

Conceptual Framework: How to Engineer Online Trust for Disabled Users

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Abstract—The Internet has penetrated our lives, becoming an indispensable tool for social, business and personal growth. Thanks to the Web, users can easily carry out many tasks that were previously difficult. Differently-abled persons need to have the same opportunities as everyone else, so accessibility and usability must be included in the design of all Web resources, applications and services. To be extensively applicable, accessibility and usability guidelines should be delivered as simple design features. In previous studies some conceptual frameworks have been introduced with this aim. However, the specific applicative environment such as trustworthy e-commerce services, may offer ad hoc challenges. In this paper, we propose some guidelines to extend the design of usability conceptual frameworks in order to promote trust in e-commerce websites for people with visual disabilities.

Keywords: *trust, e-commerce, accessibility, usability, disabilities, blind*

I. INTRODUCTION

With the emergence of Internet technologies, access to e-commerce is becoming increasingly important in academia, public administration, industries, and organizations. Everyone acknowledges the importance of trust in electronic commerce (e-commerce), appreciating e-commerce characteristics such as ubiquity, anonymity, reliability, security, accessibility and availability 24h/day, 7 days a week, throughout the year.

A website or application is accessible if it can be used by all, including people with disabilities. An accessible (Web) user interface means that potential technical barriers have been eliminated, and thus anyone can interact with it.

A website's usability is determined by user satisfaction, ease of learning and remembering its organization and functions, user effectiveness, efficiency and likelihood of errors while performing the tasks the site has been designed for, such as finding information or completing e-commerce operations. A favorite definition of ours is from the ISO 9241 standard, which defined usability as the "extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use" [8].

It is essential to implement both usability and accessibility principles when designing a user interface (UI). Accessibility is a basic pre-requisite for allowing users to have access to the web page content, while usability provides

online users with simple, rapid and satisfying navigation and interaction.

Many conceptual guidelines specifically related to Web content and applications have been produced, in order to help developers create accessible and usable applications [19], [20], [13], [14]. One set of authoritative guidelines is defined by the World Wide Web Consortium (W3C), with the Web Content Accessibility Guidelines (WCAG). Recently a new version of WCAG, the 2.0 [20], has been published and embraces both accessibility and usability, addressing perception, comprehension, interaction, and robustness with the aim of making all web content perceivable, understandable and usable by anyone.

Special needs persons are a rapidly growing sector of consumers in developed countries, mainly due to the increasing median age of the population considered when designing e-commerce services. Several countries have enacted laws or directives to promote adoption of specific accessibility (and usability) guidelines [16], [21]. However at the moment many Web applications such as news websites, eLearning systems, and e-commerce applications are still not accessible or easily usable for people with disabilities.

Accessibility and usability guidelines adopted in the design phase in web application development could also engineer trust among differently-abled users. Actually many factors can impact user trust, such as the rapidity of finding information, efficiency and security when carrying out the transaction, and reliability of the delivery service behind the website. Thus, usability may be a key factor in the success of e-commerce systems, as several studies affirm. Egger [7] proposed usability, attractiveness and perception as the most important interface properties in his model of customer trust in on-line transactions.

Jarvenpaa et al.'s [10] study highlights that there are factors besides size and reputation that affect user trust in websites. These factors can be website layout, ease-of-use, appearance, and the local language. For example, the degree of usability could reflect the vendor's concern for consumers.

Numerous user studies suggest that the totally blind encounter more difficulty than those with other sensory disabilities (such as low vision, motor or hearing impairments) when executing specific tasks ([15], [5], [9]). Petrie et al. tested the accessibility of 100 websites with users with various (visual, motor and perceptual) disabilities, showing that accessible websites can also be

visually pleasing [15]. The tested websites spread out over five sectors (including e-commerce-commerce) were analyzed with automated verification and user testing, involving 51 differently-abled users, including 10 totally blind users. Concerning user satisfaction, authors recorded that the blind encountered more difficulties than other differently-abled users. Researchers at Manchester Metropolitan University [5] carried out a user test with a sample of blind and visually-impaired users who performed four information-seeking tasks. Visually-impaired users searching the Web for a specific piece of information took an average of 2.5 times longer than sighted users. The efficiency gap was further quantified by Ivory et al. [9]; when blind subjects executed a set of tasks, they took twice as long as sighted users to explore search results and three times as long to explore the corresponding web pages.

According to the World Health Organization, in 2002 more than 161 million people worldwide were visually impaired, 37 million of whom were blind. More than 82% of them are 50 years of age and older [18]. Therefore a considerable number of persons who are experiencing vision loss may encounter electronic barriers to accessing on-line information and services. These barriers can be somewhat frightening [15] since they cannot be overcome through training the blind, but only by the intentional development of accessible pages.

Blind persons usually navigate the Internet via screen reader and voice synthesizer. The screen reader is an assistive technology that interprets the Web page by announcing its content sequentially, from the title to the last word, losing style, font size and any other visual cues. Interaction via screen reader brings up several issues:

1. Information overload. Menu and navigation bar are repeated on every page. As a consequence, blind users often stop the reading at the beginning, and prefer to navigate by Tab Keys from link to link, or explore content row by row, via arrow keys.
2. Lack of interface overview. Blind persons do not perceive the overall structure of the interface, so they can navigate for a long time without finding the most relevant content.
3. Lack of context. When navigating via Tab and arrow keys the user can access only small portions of text and may lose the overall page context.
4. Content and structure mixing. The screen reader announces the most important interface elements such as links, images and window objects as they appear in the code.
5. Difficulty understanding UI elements. If the table's content is organized in columns, the screen reader announces the page contents out of order. Links, content, and button labels should be context-independent and self-explanatory.
6. Difficulty working with form control elements.
7. Multimedia content are inaccessible if equivalent alternative descriptions are not provided.

Visually-impaired users may use magnifiers, software that enlarges screen content, increasing the size of web page

components, and providing various degrees of magnification. Due to the screen's physical limitations, the greater the magnification, the smaller the amount of content shown. Also in this case a user may access small portions of text, losing the overall page context. Furthermore, depending on the degree of vision loss, a visually-impaired person may also use a screen reader in order to rest their eyes.

To overcome problems of navigation via screen reader and interaction via keyboard, specific guidelines have been developed: the (WAI-ARIA) suite defined by the Web Accessibility Initiative (WAI) group of the W3C [19]. ARIA makes dynamic content such as AJAX (Asynchronous JavaScript and XML), (X)HTML and related technologies more accessible to the disabled.

In the following part of this paper we will limit our discussion to visual impairment. Web access is becoming more difficult for blind users as more visual content, such as image links, graphics, and movies, is being used in Web sites. Blind users' problems can range from mere annoyance at wasting time and effort, to even having to abandon a task, or ask for sighted help. On-line e-commerce services are especially useful for blind persons who have mobility problems. Unfortunately these websites have often complex layouts, crowded with active elements that can be difficult to navigate via screen reader [4]. The challenge for web designers is to create a website that is not only visually attractive and informative, but is also accessible and friendly to visually-impaired people. Accessibility and usability should be seen by designers and implementers as a opportunity for potential business expansion rather than as a constraint.

In this paper, we propose some guidelines for extending conceptual frameworks to foster trust in commercial transactions for people with disabilities. Section 2 presents the factors that influence trust level. Section 3 proposes basic suggestions for incorporating trust in conceptual frameworks and Section 4 concludes our discussion.

II. FACTORS INFLUENCING THE TRUST LEVEL

Some previous studies proposed a conceptual framework for designing and developing Web applications to improve accessibility and usability for people with disabilities [12], [17], [2]. Kouroupetroglou et al. proposed a semantic Web application framework to favor cooperation and interaction between groups (ontology creators, annotators, developers and users) that collaboratively should work to enhance WWW accessibility [12]. Velasco et. al. describe a Web compliance framework developed to support the creation of accessible content for Rich Internet Applications [17]. This framework extends the traditional accessibility evaluation tools to verify compliance to quality standards. Baguma and Lubega proposed a framework for designing and developing Web applications [2] based on the three Web components: content, navigation and user interface. For each component, the framework identified a set of Web accessibility requirements, which are modeled as primary and sub goals.

However these studies propose generic frameworks that do not directly focus on the context of use, necessary for meeting website usability requirements. In particular in e-

commerce applications that involve economic transactions trust and security aspects are crucial. Since money transactions are permeating many on-line activities and sectors it is increasingly important to encourage trust.

Effective, efficient and satisfying Web interaction boosts blind consumers' perception that a site can meet their needs, whether or not a brand is well known. Users perceive chaos on the Web, where data is at risk from hackers, technology is not secure, and good intentions may lead to undesirable outcomes. Lack of trust in the online environment is one of the barriers to growth of e-commerce and online shopping [11]. A previous study [1] provided some evidence that a user's initial trust is directly related to a website's interface. However, their analysis did not necessarily find the presence of security features in an online medium to be perceived as more important than design features such as navigation, depending on the respondents' technical and social backgrounds. Technically-inclined respondents generally prefer security features over design features, while non-technical subjects tend to examine the overall design features when deciding whether to pursue a purchase.

A well-structured interface orients the differently-abled in navigation as well as task execution, showing how, what, and where to find website resources. Users are likely to terminate their online transaction or stop website exploration if they encounter a complex task and a barely understandable interface. Therefore, even more than before, organizations and companies recognize the importance of usability, to favor comprehension (of website content and navigation) and to make interaction easier. Navigation is vital for special-needs persons, and especially for the blind, since it is crucial for them to be aware of their current location on the webpage and how to return to the beginning, or how to reach a certain point in the material [6]. Organizing a page in logical sections enhances the blind user's experience when navigating a page in two ways: it provides a page overview and offers the possibility of jumping from section to section. Specifically, heading levels may improve navigation since screen readers have special commands for moving from one heading to another. Brudvik et al. [3] present an interesting study on how sighted users associate headings with a web page, observing very different results depending on factors such as whether the page has a hierarchic structure, how users identify sections, etc. Furthermore authors applied techniques of information retrieval (i.e. training data and a classifier), developing a system for automatically inferring from the context (font, size, color, surrounding text, etc.) if a phrase "works semantically" (and may function) as a heading, and dynamically adds the heading level.

Another cleaner and scalable approach is the use of ARIA regions for structuring content. This approach offers the user a page overview, allowing one to move rapidly from one region to another, and limit reading to the regions chosen by the user.

III. BASIC SUGGESTIONS FOR INTEGRATING SECURITY IN A CONCEPTUAL FRAMEWORK

In this section we propose some criteria for enhancing blind users' trust in e-commerce websites by improving their perception of security features.

Visual UI features such as fonts, colors, images, and also positioning of Web page elements convey navigational and semantic information to sighted persons.

When carrying out a commercial transaction, sighted users get security information from the URL (https protocol) and other visual features such as the closed lock in the lower right-hand corner. These visual clues are available immediately. Equivalent information should be provided to the blind, as soon the page is loaded.

General guidelines on security features to improve user trust in websites include:

- Inform the user that he/she is accessing a protected resource to convey the meaning that the session is protected using the secure http protocol (https). Specifically, data travelling in the networks are ciphered. Developers of assistive technologies such as screen readers (e.g. which announce equivalent text) and magnifiers (e.g. to move the focus onto the security feature) should consider these aspects carefully. For instance, a tone may be played or a phrase announced by the screen reader. However, since malicious websites might reproduce fraudulent analogous screen reader behaviors by embedding code in the page, a command (a combination of keys) should be provided by the screen reader so the user can verify the authenticity of the secure info provided by the website anytime.
- Security info (Certification Authority that signed the server certificate, certificate status, etc.) and privacy policy (sensitive data storage and use) embedded in the page, should be provided "early" by the screen reader (as seen immediately by sighted persons). Actually this security info is announced by the screen reader if the user reads the entire page content, but due to info overload the user tries to minimize the reading. Since security info is usually graphically arranged on the bottom right side of the page, it is announced by the screen reader just at the end of the file, after the user has already visited the form for the transaction data input. At the same time, a way to skip this section should be provided; thus users familiar with the website can jump to the next page sections, for instance by structuring the page in logical sections.
- There are different ways to make security features accessible for the visually impaired. For instance:
 1. it is possible to duplicate this info before the user inserts his/her data (i.e. fill the form for the transaction) as hidden text, invisible but accessible via screen reader.
 2. Another possible solution is to move this content up in the source code and using an

absolute positioning in the CSS to visually arrange the content in the desired part of the GUI (graphic user interface).

3. Another interesting effective and “clean” solution is to use an ARIA region for the security info.
 - If part of the UI are reloaded during the transaction (for instance in pages using AJAX) the change should be immediately announced to the user by the screen reader. This is possible using ARIA Live regions.

IV. CONCLUSION

A website should provide a sufficient overall trustworthy design impression to create a certain comfort level among blind consumers. Easy, effective navigation can be a foundation for communicating trustworthiness. New companies can compete with well-established businesses by improving usability for sighted and blind consumers. This communicates trustworthiness and increases consumer perceptions that a website can meet their needs.

There are different ways to make security features accessible and usable for the visually impaired. The suggestions provided in this study should be incorporated in an existing conceptual framework for creating accessible Web applications and contents. They explore some of the possibilities, but other technical solutions can be applied to obtain the same effect.

Frameworks are useful since guidelines such as WCAG 2.0 are numerous and full of examples, so it may be difficult for Web developers retrieve and extract the desired information. Thus WCAG 2.0, in addition to categorization and numbering, are organized to facilitate guideline comprehension and application, providing guideline-related links such as: How to Meet, and Understanding.

Beside, since eCommerce transactions involve some sensitive data (credit card details, personal data, address), the issue of privacy must be addressed and included in a conceptual framework.

Future work applies the proposed criteria to an e-commerce website and validates the usability via screen reader of the modified respect to the original UIs.

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