prioritization, home page clarity, user-centered language, and layout adaptation, showed that critical actions appear prominently and that labels emphasize protection, security, and privacy, while indicating the need to reduce redundancies, clarify the consequences of advanced modes, and validate responsiveness, zoom, keyboard navigation, visible focus, and screen reader compatibility. The analytical evaluation thus suggests adherence to usability principles, but reinforces the need for complementary accessibility validation before consolidating the application.

Table 1: Summary of NAVEGO personas.

Aspect	Person 01: Josefa	Person 02: Valmir
Profile	Woman, 70 years old, low education level, low digital proficiency, and predominantly uses a cell phone.	Man, 64 years old, medium to high education level, average digital proficiency, and uses a cell phone and laptop.
Relevant conditions	Reduced visual acuity, fear of making mistakes, caution, and technological support from children.	Hearing and motor impairment, use of online shopping and banking, impulsivity, and a history of fraud.
Implications for design	The need for simple language, contrast, enlarged font, and step-by-step guidance.	The need for error prevention, clear alerts, confirmation of critical actions, and decision support.

**Figure 1: NAVEGO's low-fidelity interfaces.****Figure 2: NAVEGO's medium-fidelity interfaces.**

3.5 Heuristic evaluation

The medium-fidelity screens were also subjected to a heuristic evaluation, conducted by three of the authors as evaluators, with the objective of identifying perceived problems in the main screens. Heuristic evaluation is an inspection method in which evaluators examine the interface based on recognized usability principles. Its application is recommended throughout the design cycle and with more than one evaluator, since different evaluators tend to identify different problems [23].

Heuristics such as visibility of system status, match between the system and the real world, user control and freedom, consistency and standards, error prevention, recognition rather than recall, aesthetic and minimalist design, help users recognize and recover from errors, and help and documentation were considered. The evaluators recorded the problem, location, violated heuristic, severity, and proposed improvement.

The main findings involved ambiguity in the indicators of blocked ads and detected threats, the need to replace technical

terms with language closer to that of older users, lack of initial guidance on the consequences of actions, ambiguity of the “Leave this page” button, use of red in the safe action button, and difficulty understanding toggle-type controls.

The most severe criticism was the possibility of disabling protection against online scams without additional confirmation, which could increase the user’s vulnerability. The recommendations focus on making indicators more specific, revising terminology, including an initial guide, making configuration states explicit, and requiring confirmation for critical actions.

3.6 Planned usability evaluation with older adults

A usability evaluation with older adults was designed during the course but has not yet been conducted. It is described here because it delimits what the present work does not demonstrate, and because its protocol was shaped by the problems reported in the following sections. Its purpose is to verify whether older adults, with little or no familiarity with computers, understand the NAVEGO interface, locate the appearance settings area, and adjust accessibility features such as dark mode, high contrast, bold text, font size, and notifications.

This stage cannot be replaced by the analytical, heuristic, and inspection methods reported in this paper, since the direct observation of the target audience makes it possible to identify hesitations, misinterpretations, spontaneous doubts, and trial-and-error strategies. Jeffries and Desurvire [14] argue that inspection methods are useful, especially when conducted by experts, but they do not replace testing with the target audience.

The planned protocol comprises individual sessions in a controlled environment, lasting approximately 25 minutes, using a desktop computer, presentation of the Free and Informed Consent Form, observation of the interaction, the Thinking Aloud technique, spreadsheet recording, and application of the System Usability Scale (SUS), with total task time, success rate, error rate, time without interaction, and favorable or unfavorable comments as metrics. Quantitative data are to be analyzed using descriptive statistics, and qualitative data by identifying patterns of problems. No SUS score and no task metric are reported in this paper, since no session has been carried out. As stated in Section 6, this study will be submitted to a Research Ethics Committee before any data collection.

4 THE NAVEGO APPLICATION

The functional version is an extension for Firefox browsers, whose focus was maintained on blocking intrusive content and protecting against deceptive elements, such as suspicious payment forms, without exposing the user to complex settings.

Architecturally, the extension combines declarative network request rules (`declarative_net_request`) in `manifest.json`

and `rules.json` with DOM heuristics in `content.js`. The `background.js` file manages the global state and toggles the ruleset according to `storage.local`, while the pop-up and options page display states, preferences, and local counters.

The `content.js` file uses keywords, regular expressions, and specific selectors to identify ads and sensitive forms. Ads are hidden via CSS with priority and markers in the dataset to avoid double processing, while payment forms are disabled and receive an explanatory overlay. A `MutationObserver` ensures that mitigation also works on dynamically loaded content, such as SPAs.

These choices represent trade-offs between performance, privacy, and simplicity. DNR blocks resources at the network level, reducing overhead and avoiding dependence on external telemetry, while DOM heuristics allow immediate offline detection; a lightweight background script and local storage prioritize efficiency and privacy. Reliance on static rules and heuristics, however, may limit coverage and generate false positives.

5 RESULTS OF THE EXPERT-BASED ACCESSIBILITY EVALUATION

The accessibility evaluation of NAVEGO investigated whether the implemented interface provides adequate conditions for access, navigation, comprehension, and operation in scenarios associated with older adults and their functional needs. It was an expert-based, formative evaluation: the tasks were executed and observed by three of the authors, in a controlled setting, without the participation of the target population. It therefore complements the analytical and heuristic inspections reported above, but it does not stand in for the observation of real users. As discussed by Jeffries and Desurvire [14], inspection methods are useful for anticipating usability problems, but they do not replace observations of participants representing the target audience. Similarly, Rocha and Baranauskas [23] argue that evaluation should accompany the interface development cycle and provide evidence for successive design refinements. The findings reported below should accordingly be read as barriers anticipated by evaluators, and not as effects measured on older adults.

5.1 Evaluation Protocol

The evaluation was conducted as a formative inspection by three graduate students enrolled in the HCI course, who are also authors of this paper. The three alternated roles across the sessions: in each session, one executed the pre-defined tasks while the other two observed and recorded findings. The person executing the tasks worked under a persona-based scenario derived from the design process and, where the scenario required it, under simulated interaction conditions, using the VoiceOver screen reader in the screen reader scenarios. There were no external participants and no participants from the target population. The goal was neither to produce statistically generalizable results nor to estimate how older adults would perform, but to surface accessibility barriers that would obstruct such a study if left uncorrected.

Each session lasted approximately 25 minutes and was guided by predefined activities involving the operation of the NAVEGO extension. During the sessions, the observers recorded task execution, interaction difficulties, hesitations, requests for help, comments, and suggestions. The evaluation focused especially on the comprehension of interface elements, visibility of controls, accessibility of configuration options, clarity of protection states, and communication of consequences in critical actions.

The collected observations were consolidated by the evaluators and organized according to problem severity. The evaluation also incorporated accessibility checks with screen reader interaction and automated and semi-automated inspection tools, allowing the analysis to combine evaluator judgment with technical accessibility evidence.

5.2 Persona-Based Tasks

The activities were structured around the two personas used throughout the design process. The first persona, Josefa, represents an older adult with reduced visual acuity, low digital proficiency, predominant smartphone use, and fear of making mistakes when interacting with digital technologies. For this profile, two activities were proposed.

In the first activity, Josefa, out of fear of scams and fraud, decides to block all forms encountered while browsing: the task involved opening the extension, accessing the settings page, adjusting accessibility resources such as dark mode, high contrast, and font size, enabling strict mode in the “Form Blocking” section, saving, and refreshing the browser. The second activity required enabling additional protection filters in the general settings tab.

The second persona, Valmir, represents an older adult with reduced auditory and upper motor functions, intermediate digital proficiency, use of online shopping and banking services, and previous exposure to digital scams. Two activities were also proposed for this profile. The first required disabling protection against malicious forms, simulating a risky decision on a critical protection feature; the second required disabling NAVEGO completely, confirming the decision, refreshing the page, and reactivating protection after a simulated change of mind. These tasks examined not only navigation through the interface, but the clarity of protection states, the communication of consequences, and the need for confirmation in potentially risky actions.

5.3 Consolidated Accessibility Findings

The consolidated evaluation identified problems with different levels of severity. Table 2 summarizes the number of findings by severity level. Overall, the results show that NAVEGO already provides relevant accessibility resources, but still presents barriers that may compromise safe and autonomous use by older adults, especially when using screen readers or when performing critical configuration actions.

The most critical findings concerned screen reader accessibility. First, the confirmation modal displayed when disabling protection appeared visually but was not announced

Table 2: Number of problems identified by severity level.

Severity	0	1	2	3	4	N/A
Number of findings	2	1	5	7	2	1

by VoiceOver, so a blind user may not perceive that a dialog requiring action has opened; this indicates the need for appropriate dialog semantics, such as `role="dialog"`, focus management, and live region mechanisms. Second, feedback messages exhibited a systematic defect: when controls were activated, the extension announced internal technical names, such as *fontSize*, *darkMode*, and *blockForms*, instead of user-facing labels. The defect affects both the pop-up and the options page, and it is especially serious in a security tool, where the user must be able to tell whether a protection resource is enabled or disabled.

Several high-severity issues were also identified. The extension pop-up opened without an automatic announcement by VoiceOver and without moving focus to a meaningful element. The settings button, represented by a gear icon, was announced only as “button”, without an accessible name describing its function. In addition, counters for blocked advertisements were not reachable through keyboard navigation and were not read by the screen reader. Controls in the “Form Blocking” section were also announced without sufficient functional description, and changes in toggle controls did not clearly communicate the new state to the user.

These findings indicate that the main accessibility barriers are not limited to visual design, but also involve semantic structure, accessible naming, focus order, and state communication. For older adults with visual impairments or low digital literacy, unclear feedback may increase uncertainty, reduce trust, and lead to incorrect decisions in security-related interactions.

5.4 Positive Aspects

The evaluation also revealed positive aspects. The main pop-up button had an accessible name and was announced as “Change protection”, and the extension provides native accessibility options — font size adjustment, dark mode, and high contrast — relevant for users with reduced visual acuity. The options page was mostly readable by VoiceOver, and the interface was considered simple and composed of few elements, which reduces visual complexity and cognitive load. A further positive design decision was the presence of a confirmation step before protection is disabled: although the modal itself requires accessibility corrections, the existence of the step contributes to error prevention in a critical security action.

5.5 Automated Accessibility Inspection

An automated accessibility evaluation of the extension’s settings page was carried out with the WAVE extension, which supports the identification of nonconformities and possible

WCAG violations while still depending on human interpretation of the findings [24, 27]; it does not replace manual inspection, keyboard navigation, testing with screen readers, or evaluation with real users.

The analysis of the `options.html` file identified a missing or insufficiently informative title, a contrast error in the active item of the side menu, the absence of semantic regions, and the absence of a first-level heading. As positive points, the language was defined as pt-BR, alternative texts were observed in images, level-2 headings were present, and ARIA was used in a dynamic message area. The convergence between these findings and the evaluators' observations is notable: the barriers most frequently reported during the sessions — controls without an accessible name and states that are not communicated programmatically — correspond to nonconformities that an automated tool also flags, which suggests that a substantial part of the reported problems could have been detected and corrected before the sessions took place.

5.6 Semi-Automated Accessibility Inspection

The evaluators' observations were complemented by semi-automated inspections. The Firefox Accessibility Inspector was used to examine the `options.html` page and identified accessibility issues related to elements with generic roles and null accessible names, as well as contrast and keyboard-related warnings. These findings reinforce the need to improve semantic markup, keyboard navigation, and accessible naming across the interface.

The W3C HTML Validator also identified structural problems in the `options.html` file. The first issue was the absence of a required `title` element in the `head`, which violates the expectation that pages provide an informative title and may impair identification by users navigating with assistive technologies. The second issue was the absence of a first-level heading, since the page starts with lower-level headings. This affects the document hierarchy and may compromise navigation by screen reader users.

Together, these semi-automated inspections confirm that some accessibility barriers are associated with the underlying HTML structure of the extension, rather than only with visual layout decisions. Therefore, improving NAVEGO requires both interface redesign and code-level accessibility corrections.

5.7 Threats to Validity

The design of this evaluation restricts what may be concluded from it, and three of these restrictions are substantive.

The first is expert bias. The people who executed and observed the tasks are the same people who designed the interface. They knew where each control was, what each label was meant to convey, and which state each toggle should reach. Barriers that depend precisely on *not* knowing the interface — searching for a function in the wrong place, forming an incorrect mental model of what “blocking” does, abandoning

a task out of uncertainty, or interpreting a security warning as an accusation — are systematically invisible to this design. The problems reported above should therefore be read as a lower bound: they are the barriers that persisted even for evaluators who already knew the answers.

The second is the limit of simulation. Simulating reduced visual acuity or restricted motor function reproduces a constraint on the channel of interaction, but not the conditions that accompany it in the target population: fatigue, fear of an irreversible mistake, unfamiliarity with the vocabulary of digital security, the absence of a repertoire for error recovery, and the differences in digital literacy that the personas were constructed to represent. A younger evaluator using a screen reader is learning an assistive technology under observation; an older adult who depends on one is not. In particular, nothing in this evaluation speaks to whether the preventive guidance offered by NAVEGO is understood, trusted, and acted upon by the people it addresses — which is the very mechanism through which the tool is supposed to protect them.

The third concerns the severity ratings summarized in Table 2. Severity was assigned by the designers of the interface, without independent raters and without a measure of inter-rater agreement. The counts should be read as an ordering of priorities for redesign, not as a measurement.

These limits are the reason the present work is framed as a formative design study. The corrections listed in Section 5.8 are preconditions for an evaluation with older adults, not substitutes for it.

5.8 Design Implications

The evaluation provided concrete recommendations for re-designing NAVEGO. The first set of improvements concerns screen reader accessibility. All interactive controls should receive clear, accessible names that describe their function, avoiding the announcement of internal variable names. Toggle controls should communicate their current state through appropriate attributes, such as `aria-pressed` or equivalent mechanisms. Confirmation dialogs should use proper dialog semantics, move focus to the modal when opened, and return focus to the triggering element when closed.

The second set concerns keyboard navigation and focus order: counters and status information should be reachable or announced meaningfully, the focus sequence should follow the visual and logical structure of the interface, and the pop-up should provide an initial focus target or announcement when opened. The third set concerns visual accessibility and cognitive simplification: buttons should be placed closer to the explanatory texts they relate to, the size and visibility of interactive elements should be increased, icons such as the settings gear should be made evident and properly labeled, and the warning modal should be simplified, with sufficient contrast and a clear indication of the consequences of critical actions. Finally, the structure of the options page should be corrected by adding an informative `title`, a unique `h1`,

and semantic regions such as **nav** and **main**, improving orientation, predictability, and autonomy for users of assistive technologies. None of the problems reported in this section were corrected in the version evaluated here; they are reported as an open correction backlog, ordered by the severity ratings of Table 2. The accessible naming and state communication of controls, the semantics and focus management of the confirmation dialog, and the announcement of the pop-up are blocking issues, in the precise sense that an older adult who depends on a screen reader cannot use the protection features autonomously while they persist. Correcting them is a precondition for the study described in Section 3.6, since running that study on the current version would measure defects that are already known rather than the design questions of interest. Overall, the evaluation indicates that NAVEGO offers relevant resources for supporting safer browsing, but that its accessibility depends on improving semantic feedback, state communication, keyboard navigation, and the clarity of critical interaction flows.

6 ETHICAL ISSUES

This study was conducted within the scope of a graduate course in Human-Computer Interaction at the Institute of Mathematics and Computer Sciences of the University of São Paulo (ICMC-USP). No approval by a Research Ethics Committee (CEP) was requested for the activities reported in this paper, and the reasoning behind that decision deserves to be stated explicitly rather than left implicit.

The evaluations reported here did not involve human participants in the sense of Resolution 510/2016 of the National Health Council [4]. The three people who executed and observed the tasks are themselves authors of this paper. No one was recruited, invited, or enrolled as a participant; no data about persons were collected, analyzed, or reported; and the unit of analysis was the interface, not the people operating it. What Section 5 reports are records of defects in an artifact, produced by its own designers, in the same sense as the automated and semi-automated inspections reported alongside them. Before each session, these three authors nevertheless agreed on the procedure, on the simulated interaction conditions, and on the possibility of interrupting the activity at any time.

The situation is entirely different for the study described in Section 3.6. It involves older adults, a group whose participation demands particular care with regard to consent, fatigue, and the asymmetry between participant and researcher, and it concerns behavior in the face of simulated fraud, a sensitive topic. That study will be submitted to a Research Ethics Committee through Plataforma Brasil, accompanied by a Free and Informed Consent Form, and no data will be collected before approval is obtained. The present paper reports no data originating from it.

Data protection commitments follow the same distinction. The records produced in the present evaluation contain no personal data. In the planned study, collection will be limited to what the usability analysis requires — task completion,

time on task, interaction errors, requests for help, subjective satisfaction, think-aloud comments, and evaluator notes — with anonymized records, no images of participants, and treatment in accordance with the Brazilian General Data Protection Law (Law No. 13,709/2018) [3].

7 FINAL REMARKS

This article presented NAVEGO, a web tool aimed at supporting safe browsing for older adults, with a focus on preventing digital fraud and promoting more accessible, clear, and predictable interaction. The proposal was developed based on principles of Human-Computer Interaction, considering stages of ideation, benchmarking, persona construction, prototyping, and different forms of interface evaluation.

The evaluations conducted characterize what the current version of NAVEGO does and does not offer to a user who depends on assistive technology. On the one hand, the extension provides native accessibility resources such as high contrast and font enlargement, an interface composed of few elements, and a confirmation step before protection is disabled. On the other, the evaluations revealed barriers in the clarity of labels, the visibility of controls, the semantic structure of the page, the communication of system states, and the accessibility of the confirmation of critical actions. These findings are perceptions of evaluators in persona-based scenarios: they do not establish that NAVEGO is effective in protecting older adults against digital fraud, and no claim to that effect is made here.

It is concluded that accessibility should be understood as a central requirement of NAVEGO, and not merely as a technical validation step. Furthermore, reflecting on different possible profiles and characteristics, such as those present in the older population, is also a crucial aspect to consider in the development of the solution. Therefore, since NAVEGO was developed with the purpose of protecting older adults against digital fraud, its interface must promote autonomy, understanding, safety, and error prevention.

7.1 Limitations

The main limitation of this work is that no older adult took part in any of its stages. The requirements were derived from secondary data and from two personas, and the evaluations were conducted by three of the authors, acting simultaneously as designers and as evaluators of their own artifact. The work consequently offers evidence about the design of NAVEGO and about accessibility defects in its implementation, but no evidence about its effectiveness or its usability for the population it addresses. Section 5.7 discusses the specific ways in which this design may have masked interaction barriers.

Two further limitations should be noted. The evaluation covered the extension's own interfaces, not its behavior across the diversity of real web pages, so the coverage of the blocking rules and the false-positive rate of the form heuristics remain unmeasured. In addition, automated accessibility evaluation does not replace manual inspection, keyboard navigation, or validation across different devices and browsers.

As future work, we intend to implement the corrections listed in Section 5.8, submit the protocol described in Section 3.6 to a Research Ethics Committee, and then conduct it with older adults presenting different levels of digital literacy and different sensory and motor conditions. Assessing the technical effectiveness of NAVEGO against suspicious forms, intrusive advertisements, and malicious links in real browsing scenarios constitutes a separate line of work, requiring its own methodology.

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The authors declare that AI was used in this text solely for spelling correction, using the Grammarly tool.

REFERENCES

- [1] Sanjay Kumar Aggarwal and Jagvinder Singh. 2025. Adblockers vs. Digital Advertising: Implications for Marketers and Publishers. In *2025 2nd International Conference on Integration of Computational Intelligent System (ICICIS)*. IEEE, Pune, India, 1–7. <https://doi.org/10.1109/ICICIS65613.2025.11371275>
- [2] Sabrina Sabrina Souza de Oliveira Alvaro, Larissa Amaral de Mello, Lilian Dias Bernardo, and Taiuani Marquine Raymundo. 2022. Navegando em ondas virtuais: barreiras e facilitadores para a inclusão digital de idosos. *Research, Society and Development* 11, 9 (2022), e19111931685. <https://doi.org/10.33448/rsd-v11i9.31685>
- [3] Brasil. 2018. Lei nº 13.709, de 14 de agosto de 2018. https://www.planalto.gov.br/ccivil_03/_ato2015-2018/2018/lei/L13709compilado.htm Lei Geral de Proteção de Dados Pessoais (LGPD).
- [4] Brasil. Conselho Nacional de Saúde. 2016. Resolução nº 510, de 7 de abril de 2016. <https://www.gov.br/conselho-nacional-de-saude/pt-br/atos-normativos/resolucoes/2016/resolucao-no-510.pdf/view> Dispõe sobre as normas aplicáveis a pesquisas em Ciências Humanas e Sociais.
- [5] Cetec.br. 2026. Centro Regional de Estudos para o Desenvolvimento da Sociedade da Informação. <https://cetic.br/> Acesso em: 9 jun. 2026.
- [6] Flávio Chaimowicz and Gabriel de Faria Chaimowicz. 2022. O envelhecimento populacional brasileiro. *PISTA: Periódico Interdisciplinar [Sociedade Tecnologia Ambiente]* 4, 2 (2022), 6–26. <https://periodicos.pucminas.br/pista/article/view/29830>
- [7] Stylianos Despotakis, R. Ravi, and Kannan Srinivasan. 2017. *The Beneficial Effects of Ad Blockers*. Working paper. Carnegie Mellon University, Pittsburgh. <https://doi.org/10.2139/ssrn.3083119>
- [8] Natasha Ramos Palma Domingues, Adriana Ramos de Sene, Taiuani Marquine Raymundo, and Lilian Dias Bernardo. 2021. Inclusão digital e participação social de idosos. *Estudos Interdisciplinares sobre o Envelhecimento* 26, 1 (2021), 369–390. <https://doi.org/10.22456/2316-2171.102091>
- [9] Alisa Frik, Leysan Nurgalieva, Julia Bernd, Joyce Lee, Florian Schaub, and Serge Egelman. 2019. Privacy and Security Threat Models and Mitigation Strategies of Older Adults. In *Fifteenth Symposium on Usable Privacy and Security (SOUPS 2019)*. USENIX Association, Santa Clara, CA, 21–40. <https://www.usenix.org/conference/soups2019/presentation/frik>
- [10] Fundação Sistema Estadual de Análise de Dados. 2026. Fundação Seade. <https://www.seade.gov.br/> Acesso em: 9 jun. 2026.
- [11] Kiran Garimella, Orestis Kostakis, and Michael Mathioudakis. 2017. Ad-blocking: A study on performance, privacy and countermeasures. In *Proceedings of the 2017 ACM on Web Science Conference (WebSci '17)*. Association for Computing Machinery, Troy, New York, USA, 259–262. <https://doi.org/10.1145/3091478.3091514>
- [12] Hans-Joachim Hof. 2015. User-Centric IT Security: How to Design Usable Security Mechanisms. arXiv:1506.07167 [cs.CR] <https://arxiv.org/abs/1506.07167>
- [13] Instituto Brasileiro de Geografia e Estatística. 2026. IBGE: Instituto Brasileiro de Geografia e Estatística. <https://www.ibge.gov.br/> Acesso em: 9 jun. 2026.
- [14] Robin Jeffries and Heather Desurvire. 1992. Usability Testing vs. Heuristic Evaluation: Was There a Contest? *ACM SIGCHI Bulletin* 24, 4 (Oct. 1992), 39–41. <https://doi.org/10.1145/142167.142179>
- [15] Sara Kado Mateus, Lorena Jorge Lorenzi, and Paula Costa Castro. 2024. Adoção e uso de tecnologias de informação e comunicação pós-pandemia na Universidade da Terceira Idade. *Estudos Interdisciplinares sobre o Envelhecimento* 29 (2024), 1–6. <https://doi.org/10.22456/2316-2171.142826>
- [16] Francisco Montero, María Lozano, Pascual González, and Isidro Ramos. 2002. A First Approach to Design Web Sites by Using Patterns. In *Proceedings of the First Nordic Conference on Pattern Languages of Programs: VikingPLoP*. Hojstrupgard, Denmark, 137–158.
- [17] NIC.br and CGI.br. 2017. *#Internet com Responsa 60+: Cuidados e responsabilidades no uso da Internet*. Núcleo de Informação e Coordenação do Ponto BR and Comitê Gestor da Internet no Brasil, São Paulo. <https://nic.br/publicacao/internet-com-responsa-60-cuidados-e-responsabilidades-no-uso-da-internet/Guia publicado em 2 de outubro de 2017>
- [18] Jakob Nielsen. 2001. 113 Design Guidelines for Homepage Usability. <https://www.nngroup.com/articles/113-design-guidelines-homepage-usability/> Acesso em: 10 jun. 2026.
- [19] John Pruitt and Tamara Adlin. 2006. *The Persona Lifecycle: Keeping People in Mind Throughout Product Design* (1 ed.). Morgan Kaufmann, San Francisco. <https://shop.elsevier.com/books/the-persona-lifecycle/pruitt/978-0-12-566251-2>
- [20] Taiuani Marquine Raymundo, Henrique Teixeira Gil, and Lilian Dias Bernardo. 2019. Desenvolvimento de projetos de inclusão digital para idosos. *Estudos Interdisciplinares sobre o Envelhecimento* 24, 3 (2019), 22–44. <https://doi.org/10.22456/2316-2171.87420>
- [21] Ignacio Redondo and Gloria Aznar. 2018. To use or not to use ad blockers? The roles of knowledge of ad blockers and attitude toward online advertising. *Telematics and Informatics* 35, 6 (2018), 1607–1616. <https://doi.org/10.1016/j.tele.2018.04.008>
- [22] Jochen Rick, Phyllis Francois, Bob Fields, Rowanne Fleck, Nicola Yuill, and Amanda Carr. 2010. Lo-Fi Prototyping to Design Interactive-Tabletop Applications for Children. In *Proceedings of the 9th International Conference on Interaction Design and Children (IDC '10)*. Association for Computing Machinery, Barcelona, Spain, 138–146. <https://doi.org/10.1145/1810543.1810559>
- [23] Heloísa Vieira da Rocha and Maria Cecília Calani Baranauskas. 2003. *Design e avaliação de interfaces humano-computador*. NIED/UNICAMP, Campinas. <https://www.nied.unicamp.br/biblioteca/design-e-avaliacao-de-interfaces-humano-computador/>
- [24] Janicy Aparecida Pereira Rocha and Adriana Bogliolo Sirihal Duarte. 2012. Diretrizes de acessibilidade web: um estudo comparativo entre as WCAG 2.0 e o e-MAG 3.0. *Inclusão Social* 5, 2 (2012), 73–86. <http://revista.ibict.br/inclusao/article/view/1678>
- [25] Enrique Rus-Arias, Pedro R. Palos-Sanchez, and Ana Reyes-Menendez. 2021. The Influence of Sociological Variables on Users' Feelings about Programmatic Advertising and the Use of Ad-Blockers. *Informatics* 8, 1 (2021), 5. <https://doi.org/10.3390/informatics8010005>
- [26] Nelcy Renata Silva de Souza, Verônica Maria Félix da Silva, Amanda Nicole Aguiar de Oliveira, and Roselma Coelho Santana. 2025. Prevenção de Golpes Digitais: O Papel da Cibersegurança na Proteção do Usuário. In *Anais da II Conferência de Tecnologia do ICET (CONNECTech 2025)*. Sociedade Brasileira de Computação, Itacoatiara/AM, 236–248. <https://doi.org/10.5753/connect.2025.12176>
- [27] WebAIM. 2026. WAVE: Web Accessibility Evaluation Tools. <https://wave.webaim.org/> Acesso em: 6 jun. 2026.
- [28] Ailton Stefani Wojahn, Carolina da Paixão Michael, Deivid Jonas Silva da Veiga, Rodrigo Lenz, Sabrina Gutknecht da Silva, Tael Pukall Rossetto, and Marcelo Loeblein dos Santos. 2022. A vulnerabilidade social de idosos frente a golpes no âmbito digital. *Research, Society and Development* 11, 11 (2022), e452111133652. <https://doi.org/10.33448/rsd-v11i11.33652>