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Review

A Holistic and Multidimensional Methodology Proposal for a *Persona with Total Visual Impairment* Archetype on the Web

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Abstract: The web was conceived in 1997 with the goal of universal accessibility. However, it still presents obstacles for users with diverse abilities. Although interactions in digital environments have improved the quality of life for many people, they remain a source of limitations and frustrations, up to twice as much for users with total visual impairment, which is commonly known as blindness. This article emphasizes the need to provide designers and developers with methodologies and tools that consider users with different abilities in all stages and from the beginning of the design, redesign, and development of digital products and services on the web, collecting their needs and goals and delving into their reactions and emotions. While an approach based on *persona* archetypes can optimally represent each group of users with disabilities throughout website design processes, serving as a communication and empathy tool for development teams and stakeholders, it is essential that this tool considers all dimensions involved in the experiences of people with disabilities. This conceptual paper develops a methodology that provides designers with a *persona* tool that effectively captures the goals and emotions of these users in their interaction with the web. This methodology proposal is multidimensional and holistic. It addresses conscious and subconscious dimensions, combines traditional user experience and neuroscientific techniques, focuses on total visual impairment, the most challenging in digital environments, and makes it adaptable to other disabilities.

Keywords: accessibility; web; user experience; neuroscience; user-centered design; inclusion

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1. Introduction

The evolution of various technologies over the last two decades, particularly the integration of digital environments such as the web, applications, and devices, has enabled widespread access to a diverse range of products and services for a significant portion of the global population. This progress holds the potential for a substantial improvement in the quality of life for individuals with disabilities, streamlining processes and tasks and facilitating their inclusion in numerous areas that were previously unavailable [1–4].

Despite efforts and initiatives from various organizations in favor of equal access and the use of products and services by individuals in their diversity, many people still face numerous difficulties and obstacles in these interactions. In digital environments, specifically on the web, whose maximum value lies in its universal access to information and services, as its creator Tim Berners-Lee claimed [5], it continues to be a source of limitations and frustrations for certain user groups who cannot achieve their goals [1,6–9]. In fact, both the time invested for tasks and their performance differ among people with different abilities, widening the gap and indicating the lack of full equality of use of digital products and services [1,10,11].

Therefore, the accessibility of websites becomes a crucial aspect for the development and autonomy of individuals with disabilities, ensuring their proper participation and

inclusion in society. This importance is particularly relevant considering the 2011 census conducted by the World Health Organization (WHO), which reported that approximately 15.6% of the global population (aged 18 years and older [11]) lives with some form of disability, which represents more than 700 million people [12]. This statistic implies that at least one in six people in the world has some type of disability. These figures, and the projections indicating a progressive increase due to the population aging in the following years, underscore the magnitude of the issue.

In this sense, in order to eliminate the barriers and obstacles that people with disabilities encounter on the web and guarantee their inclusion in the different aspects of modern life, it is necessary to directly collect the needs and experiences of these users in their web interactions and analyze their reactions and emotions to obtain and provide valuable information and foundations for designers to develop accessible websites. This information should be included in all design phases from the earliest stages in order to ensure usability and accessibility, avoiding assumptions and biases [3,13–17].

To cover this need, this study introduces a multidimensional framework to generate a *persona* archetype (a *persona* archetype is a tool that represents a typical user within the target audience of a product or service. This tool is developed to assist designers and developers in understanding the needs, behaviors, and characteristics of their users during the design process. Further information about this tool can be found in Section 3.4. Persona Archetype and Disabled Persona) which will guide designers and developers in designing accessible and usable digital products and services for people with disabilities. This design tool will gather the experiences of these users while navigating the internet through a holistic methodology that combines qualitative and quantitative techniques with neuroscientific approaches, ensuring a comprehensive user-focused approach.

This methodology allows institutions, government or private organizations, non-profit foundations as well as consulting firms, as agents of change in their capability to improve the quality of life of people, to develop this primary and fundamental tool, making it available to designers and developers from different companies. The aim is to provide designers and developers with an effective user-centric tool, which is presented in a comprehensive and visually engaging format that fosters empathy with groups of users with disabilities.

Thus, through this multidimensional and holistic methodology, this *persona* tool enables designers and developers to create universally accessible and usable products and services based on diversity.

The methodology developed in this paper is designed with a focus on individuals with total visual impairment or blindness to achieve the final outcome of a *Persona with Total Visual Impairment* profile that universally will represent the basic needs, goals, and expectations of blind users in their digital interactions, specifically on websites. This decision is driven by the realization that 80% of the information individuals require for everyday life management relies on the sense of vision, playing an essential role in their personal and social development [18,19]. As we mentioned previously, while digital technologies, including the web, enhance the quality of life of people with disabilities and their integration into society, they still present significant hurdles for this group of users [13]. Due to the predominantly visual nature of these technologies, people with visual impairments face significant challenges, particularly those with total visual impairments or blindness, which entails a complete lack of any visual resources, thus encountering numerous difficulties in their web interactions [1,13,18–24]. Covering the most complex methodological context with the greatest number of difficulties and variables that people with total visual disabilities face will facilitate the adaptation of this methodology to other disabilities.

To achieve the purpose of this proposal, two phases are deployed: a "Research phase" to gather user data and a "Design phase" to analyze and develop a *persona* profile. In the first phase of research, a mixed methodology is presented with a holistic approach composed of various techniques that enable covering all layers involved in the digital

experiences of individuals with total visual impairment from needs and expectations to emotions and frustrations. The research design addresses limitations and validates findings among the different selected methods [25]. This methodology, which is original due to the combination of techniques and its application with blind individuals, stems from an in-depth literature review. It combines traditional quantitative and qualitative methods, specific user experience (UX) and usability techniques, and biometric instruments from neuroscience. This combination of resources allows validating findings across methods, applying a subconscious level of behavior. The incorporation of physiological techniques from the field of neuroscience addresses the limitations that traditional methods and measurements encounter in evaluating user experiences and reflects real-time psychological states and their impact on user behavior and decision making [26].

Finally, accessible websites not only enhance interactions for individuals with disabilities but also benefit all users regardless of their abilities, improving their overall experience [11,27,28]. Additionally, thanks to websites optimized for all users, organizations can streamline resources, enhance operational efficiency, and yield better outcomes. This is achieved by minimizing redesign expenses, attracting a larger base of satisfied users who not only make more purchases but also spend more time on the websites and revisit them more frequently [29,30].

2. Materials and Methodology

In parallel with the increasing relevance of topics such as accessibility and universal design, studies considering the needs of people with disabilities are on the rise. The same applies to the tool of *personas* with disabilities; although they are being used more frequently, there is still a lack of research that delves into them [15,16,31–33]. Therefore, this work aims to present a methodologic framework that allows for developing a *Persona with Total Visual Impairment* template that covers all dimensions involved in users' experience from needs to emotions, allowing accessibility issues to be prioritized based on their emotional and/or subconscious impact.

This *Persona with Total Visual Impairment* profile will be able to guide and accompany the product and service design process, promoting empathy and communication among development teams, maintaining a solid focus on blind users. It is not just about removing accessibility barriers but ensuring that these users have their needs, expectations, and goals met through satisfying, efficient, and fulfilling experiences.

To construct this holistic research methodology, an integrative literature review is conducted to synthesize knowledge on the methodology, theoretical insights, and research findings to reach a conclusion on these specific topics [34]. This review encompasses both empirical and theoretical literature, aiming to establish a new conceptualization regarding the efficiency of the data to be collected in a *Persona with Total Visual Impairment* profile.

A complete bibliographic review has been developed. In this exploratory investigation, a search of scientific articles was conducted on the Web of Science (accessible online: www.webofscience.com (accessed on 23 March 2024) (WoS) using the following keywords and various combinations of them: #web accessibility, #disability, #visual disability, #user experience, #usability, #neuroscience, #biometrics, #neuromarketing, #galvanic skin response, #persona, #user centered design. At the same time, the results of these searches have generated the availability of relevant documents referenced in these papers. A thematic classification of these documentary sources has been carried out through spreadsheets, which was followed by the curation of articles relevant to the purpose of this review, prioritizing the most recent ones.

As a result, more than 400 studies and papers have been analyzed to collect different techniques, methods, and approaches and to acquire the knowledge and a complete perspective on the issues.

In order to obtain a comprehensive understanding of all the aspects that influence the experiences of users with total visual disabilities and their subsequent inclusion in the *persona* archetype, we sought to complement the best and more appropriate techniques and

methods, covering each other's possible limitations or weaknesses, allowing to address the complex nuances involved in this type of user.

It is essential to the purpose of this methodology to generate a well-structured approach that guides the research phases to build a *persona* archetype so that researchers can effectively plan and execute all of the steps, ultimately leading to holistic, robust, and reliable research outcomes.

3. Theorical Context

3.1. Web Accessibility and People with Disabilities

Technology, digital environments, and, by extension, the web, have significantly transformed society, providing access to previously unimaginable resources, and giving rise to new products, services, and environments. This development has created new interactions and relationships, generating numerous economic and professional opportunities [3,13]. The role of accessibility and the design for all individuals becomes more crucial in this context, since the lack of access to information "violates the universal rights of citizens" to the equality of opportunities [35]. In fact, technology emerges to break down barriers and make life easier for human beings. As the creator of the web, Tim Berners-Lee (1997) emphasized, "The power of the web is in its universality. Access by anyone regardless of disability is essential" [5].

Web accessibility allows individuals with sensory, physical, or cognitive disabilities to freely access information and participate in a multitude of activities [1,20,36]. This importance became indispensable during the COVID-19 health crisis, where the adoption of digital tools was crucial to enable people with and without disabilities to carry out various tasks [13].

To ensure equal access to digital technologies for all individuals in every dimension of society, regulations and standards are deployed globally. A pivotal reference in this regard is Article 9 of the Convention on the Rights of Persons with Disabilities (CRPD), explicitly stating the requirement for equal access to "information and communications, technologies, and systems" [37]. This right to accessibility is reflected in numerous legislations worldwide. Globally, the International Organization for Standardization (ISO) 40500:2012 [38] is the most used standard in accessibility regulations and is based on the Web Content Accessibility Guidelines (WCAG) [36], developed by the World Wide Web Consortium (W3C) (the W3C is dedicated to spearheading the development of global web standards, promoting accessibility and interoperability across diverse digital environments. See https://www.w3.org/ (accessed on 23 March 2024)), which is the primary internet standards organization. In Europe, the directive on UNE 301.549 [39], on which the European accessibility regulations are developed, or, in the United States, Section 508 of the United States Rehabilitation Act [40], are based on this international guideline.

The goal of the WCAG is to help create a more inclusive online environment by providing guidelines and recommendations to design and develop web content that is more accessible and usable for individuals with different disabilities [21,35]. In this context, web accessibility refers to the ability of a website or an application to facilitate user access, perception, understanding, navigation, and interaction with information on the web regardless of their physical or technological capabilities [1,35,36].

Since the beginning of this standard in 1999, with the launch in 2008 of the WCAG 2.0 version, there has been an evolution around four fundamental principles for the accessibility of digital content: Perceptible, Operable, Understandable, and Robust [36]. The current WCAG 2.2 version (October 2023) relies on these principles to develop and update the 13 accessibility guidelines with their corresponding success criteria, which were classified according to three levels of conformance from lowest to highest requirement: A, AA, and AAA [36]. To reach a compliance level, all the success criteria of that level and previous levels must be met (Figure 1).

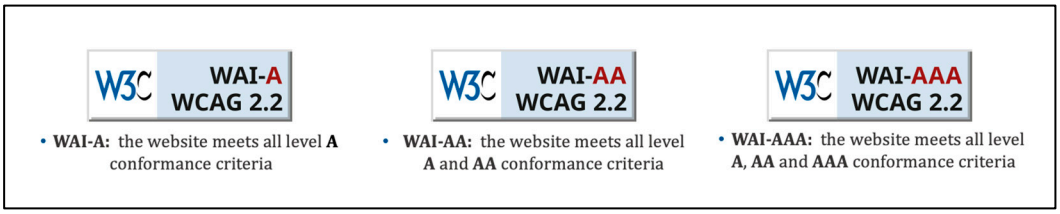


Figure 1. WCAG compliance levels. Table elaborated by the authors. Images from [36].

However, as indicated by several studies, the accessibility achieved through WCAG-recommended guidelines could be viewed more as 'technical accessibility,' requiring compliance with technical requirements and elements in website code [20,41,42], moving away from the needs and preferences of users. The study by [21] on the interaction of blind users with the web revealed that only 50.4% of the problems encountered by users were covered by WCAG 2.0 accessibility guidelines. The study also revealed that despite the implementation of recommendations outlined in the WCAG guidelines, the adjustments employed did not effectively address the identified issues. These standardized criteria are more directed toward information access and do not consider other aspects related to the interaction with websites themselves [20]. Therefore, the definitive criteria for determining web accessibility should be based on users [42].

People with Visual Impairment: Total Visual Impairment and the Web

"Visual impairment is the consideration stemming from the total or partial decrease in vision" [18] (p. 4). This level of impairment is measured through various parameters: near and distance reading ability, visual field, color vision, contrast sensitivity, or visual acuity [18,19].

In this regard, total blindness or severe visual impairment refers to complete or very severe limitations in visual function in one or more of these variables, resulting in significant limitations for individuals to autonomously carry out daily activities or access information as well as participate in various aspects of personal life such as education, work, or leisure [18].

On the other hand, moderate visual impairment, also known as low vision (depending on the classifications of each country), encompasses various symptoms and conditions that do not substantially improve with the use of glasses. However, individuals retain some residual vision or visual remnants that enable them to carry out certain activities in their daily lives albeit with significant efforts and the support of special aids [18,43].

The common eye conditions that can cause vision impairment, even blindness, include the following [19,43]:

- Age-related macular degeneration;
- Cataract;
- Corneal opacity;
- Diabetic retinopathy;
- Glaucoma;
- Refractive error; and
- Trachoma.

Globally, in 2020, at least 2.2 billion people had some kind of visual impairment, of which 43 million were blind [19,44]. The global prevalence of vision impairment is 14% of the world population with estimates indicating a growth rate of 15.9% for these figures by 2050 [44].

On the web, people with visual impairments rely on assistive technologies—appliances, products, or devices—that allow them to compensate for any difficulty or adapt to the user's needs. In the case of individuals with total visual impairments, for their interaction with digital technologies, they may use Braille devices or keyboards and screen readers.

Individuals with low vision typically rely on screen magnifiers, electronic magnifiers, or enlargers.

In this sense, while individuals without visual impairments experience a multidimensional web interaction, for users with total visual impairment using assistive technology or screen readers, navigation is linear and one-dimensional. This often leads to a loss of contextual information and cognitive overload due to continuous sequential reading, resulting in lower usability [1,20,42].

Furthermore, a study conducted among individuals with disabilities revealed that barely half of blind individuals can complete tasks on the web (53%) compared to 73% for those with low vision, 83% for those with dyslexia, or 85% for those with physical or auditory disabilities [23]. In another research [24] including 100 blind users, it was found that these users experienced an average time loss of 30.4% due to difficulties in managing their interactions on the web. These studies highlight the need for further research with users with total visual disabilities so that websites not only comply with technical accessibility criteria but also cover functional and usability aspects, enabling smooth interaction [1,24].

Some of the recurring obstacles and difficulties that individuals with total visual impairment frequently encounter on the web include the improper use or absence of alternative text for images, poorly designed and unlabeled forms, various issues with links, inaccessible programming objects such as JavaScript or Flash, confusing website structures, etc. [1–3,6,20,21,23,24,37,42].

Accessibility is an attribute that benefits all users, not just those with disabilities [11,15,45], especially considering the aging of the population and other types of limitations that are not only permanent but also transient or contextual [15,46]. Websites with high levels of accessibility not only do not degrade the experience for users without disabilities but also result in shorter task completion times, higher task completion rates, better perceived usability and aesthetics, and lower cognitive load for all users [10,11,47–49].

Because accessible designs benefit the usability and the experience of all users in general, it is an imperative to consider user needs and include accessibility, both as a requirement and a goal, in every phase of the development process, starting from the early stages of design. This ensures more robust end results and optimized processes, improving development costs and finally the overall user experience [13,50,51].

In conclusion, a design will be accessible when it is usable for the broadest spectrum of individuals with different abilities and skills in the most situations or usage contexts, allowing them to achieve their goals efficiently and satisfactorily [15,46,52].

3.2. User Experience (UX) and Usability

Interactions with products and services are increasingly becoming more important for people, since decision making is not limited to the cost–benefit equation but considers the experiences that are generated before, during, and after the specific moment of purchase [53]. In fact, interactions with products, services, or systems, both direct and indirect, are part of people's experience and are not limited to the basic attributes expected of them.

Experiences have a greater impact on people's emotional states and well-being than purely transactional or material events; therefore, it is optimal to emphasize the experiential part in interactions with products over the merely functional part [54,55].

On the other hand, usability is an attribute that directly influences user experiences and determines how easy and pleasant it is for users to interact with interfaces, products, or services [56]. The different existing definitions of usability share certain common elements that include objective and quantifiable aspects related to the performance of users, such as the effectiveness and efficiency of use, ease of learning and usefulness, memorization, or recall rate. Some subjective aspects are also included, such as satisfaction, liking, or pleasure [57].

Currently, usability has been established as a fundamental pillar in the design of technological products and systems, guiding the creation of digital interfaces, mobile

applications and complex systems, and its effective application has a direct impact on the satisfaction of needs and expectations of the modern user as well as in customer retention and the achievement of business commercial objectives [58].

A holistic approach to user experience includes both usability and accessibility as dimensions and encompasses all the subjective, emotional, and behavioral aspects of the user's interaction with a product, service, or system, fluctuating between the diversity of capabilities and abilities of individuals [57].

Ultimately, experiences become a way to convey the essence of a brand and wield the potential to turn into an opportunity or a threat, since the set of impressions generated by interactions will influence future customer decision making.

The experiences provided to users will determine the long-term sustainability of businesses. Therefore, experiences transition from abstract concepts to tangible outcomes.

3.3. Biometrics/Neuroscience

Psychophysiology is a branch of neuroscience that delves into the link between mind and body through the involuntary reactions of the Autonomous Nervous System (ANS) and the triggers that cause them [59]. This system is directly involved in the regulation of the emotional behavior of human beings.

The evolution of different methods and techniques allows the collection of these reactions to different stimuli, the synchronization of several sensors simultaneously, and the availability of lightweight, portable, and easy-to-wear devices—for example, smart watches [26,60]. Another relevant aspect provided by these biometric devices and techniques is the real-time collection of psychophysiological responses, i.e., the signals are produced and collected at the same moment that the stimulus generates them.

These techniques overcome challenges faced by other methods, such as interviews or surveys, which may be influenced by biases from both participants and researchers, isolating objective data from subjective data [26,61,62].

In broad terms, these biometric devices and sensors have the capability to detect and record involuntary psychophysiological signals and reactions at the subconscious level. These signals include brain or neuronal activity, pupil size, variations in heart rate, fluctuations in respiratory rhythm, or shifts in the electrical conductance of the skin. All these responses are associated with cognitive, affective, and/or emotional states [63–65]. These states of the participants can reveal information about visual attention, effort, cognitive load and emotional agitation or arousal, which can be caused by anxiety, frustration, or stress [61,63,66–68].

In this manner, the advantages arising from the mentioned features—such as gathering involuntary or subconscious data, real-time collection, simultaneous multimodal research, and unbiased objectivity—have led several disciplines, not directly related to neuroscience, to progressively integrate these psychological techniques. This incorporation aims to unveil specific human behaviors, discern emotions, validate results, and provide objective data. These disciplines include neuromarketing, neurocommunication, computational neuroscience, neuroeconomics, behavioral economics, and user experience.

Specifically, in the field of user experience, conventional techniques usually incorporate different types of biases that can result in the distortion and inaccuracy of the data collected [69–71]. In response to the limitations of traditional methods, diverse user experience research now integrates psychophysiological and biometric measurement techniques. These methods aim to objectively capture and measure the subconscious reactions and emotions of users during their interactions with various products, services, or systems. Additionally, they assess the impact of these experiences on users' behaviors and subsequent decision-making processes. By doing so, these neuroscientific techniques mitigate biases and effectively fill the gap not covered by conventional approaches [26,59,62–64,72,73].

In fact, the evidence captured by biometric sensors (skin conductivity, heart rate, pupil size, respiration, blood volume, etc.) reflect the reactions of the autonomic nervous system [59,74,75] and provide continuous, constant, contextual, reliable, and objective

information on the psychophysiological resources that users engage when carrying out tasks and interacting with different systems [59].

In conclusion, the use of measurements from psychophysiological techniques is becoming increasingly positioned as an effective method to evaluate the experience of users, especially to collect reactions derived from their interactions with products, services, or systems. These methods also reveal information about the emotional, affective, and/or cognitive states of the users [61,65,76]. Finally, the relevance of identifying certain emotions such as the sadness, joy, frustration, or anger of users during their interactions lies in their importance for the design of better products and/or services [65].

Galvanic Skin Response (GSR)

GSR or skin conductance is a physiological measure that evaluates the electrical conductance of the skin in response to emotional, cognitive, or environmental stimuli, providing information about moments of emotional arousal of users in the interaction with these stimuli [61,63,66]. It is based on the evidence that the skin has electrically conductive properties that vary depending on the activity of the sweat glands, which are activated through the sympathetic nervous system when a person experiences intense emotions or significant cognitive changes, which is reflected in changes in skin conductance [77]. These signals are similar among most people [63].

Over time, GSR has been widely used in psychological and physiological research to measure organic responses to emotional phenomena, stress levels, and psychosomatic behavior and as a tool in research on human emotion and decision making [63,78]. Various studies confirm the linear relationship between skin conductance and emotional and mental states such as anxiety, frustration, stress, or fatigue, which result in high levels of arousal, being therefore capable of collecting both emotional responses as cognitive activities [65,79,80].

Nowadays, the skin conductivity signal is very easy to record via two electrodes placed on the second or third finger of either hand, by varying a low voltage current between both electrodes, which will measure electrodermal activity. The "peaks" in the skin conductivity signals are due to emotional responses, stress, or anxiety; therefore, they are valid as a source of additional information for the evaluation of the users' experience.

The greatest limitation of the GSR technique is that changes in the intensity of the emotion or arousal do not indicate its valence, that is, whether this arousal is positive (joy, enthusiasm) or negative (stress, frustration) [81]. To assess the nature of the intensity manifested, it must be identified with the moments of the stimuli presented together with the tests carried out, complementing these signals that occur at a subconscious level with the data collected by traditional usability metrics [82].

The utilization of neuroscientific methods in the field of user experience (UX) is recent [62,63,72,83,84] and provides a new approach and scope in the analysis of user experiences that is not available with traditional techniques [85]. The combination of both techniques, psychophysiological and traditional user experience techniques, will return more robust results [63,72]. On the other hand, their application with individuals with disabilities to measure their experiences and prioritize design elements is innovative in the realm of UX research.

3.4. Persona Archetype and Disabled Persona

User-centered design (UCD) is an approach that places the end user at the heart of the design process. It is based on a deep understanding of users' needs, preferences, and limitations, as well as their usage contexts, to create products and services that are easy to use, intuitive, efficient, and satisfying. This approach involves designing with empathy and prioritizing users' needs, actively involving them throughout all stages of design, from initial research to continuous evaluation and improvement, with the aim of ensuring an optimal user experience.

Within the user-centered design techniques, the *persona* archetype is a powerful tool that allows design teams to become familiar with users, discover and better understand their needs, motivations, and goals, and learn how they interact with products and/or services, their usage contexts, and experiences. A *persona* is a fictional representation of a potential or real user of the product, service, or system that will be designed or redesigned [86].

This tool arises to avoid designers and developers of technological solutions making assumptions [86] about an imaginary, vague, and confusing user (elastic user), materializing designs based on real users who will use the systems and thus generating a connection with users. In this way, a new dimension is introduced in the consideration of user groups: personality, "realistic characters driven by personal motives" [87] (p. 1). These characters help designers to think beyond technical functionalities and consider how a solution will impact real people's lives. Empathy toward the user according to Cooper [86] allows a shift in the traditional way of working for designers and developers, directing designs from their goals to users' goals.

To define the *persona* archetype, user target data are needed. In order to gather this information, different methods are used involving directly or indirectly actual users through qualitative and quantitative techniques in enough quantity to identify trends and patterns: interviews, contextual observation, surveys, netnography, web analytics, A/B testing, focus groups, user testing, etc. [31,57,88,89]. The choice of these techniques will depend on the variables that condition the project: type of product/service, project goals, resource availability, target audience, etc.

The collected information and emerging insights will be translated into cards or templates using visual elements that help generate awareness, connection, empathy, and recall about the users [90,91]. Unlike other user representation models, the *persona* includes a brief realistic description, background, needs, and goals related to the specific product or service, literal quotes, a fictitious name, and an inspiring photograph or image. This information allows "bringing to life" the data that characterize this fictional archetype [88,92].

According to Cooper [86], *personas* should be used as constant reference points throughout the design process. They help communicate and maintain team focus and alignment by a shared vision, guiding decisions, and facilitating the evaluation of solutions' effectiveness for users. These archetypes provide relevant information that is useful throughout the design process, eliminating the need to directly involve users in every aspect of the project. Many times, they address to design issues without the need to carry out series of user tests repeatedly [88].

Providing the design team with *persona* cards not only helps to avoid decisions based on assumptions about a hypothetical user but also allows for better decisions focused on the real user [93]. Therefore, this tool leads to more effective and satisfying solutions, making the design processes more efficient and less costly in terms of time and resources involved because they better meet user expectations, increasing their chances of success [88].

Finally, the qualities of using *persona* archetypes are reflected in business results. In 2010, Forrester indicated that product and service designs using *personas* in their projects can multiply return on investment (ROI) up to four times over [94].

Disabled Persona

Understanding the experiences of users with disabilities is not easy. Nowadays, a large number of frustrations and specific needs of these users are still unknown [16]. In this sense, due to its ability to put users at the center of the design process, the *persona* card is an effective resource for designing while considering the needs of people with different abilities [31].

A *persona* profile is a realistic but fictitious representation that reflects the characteristics, needs, objective behaviors, and expectations of target users. In this sense, *personas* based on users with disabilities help raise awareness about accessibility needs, empathize,

and recognize the problems they experience in their interactions with different products and/or services, digital environments included [16,31,95,96].

A *persona* archetype with a disability should include the usual sections, descriptions, characteristics, elements, and sociodemographic details. Additionally, in order to empathize and understand the specific situations faced by this user group, the *persona* card should incorporate some considerations regarding the nature of the limiting condition, information on how this archetype interacts with the system and the adaptive strategies developed, the assistive technology used for such interactions, the experience and skill in using these support tools, and their frequency of use [15,33]. Other authors [16,32] propose incorporating visual elements such as photographs or diagrams to visually illustrate the restrictions of different abilities as a way to generate empathy and using a communication format and style aligned with design and development teams. Zubair et al. [31] recommends making the descriptions in the third person with a short background story.

The development of a *persona* with disabilities card will serve as a representation of users that can enable product developers to focus on design, evaluate functionalities, and guide decision making [31].

On the other hand, when collecting data from users with disabilities, it is necessary to take into account some considerations in the methods applied. For instance, questionnaires must be drafted considering this diversity, as well as their support and format, which must be accessible and compatible with assistive devices (e.g., screen readers). Interviews and user testing require a moderator with experience in accessibility that is capable of generating appropriate trust, being sensitive to different disabilities, and demonstrating empathy [97].

According to [33], despite their highly recommendable use and proven effectiveness, resources to properly develop *personas* with disabilities are usually scarce, leading to the risk of addressing them inaccurately. Thus, using existing *personas* with disabilities as a starting point for the development of a specific archetype provides previous understanding and insight into users as well as requires fewer resources (economic, time, and personnel involved) [16].

In line with previous sections, considering these needs, eliminating frustrations, and contributing to people with disabilities achieving their goals can represent a competitive advantage, leading to user loyalty and market share expansion.

4. Research Methodology Proposal for a Persona with Total Visual Impairment

Based on the data from the studies and documents reviewed and selected in the different thematic areas that are the subject of this research, shown in Table 1, an analysis has been carried out to design a holistic and multidimensional methodology to be used in the creation of an effective *Persona with Total Visual Impairment* profile.

Table 1. Documents analyzed for the development of the methodology proposal. Table elaborated by the authors.

Theorical Dimensions	Documents	Methodology Phase
ACCESIBILITY & PEOPLE WITH DISABILITIES	Aizpurua et al. (2016) [6] Botelho (2021) [13] Disability Rights Commission (2004) [47] European Telecommunications Standards Institute (ETSI) (n.d.) [39] Hassan-Montero & Fernández (2004) [46] Henry (2006) [15] Huber & Vitouch (2008) [48] International Organization for Standardization (ISO) (n.d.) [38] Lazar et al. (2004) [49]	RESEARCH PHASE

Table 1. *Cont.*

Theorical Dimensions	Documents	Methodology Phase
ACCESIBILITY & PEOPLE WITH DISABILITIES	Lazar et al. (2007) [24] Lazar et al. (2010) [22] Leporini & Paternò (2008) [20] Mátrai (2018) [41] Microsoft (2010). Engineering software for accessibility (2010) [50] Nielsen Norman Group (2001) [52] Nogueira et al. (2019) [1] Pascual et al. (2014) [10] Petrie & Kheir (2007) [42] Petrie, Hamilton & King (2004) [23] Power, Freire & Petrie (2012) [21] Schmutz, Sonderegger & Sauer (2016) [11] Schmutz, Sonderegger & Sauer (2018) [11] Serrano (2009) [35] Slatin (2001) [51] Theofanos & Redish (2003) [3] United Nations (n.d.) [37] United States Rehabilitation Act (n.d.) [40] Web Accessibility Initiative (WAI) (n.d.) [36] World Wide Web Consortium (W3C) (n.d.) [5]	RESEARCH PHASE
USER EXPERIENCE & USABILITY	Brooke (1996) [98] Hassenzahl & Tractinsky (2006) [54] Hassenzahl et al. (2003) [99] Kirakowski & Cierlik (1998) [100] Laugwitz et al. (2008) [101] Matthews et al. (2020) [102] National Aeronautics and Space Administration (NASA) (n.d.) [103] Nielsen & Landauer (1993) [104] Nielsen (1993) [58] Nielsen Norman Group (1993) [58] Nielsen Norman Group (2012) [56] Petrie &Precious (2010) [105] Sauer, Sonderegger & Schmutz (2020) [57] Schmitt (2011) [53] Van Boven & Gilovich (2003) [55] Watson et al. (1988) [106]	
NEUROSCIENCE	Bruun (2018) [72] Cohn & De la Torre (2014) [69] Cowley et al. (2016) [73] D'Mello, & Kory (2015) [60] Ekman, Levenson & Friesen (1983) [66] Foglia et al. (2008) [63] Kocaleva et al. (2017) [64] Kula et al. (2018) [26] Lin et al. (2005) [59] Mandryk et al. (2006) [61]	

Table 1. *Cont.*

Theorical Dimensions	Documents	Methodology Phase
NEUROSCIENCE	Nacke & Lindley (2008) [76] Nielsen & Pernice (2010) [67] Núñez Alonso & Martín-Albo Lucas (2004) [74] Picard & Healey (1997) [65] Podsakoff et al. (2003) [70] Vallejo Ruiloba (1992) [75] Vermeeren et al. (2010) [71] Vicente, Hayes & Williges (1987) [68] Yao et al. (2014) [62] Zubair et al. (2019) [31]	RESEARCH PHASE
GSR	Bach & Friston (2013) [78] Boucsein (1992) [79] Bruun (2018) [72] Calvo et al. (2014) [83] Dawson et al. (2007) [77] Ekman, Levenson & Friesen (1983) [66] Fairclough (2009) [82] Foglia et al. (2008) [62] Ghergulescu & Muntean (2014) [84] Healey (2000) [80] Kula et al. (2018) [26] Mandryk et al. (2006) [61] Ohme et al. (2009) [81] Ward & Marsden (2003) [85] Yao et al. (2014) [63]	
PERSONA	Adlin & Pruitt (2006) [92] Blokmvist (2002) [87] Calabria (2004) [88] Cooper (1999) [86] Forrester Research (2010) [94] Garreta & Mor (2011) [90] Goodwin (2009) [91] Pruitt & Adlin (2006) [93] Pruitt & Grudin (2003) [89] Sauer, Sonderegger & Schmutz (2020) [57] Zubair et al. (2019) [31]	DESIGN PHASE
DISABLED PERSONA	Cooper (2004) [86] Goodman et al. (2006) [32] Grudin & Pruitt (2002) [96] Kitchin (2000) [97] Henry (2006) [15] Lee et al. (2021) [16] Sauer, Sonderegger & Schmutz (2020) [57] Schulz & Fuglerud (2012) [33] Zubair et al. (2019) [31]	

To address these findings identified in the literature review, a methodology is developed to effectively translate the user with total visual impairment needs into a tool that guides developers through the design process [16,31,33,42,86–88,90–97].

This methodological framework is composed of two phases: a "Research phase" for gathering user data, and a "Design phase" for analyzing and developing a *Persona* with *Total Visual Impairment* profile.

4.1. Research Phase

In the "Research phase", the proposed methodology employs a mixed research design to gain deeper insights and provide a complete overview of all dimensions involved through a concurrent triangulation strategy as a means to complement the strengths and weaknesses of various techniques [25] while considering recommendations for information gathering in the development of a *persona* profile [31,57,88,89,97]. In this kind of strategy, quantitative and qualitative data are merged to provide a comprehensive and holistic analysis including also objective and subjective, conscious, and subconscious data. This research approach collects all these types of data to compare and integrate the overall results covering different techniques commonly used and validated in UX research, as shown in Table 2.

Table 2. Classification of UX techniques based on quantitative/qualitative, objective/subjective data. Table adapted from [57].

	TECHNIQUE	QUANTITATIVE DATA	QUALITATIVE DATA	OBJECTIVE DATA	SUBJECTIVE DATA
USER BASED	User testing	*	*	*	
	Checklist	*		*	*
	Thinking-aloud technique		*		*
	Questionnaires	*			*
	User reports and complaints		*		*
	Psychophysiology	*		*	
EXPERT BASED	User observation	*	*	*	
	Heuristic evaluation	*	*		
	Automatic checking	*		*	
	Cognitive Walkthrough		*		*

(*) Techniques employed to capture UX data.

In this eclectic and novel methodologic approach (Figure 2), resulting from validated techniques in user experience research [57,97], the "Research phase" must begin with (i) a summary from the literature review of the main problems and sources of frustration for users with total visual impairment when using the internet. From this baseline point (ii), (iii) questionnaires will be administered to blind users and accessibility experts to collect data on their habits, needs, and expectations on the web. These data will be further enriched by conducting (iv) *think-aloud* (the technique involves instructing the user to verbalize their thoughts aloud while using a system or interface. https://www.nngroup.com/articles/thinking-aloud-the-1-usability-tool/ (accessed on 25 March 2024)) usability tests [107] conducted with blind users while interacting with websites on the internet, which ought to be accompanied by (v) contextual observations from moderators. Simultaneously, (vi) biometric reactions and emotional arousal signals are collected through a device that captures galvanic skin response (GSR), appealing to the subconscious.

The utilization of neuroscientific methods in the field of user experience (UX) is recent [26,62–64,72,83,84]. However, its application with individuals with disabilities to measure their experiences and prioritize design elements is innovative in the realm of UX research.

According to this methodology, triangulation [25] will be conducted from different techniques to validate the frustration or satisfaction levels experienced by users in their

web interaction. Data collected from biometric devices will further corroborate frustration or satisfaction levels [59,74,75].

This data collection not only allows for analyzing the needs, expectations, emotions, and principal sources of frustration of users with total visual impairment but also identifies discrepancies and correlations with internationally well-established WCAG 2.1 accessibility guidelines and their different levels of web accessibility. The WCAG 2.1 version is the current standard in web accessibility regulations.

This methodology is developed around blind people using screen readers for digital technology interaction. Consequently, digital and accessible alternatives must be prioritized, avoiding the need for physical presence, when the technique allows it. In this methodology, online methods are selected for the data collected via questionnaire, while the physical presence is inescapable for the (*think aloud* + observational + GSR) test.

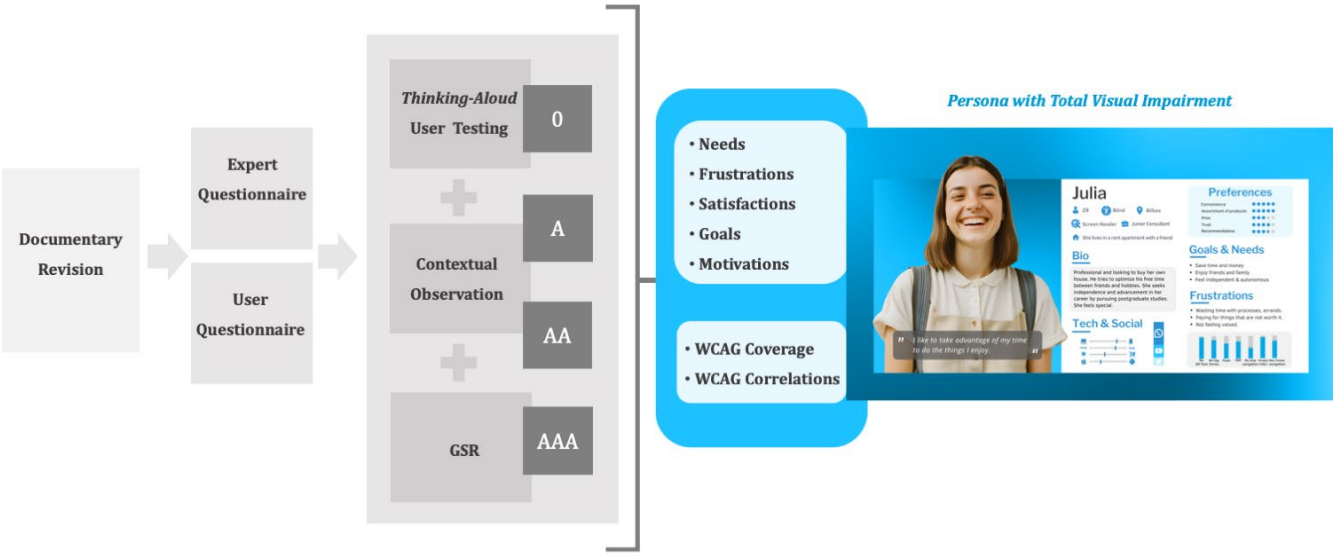


Figure 2. Methodology scheme. Research phase and *Persona with Total Visual Impairment* (the image of the visually impaired person has been generated using artificial intelligence via https://www.canva.com/ (accessed on 20 March 2024)) Design phase (developed by authors).

Instrumentation and Stimuli

The instrumentation of each technique that is deployed in this methodology and the stimuli involved are shown below, as indicated in Table 3.

Table 3. Research stimuli and instruments by selected techniques. Table developed by the authors.

Research Method	Stimuli	Instruments	Research Themes
(i) Literature Summary	Documents	Summary	Web accessibility errors frustrating to blind users
(ii) Expert Questionnaire	Question Form	PC	Common accessibility errors, WCAG
(iii) User Questionnaire	Question Form	PC	Habits, Needs, Frustration, Satisfaction, Objectives, Motivations
(iv) Thinking-Aloud Test	2–3 tasks × 8 websites (2 0 level, 2 A level, 2 AA level, 2 AAA level)	PC	Needs, Frustration, Satisfaction, Success,
(v) Contextual Observation		Recordings, Notes	Needs, Frustration, Satisfaction, Success
(v) GSR		GSR Device	Arousal

(i) Literature Summary: The data collection technique should correspond to documentary analysis and revision, compiling accessibility errors, problems, and difficulties that users with total visual impairment find on the web.

As highlighted in previous sections, these elements define user experiences and satisfaction during website interactions. They represent not only sources of frustration but also significant barriers to achieving user objectives. Addressing these factors is paramount to effectively meeting user needs.

(ii) Expert Questionnaire: A tailored questionnaire for accessibility experts should be designed combining open-ended and closed-ended questions to collect from their professional experience those dimensions and elements that influence and interfere with the digital user experience on the web. Professional digital accessibility consultants, preferably with total visual impairment, will provide crucial insights gathered from numerous accessibility audits conducted over years of practice on a variety of websites.

This expert questionnaire should address the following key aspects:

- Sociodemographic data: gender, age, years of experience as accessibility consultant.
- Internet Usage data: frequency of use, devices, screen reader, operating system.
- Internet Experiences and Goals as internet user data: objectives on the web, needs on the web, satisfaction, achievement of goals, frustrations, relievers.
- Internet Expertise as accessibility expert data: levels of accessibility and conformance on the web, errors and barriers, facilitators, accessibility needs, improvements, WCAG: implementation, efficiency, and coverage.
- A sample expert questionnaire is included in Appendix A.

Their overall perspective on the current accessibility status of websites for individuals with total visual impairment, and the extent to which WCAG accessibility guidelines are covered and effective, will provide enriched information.

(iii) User Questionnaire: A user questionnaire will be developed including sociodemographic information, experience in technological tools, internet usage and habits aspects. This questionnaire will include both open-ended and close-ended questions, providing both quantitative and qualitative information. The questionnaire delves into the motivations, needs, and expectations of users with total visual impairment in their interactions with the web.

This user questionnaire should address the following key aspects:

- Sociodemographic data: gender, age, city, visual impairment.
- Internet Usage data: years of internet usage, frequency of use, devices, screen reader, operating system, browser, level of expertise on the web, reasons, and motivations of usage.
- Internet Experiences and Goals data: objectives on the web, needs on the web, satisfaction, achievement of goals, obstacles, frustrations, relievers, accessibility, improvements.
- A sample user questionnaire is included in Appendix B.

This instrument is designed and selected to facilitate reflection on the indicated aspects and elements, eliminate time pressure, and reduce the participant biases inherent in other kind of techniques such as focus groups or interviews. The online format of the questionnaire could facilitate its dissemination across various forums and communities of users with disabilities and total visual impairments, enabling the use of the snowball sampling technique to reach a larger number of users.

Both (ii) and (iii) will be conducted in an accessible format, prioritizing digital or online ones to favor and streamline their distribution and participation. Also, these questionnaires will be asynchronous and responsive, allowing participants to choose the time and device for their responses. With no time limit for completion, this encourages participants to complete the tasks and reflect on open-ended questions.

Online survey tools can be leveraged to design these questionnaires, collect responses, and analyze the results obtained directly within these tools using the available function-

alities. Statistical analysis tools also could be utilized for more complex analyses and to compare with the rest of the results obtained.

Steps (iv), (v) and (vi) must be performed simultaneously, Therefore, the various data collections will be conducted on the same subjects, in the same space–time, and using the same devices at each moment.

Due to measurements taken with a biometric device, these tests must be conducted in a physical space enabled for this purpose.

The target user of this methodology and the specific test must meet the following requirements for proper selection and screening: they must have total visual disability or blindness, be of legal age, regularly use the internet and web, use screen readers—specifically the one provided in the test—reside in the same city where the test is conducted, and have the availability and ability to attend the test location in person.

The recruitment of blind or visually impaired users for participation in tests can be carried out through associations and organizations of people with visual impairments.

Regarding the sample size of participants in the user test, the indications of the study [104] can be followed. This paper reveals that 5 users experience 85% of the usability problems, according to the equation (N = Total number of usability problems in the design; L = Proportion of usability problems discovered while testing a single user; n = Number of users [104]):

$$N\left(1-\left(1-L\right)^{n}\right.$$

According to this paper, additional users do not significantly contribute to discovering new usability problems. Therefore, the recommendation for optimizing resources and findings in research is to involve 5 participants for each user group—in this case, 5 users with total visual impairment.

Session data with users during (iv), (v) and (vi) will be recorded, capturing both the computer screen and the computer's camera. Computer recording and biometric signals should be conducted to synchronize all resulting inputs from the experiment. Observational statements by moderators and ad hoc post-questionnaire conclusions should be included.

The qualitative and quantitative data collected from different devices should be analyzed both manually and with the support of user-centered tools (affinity diagrams, mental maps, etc.) and statistical programs to enable greater depth.

(iv) *Thinking-Aloud* Test: The *thinking-aloud* user testing is a technique which involves requesting the user verbalize their thoughts aloud while using a system or interface. The participant will receive instructions on tasks to be performed on certain test websites, where they will verbally explain the actions they are taking as well as their impressions of any element they like or, conversely, find more difficult to address, obstacles or barriers, and how this interaction with the website makes them feel.

For the user testing phase, an intragroup subject experiment should be conducted, where the same participants will perform the same 2–3 tasks on a combination of 4 different websites, each with a different conformance level (0, A, AA, and AAA) of WCAG 2.1.

The number of tasks involved takes into account the cognitive effort exerted by individuals with visual impairments when using the internet, ensuring that the maximum time spent in the user test does not exceed 30 min, with an average of 5 min per task [1,20,22].

Regarding the stimulus, the web pages provided to participants will be selected based on their degree of compliance with the accessibility guidelines proposed by the WCAG, which are classified as A, AA, and AAA. This level of accessibility compliance will serve as the independent variable, which will be modified to study its impact on the experiences of users with total visual impairment.

The websites selected as stimuli in this user test must be categorized according to their level of accessibility based on their compliance with WCAG guidelines as follows: null or minimal accessibility (0), low accessibility level (A), high accessibility level (AA), and very high accessibility level (AAA) corresponding to the maximum level of accessibility.

For the categorization process, the following procedures are proposed (one or several of them may be utilized):

- Manual expert audit;
- Automatic web accessibility tools (such as WAVE (available online: https://wave.webaim.org/ (accessed on 25 March 2024)), aXe Tools (available online: https://www.deque.com/axe/ (accessed on 25 March 2024)), Accessibility Insights (available online: https://accessibilityinsights.io/docs/web/overview/ (accessed on 25 March 2024)), etc.)
- Declaration of conformance with WCAG on the website.

In some studies [5], the highest level of accessibility was excluded because legally mandatory standards typically only require compliance up to level AA currently on level WCAG 2.1.

These websites must belong to the same category. Previous studies [5,59,63,102] have selected websites from the restaurant industry, categorizing them as leisure-related, which is essential for the integration and inclusion of people with disabilities in society.

To provide context to the user during the test, a scenario or plausible story adapted to the proposed tasks must be established. This scenario should meet everyday situations that involve the habitual performance of a person in aspects of personal life, which ensure their normal inclusion in social life autonomously and on equal terms with the rest of the population.

For the tasks, a computer with a Windows/Mac operating system, a browser, and a screen reader will be provided to participants. Users with total visual impairment use the keyboard to navigate the internet.

Prior to conducting the formal experiment with participants, a pilot test should be performed to test and measure the tasks, duration, and websites to ensure their level of difficulty, suitability, and feasibility.

Upon completing the tasks on each website, users will be asked to evaluate their experience with the specific website through a post-questionnaire before moving on to the next website.

In this regard, since the user experience is studied as a discipline, various post-questionnaire models have been developed to assess user interactions with systems. Each of these post-questionnaire models focuses on different aspects of the experiences (usability, emotions, perceptions, satisfaction, attraction...). Some of these models are widely recognized and standardized within the field.

After reviewing recognized post-questionnaire models such as EWPL [105], PANAS [106], AttrakDiff [99], WAMMI [100], UEQ [101], SUS [98], and NAS-TLX [103], the recommendation is to create an ad hoc post-questionnaire. This questionnaire might incorporate questions and aspects from these models that yield valuable insights aligned with the experiences of users with total visual disabilities. It will capture the dimensions and nuances of their interaction with web pages, which will later be reflected in the *persona* template.

The ad hoc post-questionnaire will assess both the websites and the overall experience. It should include questions covering emotional aspects (EWPL [105], PANAS [106]) and questions regarding usability, such as task performance, task load, difficulty and/or effort, satisfaction, and perceived accessibility by participants (WAMMI [100], NASA-TLX [103], SUS [98]). Questions beyond the scope of this methodology will be excluded.

A sample of an ad hoc questionnaire considering all these aspects is included in Appendix C.

(v) Contextual Observation: Additionally, the test moderators will collect task performance and emotional data to determine the user experience for each participant during the *thinking-aloud* test.

The parameters to be measured and collected during this observation include the following:

- Task completion times;
- Task success (considering a task completed when it is successfully performed within the provided time frame);
- Perceived difficulty/efficiency;
- Perceived workload;

- Level of frustration;
- Satisfaction;
- Emotions, positive or negative affect;
- Comments and keywords relevant to the investigation.

(vi) GSR: In addition to the computer available for the tests, a GPS biometric device should be installed. This device will collect the data generated during the user test session, which will also be recorded for later interpretation. These data correspond to the users' reactions to the stimuli and are indicators of arousal from mental and emotional states (anxiety, frustration, stress, or fatigue) [62,63,65,79,80].

The data collected from the GSR enables a complex analysis of the user's reactions to the received stimuli, which need to be categorized as positive or negative. These data can uncover hidden insights by appealing to the user's subconscious emotions. Additionally, its analysis with statistical methods allows establishing cause and effect relationships between parameters.

Since users with total visual impairment interact with the computer keyboard with both hands in their web navigation, it should be considered to place the device on the user's forehead or back of the head rather than on the fingers or non-prevalent palm.

To complete the phase involving steps (iv)–(vi), an informed consent document must be provided to participants for signature and registration, which includes the procedures that will be carried out during the test and the confidential treatment of the data collected.

4.2. Persona Design Phase

In the "Design phase", a *Persona with Total Visual Impairment* template will be developed, which will reflect the findings and insights resulting from the triangulation and analysis of data from the "Research phase". This persona template will encompass the needs, expectations, pain points or frustrations, and satisfactions of users with total visual impairment in their interaction with websites. This enables designers to make informed design decisions that address these needs and eliminate obstacles in the experiences of people with disabilities, thereby making web designs more accessible and equitable [16,31,33,42,86,88,90,91,93–97].

Patterns and mental models among users and sociodemographic variables from the data collected in the different techniques deployed will be found to refine this *persona* template representing users with total visual impairment. Similarly, based on this analysis and data, there will be a selection of the most recurrent and/or significant motivations, objectives, and experiences by affinity groups. This will allow insights to emerge from the collected data on the causes of frustrations and satisfactions, which will be prioritized for consideration in the development of new websites or redesigns.

A *Persona with Total Visual Impairment* template should incorporate these findings and resulting information in different sections (Figure 3):

- **Sociodemographic data**: includes an inspiring photograph or image, a fictitious name, age, city, assistive technologies, occupation or background, and other personal relevant information.
- This information responds to a representative target user, which is invented but realistic, as mentioned in Section 3.4.
- **Biography:** includes a brief realistic description of the user.
- **Preferences and Motivations:** describes what drives the user's decisions on the web.
- **Goals and Needs:** includes the specific user's objectives and needs to be reach on the web and general goals or needs related to them.
- **Frustration:** identifies specific frustrations encountered by users when interacting with the web.
- **Problems and Barriers**: issues that the user faces on the web more frequently.
- **Quote:** provides a brief quote summarizing the essence of this *persona.*
- **Social and technological habits**: offers context to the *persona*'s social and technological behaviors.

Finally, this tool will be transferred to the design and development teams to communicate the needs and requirements of users with total visual disabilities, serving as a vehicle of empathy and representative of this group of users. This tool facilitates a deeper understanding and empathy regarding these users, their goals, and their motivations, beyond technical requirements [16,31,33,42,86,88,90,91,93–97]. Therefore, the *persona* profile should accompany designers and developers during the whole design process in order to create more usable and accessible websites for all.

The outcome is a generic *Persona with Total Visual Impairment* profile with a user-centered approach to developing accessible digital products or services on the web. This tool is designed to be intuitive and understandable, generate empathy, and guide the design process. These sections can be adapted or supplemented with more specific details based on different products and services, users, scenarios or environments, as will be discussed in the next section.



Figure 3. Example of *Persona with Total Visual Impairment* (the image of the visually impaired person has been generated using artificial intelligence via https://www.canva.com/ (accessed on 20 March 2024)) profile (developed by the authors).

5. Discussion and Conclusions

The accessibility of web pages becomes a crucial aspect for the development and autonomy of people with disabilities and their proper participation and inclusion in society. This methodology addresses the need to provide methods and tools that allow the inclusion of users with different abilities in the design and development of products and services so that the websites could be more accessible for all [3,13–17].

The objective is to enhance the accessibility levels for individuals with disabilities, particularly those with total visual impairments, on websites. This will be achieved through insights and findings obtained from the triangulation of various research techniques aimed at understanding the needs, frustrations, objectives, and emotions of these users during their web interactions, considering both conscious and subconscious dimensions. The outcome will be the design of a *Persona with Total Visual Impairment* template.

Designers can incorporate this template into the development of their digital products and/or services to address these needs and ensure accessibility and an equitable experience for these individuals. Similarly, it is necessary to verify the extent to which WCAG

accessibility guidelines cover the needs and experiences of people with visual disabilities and evaluate their level of adequacy with the real needs of users with disabilities.

In summary, the presented methodology aims to contribute to the achievement of the following goals:

- More effective and accessible designs that consider the needs of all users regardless of their abilities and skills that improve their user experience and better meet their expectations.
- Provide designers, developers, and stakeholders with a tool that allows them to know and empathize with users to develop universally usable products and/or services from which all people benefit.
- Facilitate the development of websites that are not only accessible from a technical point of view but also providing and guaranteeing a satisfactory experience for people with visual impairments that allows them to achieve their objectives, complementing the current international accessibility standards (WCAG).
- Increase companies' results thanks to the increase in the target audience and due to the increase in the efficiency of the design processes, reducing costs derived from support and redesigning and also reaching more legal compliance.
- And finally, reach more open and inclusive societies toward universal accessibility.

This research aims to contribute to scientific literature and organizations with a new approach and alternatives to design products and services for consumers based on their expectations, needs, and motivations, introducing new variables or dimensions of user research, including conscious and subconscious data.

Including these dimensions, users will see their deepest needs and motivations more efficiently satisfied with higher satisfaction rates, creating a bond with these brands and organizations. Moreover, this methodology should result in cleaner, simpler interfaces that enhance the user experience of all. Better accessibility levels represent a collective improvement also as society.

On the other hand, organizations will optimize their resources, making their products and services more efficient, effective, and universal thanks to the focus, deep understanding, and empathy of designers toward users as well as enabling them to reach a broader audience. Currently, stakeholders are aware of the significant number of people with disabilities using their products as well as the economic, legal, social, and reputational importance of providing accessible products and services for users with different abilities [16]. These considerations not only benefit people with disabilities but also contribute to building a better, more empathetic, understanding, and inclusive society.

Further research will extend this methodology to all types of disabilities from auditory, cognitive, physical, or motor impairment in order to cover the spectrum of specific needs of different groups of users.

Similarly, for future investigation, this methodology can be extrapolated to various types of websites, digital applications, different devices, and also across various environments that are not limited to digital and also include physical ones. Lastly, this methodology can be extended and applied to all types of users, each with their specific and unique characteristics.

6. Limitations of the Study

This study presents a multidimensional and holistic methodology designed to equip designers and developers with a comprehensive and intuitive resource that facilitates the design of universally accessible products and services on the web. Although this methodology encompasses various techniques to address different dimensions, it is important to acknowledge its limitations. The methodology primarily focuses on individuals with total visual impairment or blindness to develop this framework rather than considering disability as a whole or focusing on other disabilities. This choice is based on the recognition that users with total visual impairments face the most challenging and complex experiences when interacting with the web, which has predominantly visual content [1–3,6,13,18–24,37,42].

Beginning with the most complex disability in their interactions with the web, managing high amounts of difficulties, to deploy this methodology is a way to test the methodology itself and consider all the magnitudes involved in this type of interaction. Subsequently, adapting the methodology to other disabilities appears less complicated than pursuing a general disability-focused approach.

In any case, each type of disability requires a personalized approach, as the factors affecting one disability may not be related to those influencing another. This adaptation will require adjusting the testing environment, tasks, and stimuli. In this sense, once necessary adaptations are made for each disability, an analysis of common aspects among different disabilities could be undertaken to optimize implementation. The same applies when adapting the model to other environments, whether digital or physical, requiring checking each phase.

In any case, the conceptual approach of this methodology regarding the use of various user research techniques (quantitative–qualitative, traditional–neuroscientific, attitude–behavior), the collection of data from different dimensions (conscious–subconscious, objective–subjective), and the translation of the resulting findings into a *persona* template remain relevant to different users and environments [16,25,31,33,42,57,86,88,90,91,93–97].

On the other hand, the exploratory nature of this work means that the validation and effectiveness of the methodology and the *persona* tool are subject to empirical verification not only for users with total visual impairment but also for other types of disabilities and environments. It is necessary to put the model to the test and implement it in the real world, identifying areas for improvement and optimizing it.

Moreover, there are structural limitations in terms of resources. Implementing this methodology involves taking responsibility for providing the tool resulting from this methodology, the *Persona with Total Visual Impairment* template, and making it available to designers and developers of web products and services. This requires an investment in a multidisciplinary team that includes user experience and neuroscience profiles as well as sophisticated equipment and advanced programs to extract the information collected by biometric devices. Two alternatives are proposed:

1. Government organizations, institutions, foundations, or similar entities could take on the role of providing this tool as a basic and general resource for designing accessible products and services while promoting empathy and inclusion to people with disabilities.

2. Web design, user experience, or accessibility consulting firms could develop this methodology to offer it to their clients, providing insights and findings beyond technical requirements, which will be more efficient.

It is imperative that governmental and non-governmental organizations, institutions, foundations, and consulting firms take the initiative toward inclusion, universality, and the full right to equal opportunities for all individuals through the development of this methodology. Although this is just a methodological proposal, the development and availability of the *persona with disabilities* to all designers and developers could pave the way for elevating levels of accessibility, inclusion, and empathy in design and translate it to the whole society.

Regarding the implementation of the methodology, the necessary information is provided at each stage to carry out its implementation with only minor required details. Since the essence of this methodology lies in its multidimensionality and holistic approach to the diversity of techniques used, its adaptability to other users and environments, and the data collected, it is of great interest to carry out all phases to allow for the triangulation of the data obtained and to obtain consistent and reliable data. Only by putting this methodology into practice can we confirm or identify the redundancy or limited contribution of some of the steps provided and optimize them.

It is feasible to implement all phases of this methodology in different types of disabilities and environments. While in physical environments, the use of biometric devices may be challenging, there is already a wide variety of portable and wearable devices for the collection of these biometric data.

The *persona* template, resulting from this methodology, is a tool to guide design in an intuitive, understandable, friendly, user-centered, and empathic manner [16,31,33,42,86,88,90,91,93–97]. It has the potential to complement—and even replace—the current accessibility standard WCAG, which is too technical and challenging to interpret [20,42].

Designing accessible products and services that consider the needs of all individuals, regardless of their abilities and skills, entails not only a moral responsibility but also compliance with increasingly demanding legal obligations. Additionally, it involves the incorporation of up to 15.6% [11] new users to the target audience of products and services of companies.

Finally, the dissemination and availability of this tool contribute to social awareness and promote accessibility, inclusion, and empathy for people with disabilities, raising the levels of equity claimed by the United Nations Declaration of Human Rights [32].

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Informed Consent Statement: Not applicable.

Data Availability Statement: Not applicable.

Conflicts of Interest: The authors declare no conflicts of interest.

Appendix A. Expert Questionnaire

Questions:

Sociodemographic:

1. *Gender*
2. *Age*
3. *Years of Experience as a Digital Accessibility Consultant*
   Options:
   Less than 1 year
   1–5 years
   More than 5 years

Internet Usage:

4. *How often do you use the internet daily?*
   Options:
   Little or nothing
   Somewhat frequent
   Neither much nor little
   Frequent
   Very frequent (Likert scale from 1 to 5)
5. *As an internet user, what devices do you typically use to browse websites? Select all that apply.*
   Options:
   Personal Computer
   Mobile
   Tablet
   Others: Which ones?

6. *As a user, what screen reader do you use in your daily life?*
   Select all that apply.
   Options:
   Voice Over
   Jaws
   Others: Which ones?
7. *As an internet user, what operating systems do you use?*
   Select all that apply.
   Options:
   iOS
   Mac
   Windows
   Android
   Others: Which ones?
8. *Rate from 0 to 10 how much digital or online technology contributes to improving your daily life.*

   Internet Experiences:
9. *As an internet user, why do you use the internet?*
10. *As an internet user, what do you use the internet for?*
11. *As an internet user, what are the websites you use most frequently?*
    Select all that apply.
    Options:
    Work
    Shopping
    Administrative Procedures
    Information
    Leisure
    Others
12. *As an internet user, from 0 to 10, how satisfying do you consider your online experiences to be?*
13. *As an internet user, from 0 to 10, how efficient do you consider your online experiences to be in achieving your goals?*
14. *As an internet user, indicate the elements that cause you the most frustration in your online experiences.*
15. *As an internet user, indicate what are the greatest satisfactions that you find on the web/in your online experiences*?

    Digital accessibility expertise:
16. *As a web accessibility expert, from 0 to 10, what do you consider the general level of accessibility of web pages for people with total visual impairment?*
17. *As a web accessibility expert, what are the barriers or obstacles (of accessibility) that you most frequently encounter on audited websites?*
18. *As a web accessibility expert, what are the facilitators that you most frequently encounter on audited websites?*
19. *As a web accessibility expert, what do you consider to be the biggest problem preventing websites from meeting the needs of users with total visual impairment?*
20. *As a web accessibility expert, how do you think websites could be improved to be more accessible?*
21. *As a web accessibility expert, what do you consider the level of suitability of screen readers for websites and the needs of people with total visual impairment?*
22. *As a web accessibility expert, from 0 to 10, what do you consider the coverage level of WCAG 2.1 regarding the accessibility needs of people with total visual impairment?*

    Option: If the expert answered 7 or less to this question:
23. *As a web accessibility expert, what do you consider to be the biggest problem preventing WCAG 2.1 from meeting the needs of people with total visual impairment?*

24. *As a web accessibility expert, how do you think WCAG 2.1 could be improved to better adapt/cover more accessibility needs?*
25. *As a web accessibility expert, what do you consider necessary to provide a better online experience for users with total visual disabilities?*

Thank you very much, your participation contributes to building a better world for all.

Appendix B. Users Questionnaire

Questions:

Sociodemographic:

1. *Age*
2. *Gender*
3. *City of residence*
4. *Are you legally blind?*

    Yes
    No

Internet Usage and Habits:

5. *Are you a user of websites or web pages on the internet?*

    Yes
    No

Options: If the user answered Yes:

6. *How long have you been using the internet?*
   Options:

    Less than 1 year
    Between 1 year–5 years
    More than 5 years

7. How often do you use the internet daily?
   Options:

    None
    Little
    Some
    Quite a bit
    A lot

8. *What devices do you usually use to browse the internet?*
   Select all that apply.
   Options:

    Mobile
    PC
    Tablet
    Others: Which ones?

9. *What operating systems do you usually use to browse the internet?*
   Select all that apply.
   Options:

    Windows
    Mac
    iOS
    Android

10. Which internet browser do you use most frequently?
    Select all that apply.
    Options:

    Safari

Chrome
Edge
Others

11. Do you use screen readers to browse the internet?
Options:

Yes
No

If the user answered "Yes":
Which ones:
Select all that apply:

Voice Over
Jaws
Others

12. What do you consider your level of experience and proficiency with the internet and websites?
Options:

Beginner
Intermediate
Advanced
Expert

13. *Rate from 0 to 10 how much digital or online technology contributes to improving your daily life.*
14. *Briefly tell us, why do you use the internet?* (Goal)
15. *What do you usually use the internet for?* (Motivation)
Select all that apply.
Options:

Work
Shopping
Administrative Procedures
Information
Leisure
Social media
Others

Internet Experiences

16. *From 0 to 10, rate the level of satisfaction in using websites on the internet (where 0 is the lowest rating and 10 is the highest).*
17. *From 0 to 10, rate the level of internet and website accessibility in general for achieving complete and satisfactory experiences in the use of people with total visual impairments on the internet (where 0 is the lowest rating and 10 is the highest).*
18. *How often do you successfully complete the task or objective you were using the internet for?*
Options:

Never or almost never
Rarely
Sometimes
Often
Almost always
Always

19. *List some obstacles you encounter in your internet browsing (This includes both frequency and intensity of the obstacle).*
20. *List the elements that frustrate you the most in your internet browsing.*
21. *List some elements that help/facilitate your internet browsing.*
22. *List the elements that bring you the most joy or satisfaction in your internet browsing.*

23. *Rate from 0 to 10 the level of efficiency of screen readers to support navigation and use of websites on the internet.*
    Options:
    None
    Low
    Medium
    Good
    Very good
24. *Lastly, how do you think websites, or the internet could be improved to offer more satisfying experiences to users with total visual disabilities?*

Thank you very much, your participation contributes to building a better world for all.

Appendix C. Post-Questionnaire

1. *From 1 to 5, what is the level of difficulty encountered on this website?*
2. *From 1 to 5, what is the perceived level of accessibility on this website?*
3. *From 1 to 5, how appealing did you find the pages of this website?*
4. *From 1 to 5, how quickly did you find what you were looking for on this site?*
5. *From 1 to 5, what is your satisfaction level with the use of this website?*
6. *From 1 to 5, what is the level of obstacles or barriers on this website?*
7. *From 1 to 5, how much did you feel you had control over this website?*
8. *From 1 to 5, what is the level of elements that facilitated your navigation on this website?*
9. *From 1 to 5, are the contents of this website easy to understand?*
10. *From 1 to 5, when I perform an action, does it produce the expected outcome?*
11. *From 1 to 5, did you feel you knew exactly where you were always on the website?*
12. *From 1 to 5, do you consider that you have achieved the pursued objectives?*
13. *From 1 to 5, did you feel autonomous/self-sufficient when using this website?*
14. *From 1 to 5, how much did you like this website?*
15. *From 1 to 5, is the structure of this website simple/easy to understand?*
16. *From 1 to 5, is it easy to navigate this website?*

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