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Design Thinking to Enhance E-Commerce Accessibility for Blind Users in Indonesia

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ABSTRACT

Indonesia's expanding e-commerce sector still marginalizes blind users. This study aimed to determine whether a user-centred design process could convert inaccessible shopping flows into accessible ones. We applied Design Thinking to a large Indonesian e-commerce website, audited barriers with screen reader walkthroughs, mapped issues to the Web Content Accessibility Guidelines and ARIA, and iteratively prototyped semantics, headings, roles, keyboard flows, and feedback. Blind participants from a rehabilitation center completed think-aloud evaluations that compared the original and redesigned flows. Usability tests showed complete task completion across search, product, and checkout, with faster completion and fewer errors, because interface semantics matched assistive technologies and interaction steps were simplified and consistently announced. The redesign now enables truly independent transactions and reduces frustration. These findings indicate that locally adapted, standards-guided, and user-validated design can replace exclusion with inclusion in digital commerce and can be replicated by teams in resource-constrained settings to accelerate equitable access.

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1. INTRODUCTION

Digital commerce has introduced deep changes to the global retail sector [1]. The Southeast Asian e-commerce value alone was US$131 billion in 2022 and will triple by 2025. Indonesia is part of the transformation, with a 54% growth rate year-over-year between 2020 and 2023, as consumers increasingly use online shopping for everything from everyday goods to discretionary goods. This digital revolution has the potential to democratize business by allowing instant access to goods, price transparency, and round-the-clock shopping convenience. The pandemic further hastened the use of digital technologies among all demographic segments [2, 3]. In major cities like Jakarta and Surabaya, over 78% of consumers now make at least one digital transaction per month, while in rural regions, online shopping is becoming a key source for obtaining products that were previously unavailable in the area [4]. This trend not only reflects advances in technology but also represents a significant change in how goods are distributed and how economic opportunities are allocated.

But the digital revolution contains a paradox [5-7]. Technology promises universal access, but roughly 3.5 million people with disabilities in Indonesia remain vulnerable to the digital business systematization. This user category relies on screen readers to browse websites through keyboard commands and the semantic structure of HTML. Screen readers convert visual interfaces into sound or Braille [8]. However, 92% of Indonesia's e-commerce websites succeed in passing minimum accessibility tests, which reveal interfaces with unlabeled buttons, mouse-only navigation, and untagged images. Even just simple shopping, for users of screen readers, is challenging or downright impossible [9]. This situation prevents the visually impaired population from benefiting from competitive prices and product choices, and the convenience enjoyed by users, creating a form of digital apartheid in which the sighted determine all-important access to necessities and participation in society.

To examine these issues, the Setoko Web case study is introduced to show the capabilities and limitations of e-commerce in Indonesia. The site boasts more than 50,000 Indonesian micro, small, and medium enterprises (MSMEs) by integrating the payment systems with logistics providers, and having a structure similar to 70% of Indonesian e-commerce sites. However, an accessibility test revealed some of the following weaknesses which are a lack of semantic HTML and ARIA attributes, mouse-only navigation on the site, and an inability to access key features such as product search, cart management, and checkout. Screen reader testing also confirmed an overall task success rate of 33.3%. These barriers illustrate that an aging system is not the reason for accessibility issues, but are a product of design methods that do not consider the needs of non-visual users.

The long lifespan of these barriers is an indication of the prevalent web development trends that favor visual supremacy over development. Research shows that while 98% of websites invest heavily in visual design systems, a mere 23% keep track of accessibility requirements [10]. One million websites were automatically tested and detected on average 50.8 accessibility issues per homepage, and 96.3% did not meet WCAG 2.1 Level AA. An accessibility audit of Setoko Web validated these findings with 147 user flow issues. These included lost labels, inaccessibility of form errors, and dynamic changes to content that occur without programmatic announcement. These results align with existing research that has indicated that web transactions are frequently inaccessible to screen reader users [11]. Additional testing with NVDA and JAWS likewise discovered severe usability issues, including transaction cancellations at checkout and complete failures due to inaccessible CAPTCHA

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[12]. They owe it to the fact that modern buildings prioritize look over semantic ordering, thus establishing a form of architectural exclusion, technology actually reduces accessibility [13].

As a response, this research employs Design Thinking, a human-centered design approach that is based on empathy, iterative prototyping, and in-context testing [14]. Unlike conventional practices that leave accessibility just an addition, Design Thinking considers the notion of inclusivity right from the start. This research is guided by international standards such as WCAG 2.1 and ARIA [15]. At Setoko Web, this methodology was utilized for redesigning key processes, such as navigation of catalogs, product information access, and payment processes, with the active participation of visually disabled people. The systematic process through the stages of empathy, problem definition, ideation, prototyping, and testing renders accessibility the focal point of inclusive interaction design, and not merely a technical compliance. Finally, this research contributes theoretically and practically by coming up with a model of e-commerce website accessibility integration that can be replicated, particularly for developing countries.

2. LITERATURE REVIEW

2.1. Inclusive Design

Inclusive design is a user-centered approach that attempts to allow equal access and use for all, regardless of physical, sensory, or cognitive ability [16]. Unlike the concept of accessibility, which is often treated as an enforcement requirement, inclusive design considers diversity from the initial stages by putting stress on trying to minimize misalignments between the capabilities of systems and the needs of the users (Linden et al., 2016). In the virtual world, this is even more necessary, especially among visually impaired users who must interact with visually dominated interfaces. Inclusive design encourages the development of interfaces that accommodate other ways of interaction, such as keyboard navigation, screen readers, and voice input, in addition to visual cues only.

To ensure inclusive digital growth, international guidelines have been established. The World Wide Web Consortium (W3C) designed Web Content Accessibility Guidelines (WCAG) 2.1, which established the basic standards of Perceivable, Operable, Understandable, and Robust (POUR) so that content is accessible to individuals with disabilities. WCAG may be complemented by WAI-ARIA (Accessible Rich Internet Applications), a standard that strengthens the semantic web component model, particularly in dynamic and single-page applications. Moreover, laws such as EN 301 549, enforced by the European Union and other countries, provide a legal basis for accessible information and communication technology procurement and creation [18]. It has been shown that the benefits of accessible design extend beyond disabled users. Improving content clarity, navigation consistency, and input flexibility can improve overall user experience, including for users with temporary or situational impairments. For example, consistent heading structures and keyboard-navigable arrangements will improve usability for users with mobile devices or in low-visibility environments. Furthermore, accessibility introduced early in the process results in more robust and more extensible systems and reduces the need for costly retrofits.

Current reviews and accessibility audits have revealed that the adoption of inclusive design in practice remains low. Despite the presence of standards, most websites still manage minimal compliance levels. This gap is partly due to education and institutional priorities, where visual design issues are placed at the top of curricula while accessibility takes a back seat. Therefore, inclusive design is not only a matter of ethics and law, but a design that can improve the quality of products, users' confidence, and market share. Therefore, it is

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necessary to integrate these principles into the core of design and development mechanisms to ensure genuine digital equality.

2.2. Design Thinking for Accessibility

Design Thinking as a viable method of integrating accessibility into digital product development emerged from industrial design and interaction design disciplines. This human-centered process emphasizes empathy, problem definition, ideation, prototyping, and testing in a repetitive, interconnected cycle [14]. Unlike traditional software development procedures, where accessibility features are commonly tackled at the final step as some kind of polishing or compliance check, Design Thinking embeds inclusive values from the very start. Hence, accessibility is not offered as an afterthought but as a principal aspect that shapes the interface structure, content structure, and interaction flow.

In accessibility-oriented projects, the empathize phase involves engaging with users with varying visual, auditory, motor, and cognitive disabilities directly to identify issues that are often overlooked in usual usability testing [19, 20]. The define stage subsequently formulates these qualitative findings into problem statements that can be solved, such as "screen reader users are unable to negotiate the checkout process without extra assistance." Lastly, the ideate stage encourages exploration of other methods without jumping too hastily to one design solution, encouraging creativity balanced between technical feasibility and user needs. The prototype phase is all about developing low- to high-fidelity models [22]. that include accessibility components such as ARIA roles, keyboard navigation flows, and alternative text for non-text elements. Finally, the testing phase completes the loop by testing the design with the target users and refining it based on feedback obtained from them, ensuring compliance with applicable standards such as WCAG 2.1 and WAI-ARIA.

Existing research has established Design Thinking in the field of accessibility. For example, Khowaja et al. found that applying Design Thinking to the redesign of a visually impaired user's health information system resulted in measurable increments in task completion rates and satisfaction levels. Similarly, Davis et al. asserted that Design Thinking is a co-creative, human-centered method that couples stakeholder involvement, systematic collaboration, and iterative refinement to address complicated problems, encourage collective knowledge creation, and enable innovative solutions among situations [22]. They emphasize the importance of combining standards conformance and user empathy to produce legally compliant but actually usable products for a variety of uses, including in poor-resource settings where the adoption rates of assistive technologies may be unknown.

Through the application of accessibility principles at every stage of the Design Thinking cycle, developers can design e-commerce websites that are not just compliant with regulations but also extremely inclusive. This aligns with growing recognition that accessibility is a driver of innovation and user confidence, especially in markets that continue to have high digital participation gaps.

3. METHOD

This study employed a five-phase Design Thinking framework to address the accessibility challenges faced by blind users when interacting with an Indonesian e-commerce interface. Unlike conventional development models that treat accessibility as a post-design concern, this approach integrated inclusive design principles from the outset and throughout the product lifecycle. All stages adhered strictly to the Web Content Accessibility Guidelines (WCAG) 2.1 and the Accessible Rich Internet Applications (ARIA) standards.

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The Empathize phase involved collecting qualitative insights from blind users through structured questionnaires and open-ended interviews. Participants used screen readers, including TalkBack, to complete typical e-commerce tasks. During this stage, major usability challenges were identified, including poor audio feedback, disorganized navigation hierarchies, and unlabeled interface components.

In the Define phase, the researchers applied affinity diagramming techniques to categorize the findings into six thematic barrier clusters. These clusters ranged from illogical content structures and incorrect labeling to the absence of alternative text. Each barrier was then mapped against WCAG 2.1 success criteria, including 1.4.5, 2.4.6, 1.3.2, and 4.1.2 [23].

Based on this synthesis, the Ideate phase focused on generating design solutions guided by the POUR principles: perceivability, operability, understandability, and robustness. Activities in this phase included drafting accessibility tree diagrams, defining ARIA roles, and redesigning interaction flows to reduce cognitive overload [24].

These concepts were implemented during the Prototype phase, using semantic HTML and CSS to restructure catalog navigation, product details, and the checkout process. ARIA markup was incorporated to enhance screen reader compatibility. Prototypes were validated using screen readers such as TalkBack and NVDA.

In the final Test phase, usability evaluations were conducted with blind users to compare the original and redesigned versions of the website. Task-based testing followed Sauro's UX Effectiveness Model, capturing both success rates and completion times. The redesigned interface yielded significant improvements, confirming that the Design Thinking approach, when grounded in international standards and validated through real-world testing, can effectively transform abstract accessibility principles into practical, user-centered solutions [25, 26].

4. RESULTS AND DISCUSSION

Initial usability testing of the app revealed extensive accessibility barriers to visually impaired customers. Results showed significant variation across three key scenarios, which are searching the catalog, accessing product information, and checkout. Most participants completed the task of searching the catalog at an 80% success rate. However, 20% succeeded at completing the task of accessing product information, and none completed the checkout task. Overall, the general success rate in all three scenarios was as low as 33.3%. These results validate that the accessibility of the app continues to be low, especially for key features such as checkout. Problems identified during the first round of testing were the inability to locate accessible or clickable items, disorganized interface navigation, and a lack of feedback on interaction status. Heuristic evaluation also identified the highest number of errors in aesthetics and minimalist design with eight violating points, which included uneven layout and margins, excessive number of screen elements, a total lack of concern for spacing and font size, leading to a confusing visual hierarchy. Flexibility and usability were also to blame, as six violations included component size and location, and unreasonably long and unnecessarily long interaction flows.

Furthermore, four were discovered in the consistency and standards category, which was reflected in inconsistency in labelling and form of interaction throughout the interface. Two were also discovered in the recognition rather than recall category, where incomplete or unnecessary information made users unaware of how to utilize certain elements. There were three more violations in the error prevention and visibility of system status, wherein many components lacked obvious visual or auditory feedback to allow users to determine interaction state or recover from errors. The findings validate that the application remains

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low in accessibility, particularly for key features such as the payment process. The subsequent analysis, discussion, and screenshots are thus focused on the payment feature as an example case. While enhancements to accessibility were made throughout the application, paying particular attention to the payment feature was done due to its importance and the significant barriers encountered in initial testing.

Recommendations to resolve these issues are maintaining margins and layout consistency, reducing non-essential items on the screen to push the most vital information into focus, and standardizing interactions and labelling throughout the application. It is also recommended to provide short and relevant labels to each item, provide clear feedback on various interaction states by altering color or size, and display error messages prominently so that users can recognize and correct errors right away.

An in-depth test of payment functionality was subsequently conducted with the Web Content Accessibility Guidelines (WCAG). It proved that numerous crucial criteria were not met, particularly on the payment home page of payment. For example, the order of reading was disrupted, and critical areas such as order information, shipping, and payment methods were displayed out of order. A handful of action buttons relied solely on visual cues, such as the "Scroll Down" icon, and were not accessible to screen readers. While the headings and the labels were well implemented for the most part, proper programmatic definitions of the form role and the status message in dynamic components were still lacking. Accordingly, users of TalkBack were unable to differentiate between fields or be notified of dynamic changes, for instance, when a bottom sheet to choose an address or payment option was displayed. While the payment confirmation page made some steps towards these issues, there were significant gaps on the primary page, particularly in terms of significant sequencing, sensory characteristics, and status messages.

To correct these issues, the Web Content Accessibility Guidelines (WCAG) were implemented, and ARIA attributes were implemented for interface elements to improve accessibility. The app was redesigned later with the addition of semantic HTML tags, hierarchical headings, alternative descriptions for all pictures, and a redesigned accessibility tree for optimal accessibility with TalkBack on Android. The structure and sequence of such improvements are described through the Accessibility Tree Checkout (ARIA). **Figure 1** shows that the user interface objects on the payment page are arranged logically, and all items like headings, fields, and interactive buttons have a role, name, and state through ARIA attributes. Improving the accessibility tree for the payment process enables screen readers to read and convey interface components in order and with context. This allows visually disabled users to better understand and navigate through the payment process.

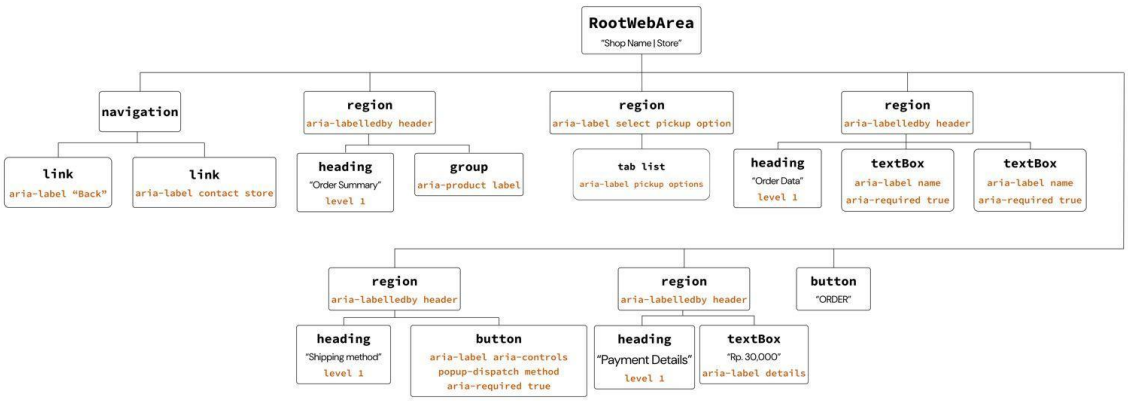

Figure 1. Accessibility tree checkout.

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To provide a clearer picture of user interaction with the improved interface, **Figure 2** is a User Flow Interaction for payment. This flowchart illustrates each step a user performs, from arriving at the payment page, filling out customer and shipping information, selecting a payment mode, and subsequently confirming the transaction. User flow points out how screen reader feedback and interactive instructions are incorporated into every step, providing clear instructions with minimal mental barriers to the visually impaired.

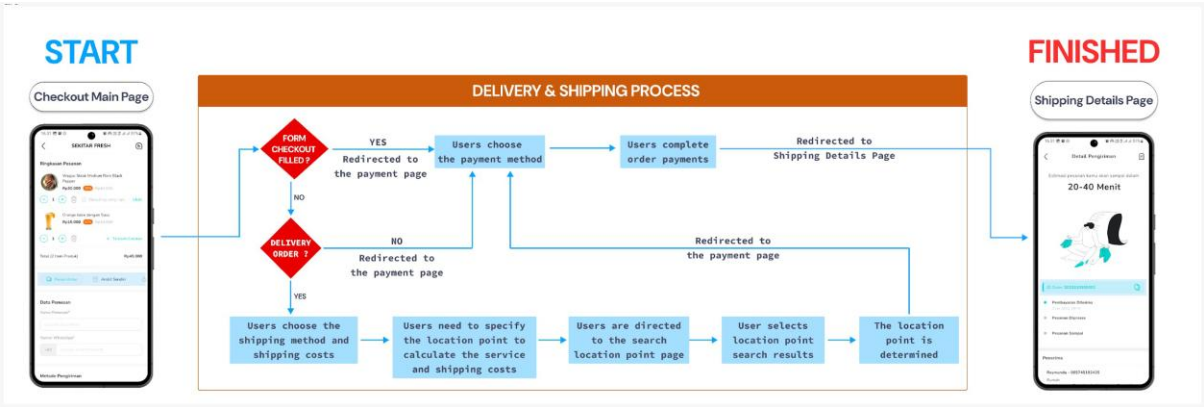

Figure 2. User flow interaction checkout.

The technical details making these accessibility enhancements possible are illustrated in **Figure 3**. The figure illustrates how the app communicates between the User Agent (the browser), the Accessibility API, and assistive technologies such as TalkBack. These technologies enable the rendering of ARIA attributes and semantic HTML into comprehensible output via a screen reader, giving all interface elements and their updates appropriate perception by the user. While these mechanisms can be used for the entire application, the workflow provided uses the payment process as a real-world example.

After introducing these changes, usability testing was conducted again using the same scenarios. After making these changes, usability testing was conducted again using the same scenarios. The results showed significant improvement in all the key tasks. All the testers were successful in completing tasks related to catalog search, product details, and payment, with 100% success.

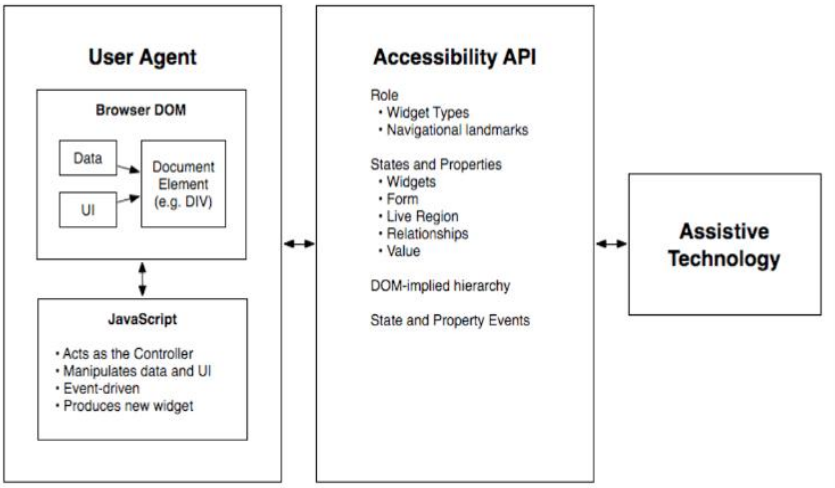

Figure 3. User interface implementation mechanism.

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This improvement is also justified by a comparison of the acceptance and rejection ratios in the first and last tests in **Tables 1** and **2**. Generally, the rate of success rose hugely from 33.3% to 100%. The participants also positively rated improved navigation, clearer interactive features, and an improved app feedback mechanism compared to prior to the improvement.

Table 1. Comparison of user acceptance tests.

Features	Beginning		End	
	Acceptance	Rejection	Acceptance	Rejection
Product Catalog	4	1	5	0
Product Details	1	4	5	0
Checkout	0	5	5	0
Total	5	15	10	0

These findings validate the effectiveness of an accessible design process modeled after WCAG and ARIA standards. Implementation of the enhancements not only satisfied accessibility needs but had a direct impact, increasing the confidence and independence of visually impaired consumers to conduct online transactions independently. Test results after redesign mirrored an in-situ experience where subjects were able to independently access all application functions without any impediment.

Table 2. Comparison of success rates.

Features	Success Rate	
	Beginning	End
Product Catalog	80%	100%
Product Details	20%	100%
Checkout	0%	100%
Average	33,3%	100%

Lastly, consistent implementation of accessibility guidelines has been shown to improve the user experience, so that digital products not only meet standards but also provide usability and convenience for visually impaired users. The user acceptance testing and usability testing covered in **Tables 1** and **2** were conducted directly by visually impaired users who were enlisted from a rehabilitation center in Bandung. This served the purpose of confirming that the testing process accurately reflected the user experience, not through intermediary testing. Five participants completed both the first and last tests, three males and two females, between the ages of 20 and 38. Referring to the demographic profile of participants provides a more specific background regarding the representativeness of findings and allows for more informed interpretation of the extent to which the conclusions may be projected across different segments of visually impaired consumers.

Although the redesign resulted in significant improvements, some challenges remain. Some of them include CAPTCHA's accessibility and complex promotional materials, optimized error messages that do not fully accommodate screen readers, and so on. Improvements were also limited to the main transaction flow without extending to scalability across devices, browsers, and assistive technologies. Such observations suggest that while the Design Thinking approach made accessibility better, more refinement and longer evaluation are required for long-term inclusivity.

This research provides significant insights into the relationship between inclusive digital commerce practice and accessibility design within developing countries. The most remarkable

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finding of the research was a drastic increase in task accomplishment rates, from 33.3% to 100%. These findings provide strong empirical support for the effectiveness of using WCAG 2.1 and ARIA guidelines within an end-user design process. Before the modifications, the visually impaired users witnessed a range of issues, such as unlabeled buttons, abnormal reading sequences, and non-functional form fields. The obstacles interfered with basic e-commerce activities, such as browsing catalogs, product options, and filling out checkouts. With the structuring accessibility improvements, the interface was successfully transformed into a fully accessible and understandable system for screen reader users. These improvements included adding ARIA semantic attributes (e.g., aria-label, aria-live, and aria-describedby), establishing a logical heading structure, and providing real-time feedback through status messages. The effectiveness of these improvements not only improved task rates but also boosted user confidence and autonomy. These benefits are lost in technical usability measures.

This research expands on previous research through the application of Design Thinking as an iterative, standards-based accessibility engineering methodology to not only satisfy theoretical constraints but to build practical returns. Previous research has pointed out the benefits of WCAG/ARIA in facilitating accessibility. This research translates these standards into actionable user interface (UI) solutions for Indonesian e-commerce. The tree model of accessibility, structured format UX audit, and interaction flow redesign discussed in this paper offer a new way of reconciling abstract compliance recommendations with concrete user actions. Moreover, success indicators designed for individualized screen reader users encourage methodological accuracy by shifting the emphasis of evaluation from mere compliance to an indication of real experience.

This research contributes to the broader discourse on inclusive digital transformation in e-commerce, going beyond its direct application to Setoko Web. These findings highlight the importance of conducting more research to create accessibility solutions tailored to local contexts, particularly in regions where technological infrastructure and user behavior differ from those of high-income countries. Future research is recommended to explore incorporating individual mobile features such as gesture navigation, haptic feedback, and multilingual screen reader capability into accessibility platforms. Recent research has evaluated the usability of such frameworks by visually impaired users within the context of smartphone use [27]. The success of this design approach underscores the importance of policies and training programs for developers that prioritize accessibility as a central aspect of digital product development. In the context of growing worldwide interconnectivity characterized by the spread of digital technologies, these research results affirm that accessible design is a strategic resource, above and beyond moral and legal requirements.

5. CONCLUSION

This research confirms that the application of a design thinking cycle of empathy, problem definition, ideation, prototyping, and testing iterations can significantly improve the accessibility of an e-commerce website to visually impaired users. Through adherence to WCAG 2.1 and WAI-ARIA standards, the redesign successfully addressed critical issues of improper labeling, lack of consistent structure of content, and inadequate interaction feedback. The solution was confirmed by real-world usability testing, which demonstrated that task success rates improved significantly from 33.3% to 100% in the primary transaction flow. Beyond technical compliance, the redesign also supported the independence and self-confidence of visually impaired users, demonstrating that user-centered accessibility design

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not only improves usability but empowers them as well. These findings underscore the need for integrating accessibility as part of digital product development and not as an afterthought. By localizing global accessibility standards, this research offers a replicable model for inclusive e-commerce innovation, particularly for developing countries that still witness enormous digital participation gaps.

6. AUTHORS' NOTE

The authors declare that there is no conflict of interest regarding the publication of this article. Authors confirmed that the paper was free of plagiarism.

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