

# Accessibility in E-Commerce Tools: An Analysis of the Optical Inclusion of the Deaf

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**Abstract.** The deaf communities are members of a unique culture and language, the Sign Language. Worldwide, the spoken/oral language is predominant, however, Deaf may encounter several hindrances to establish social relationships using spoken/oral language. E-commerce systems are significantly important not only to the listeners, but also to the Deaf, as E-commerce systems are the main vehicle for online shopping. Currently, the majority of the population shops online; nevertheless, the conditions in which information is disclosed in such systems may not appropriately respect the particularities of the Deaf. In this context, this paper supports the hypothesis that, identifying the accessibility requirements for the Deaf, the development of inclusive E-commerce systems is feasible and, thus, ensuring that the benefits and utilities provided by E-commerce systems are also accessible by deaf people. Therefore, in order to prove our hypothesis, the implications that the Sign Language (first language of the Deaf infers to the communication, to improve the accessibility of such environments, must be identified. This paper investigates the necessities of the deaf community when accessing Web systems, and based on evaluation mechanisms, analyses the environments developed using E-commerce tools concerning accessibility aspects.

**Keywords:** Accessibility · Web accessibility · Deaf community · E-commerce tools

## 1 Introduction

The way deaf people interact with the world is mainly visual (by means of visual experiences), thus, the Deaf regularly endures several difficulties, not only regarding information access, but also regarding the basic person-to-person interaction and transport (via public transportation).

Based on the aforementioned difficulties, the necessity of developing accessible and inclusive systems that provide equal opportunities to the Deaf grows considerably.

E-commerce is a category of trading in which financial transactions are performed via mobile devices and computing platforms. There are many advantages in using

E-commerce tools, for instance, such tools are constantly online, providing quick propagation of new products and the anticipation of market tendencies at a relatively low cost. In fact, the adoption of E-commerce tools is reasonably expanding worldwide.

Therefore, the deaf communities' necessity of acquiring access to E-commerce systems in Brazil, aiming to diminish the struggle of locomotion as a result of their communication conditions, becomes evident.

The World Web Consortium (W3C) states "accessibility means achieving a vast percentage of people at distinct sensorial conditions, including visual, auditory, physical, speaking, cognitive and neurologic". However, due to the lack of accessibility of current computational tools, the information technology is by far not appropriate to the Deaf.

Hence, in this paper, not only E-commerce tools, but also deaf-oriented systems are analyzed aiming to promote accessibility improvements towards E-commerce environments. Normally, the accessibility required by the Deaf is not provided by E-commerce tools, and as a consequence, the deaf user's experience is quite defective when using E-commerce websites, especially in terms of lack of content in Sign Language and the necessity of utilizing a simple, but sufficient language.

The scenario above motivated the research described in this paper, which analyzed the requirements of E-commerce tools and the challenges concerning the inclusion of the Deaf in the virtual environment.

## 2 Accessibility Recommendations for the Deaf

Currently, the Deaf not only endure several prejudices from the society and are commonly misconceived, for instance, as "deaf-mute". Furthermore, the deaf community also experiences social problems, once many people are not able to use Sign Language. Consequently, the Deaf may suffer from isolation, low self-esteem and discrimination [1], which may prevent deaf communities from growing and evolving.

Deaf communities have fought hard for the recognition of their own language. The recognition of the Sign Language must be achieved, however, this language has a lot ahead to be studied, taught and disclosed [2].

In addition, the Deaf experiences several hindrances in Brazil, as in other countries, once the communication and interaction are commonly performed using the mother language of each country while most of the Deaf have not achieved satisfactory understanding of the language [3].

The W3C highlights several barriers that the Deaf may find when accessing the Internet, for instance: lack of alternative subtitles and audio, the use of not clear and not simple language, and lack of video content. The aforementioned barriers demonstrate the importance of the research in such fields in order to prioritize the necessities of the Deaf, and waken the deaf communities' hindrances in the information and communication access.

In order to advance the state of deaf-oriented technologies, computational research has examined applications that assist collaborative activities and promote the digital inclusion of the Deaf. Generally, collaborative systems focus on users not only able to

orally communicate, but also users acquainted with Information and Communication Technologies (ICTs) [4], disregarding accessibility aspects required to the digital inclusion of disabled people.

Accessibility recommendations for the Deaf according to the view of distinct authors have been examined in this section. The recommendations are mainly related to the following aspects: content creation, visual representation of information, media alternatives, resources for Web browsing and communication leveraging [5–12].

Corradi [5] describes Sign Language requisites for the development of virtual environments focused on deaf people. In addition, she highlights the importance of using video subtitles in Sign Language to improve the comprehension of the Deaf and auditory disabled people on the interpreted content, promoting the distinction of colors between visited links and other contents to facilitate the navigation of disabled users on the Web page, and adopting dictionaries in Sign Language in case disabled users are not aware of certain signs utilized by the interpreter.

Bueno [6] highlights guidelines to create engaging and expressive content using rather visual than verbal features. The aforementioned guidelines are mostly related to multicultural aspects and the different ways to represent information. The author also recommends that the environment should be multicultural, thus, the content should not be restricted to the deaf community. The environment also should explore visual resources due to the fact that the visual sense is the cornerstone of the communication between the Deaf. Bueno [6] also states that the Brazilian Sign Language, LIBRAS, should be the main communication language of the user; the visual vocabulary (signs and arrows) should be utilized on the interface for the user navigation; regarding the interpreter mediation, the interpretation should not only respect rules of the environment, but also be well planned and organized, taking into account adverse situations, clothing, and accessories.

Debevec et al. [1] describe how technologies utilized in videos may be applied to E-commerce systems, highlighting the main criteria to ensure satisfactory quality of videos and images. The minimum frame rate should be greater than 15 frames per second. The author also affirms that the comprehension rate may be optimized in order to keep an appropriate recognition of the movements of the hands and facial expressions, taking into account the Sign Language is completely gestural. Moreover, the image delay should be lower than 1, 2 s when utilizing video resources in Sign Language. Blurry fingers during the movement are tolerable, although clearly visible fingers are preferable.

Kitunen [8] affirms that the facial recognition is significantly important to the Deaf, once they rely on facial features to communicate, thus, respective people's pictures should follow their names. Kitunen [8] also trusts that videos in Sign Language, which is used to translate the content to the Deaf, should not replace subtitles. Moreover, the author suggests the adoption of a pure written transcription of the audio followed by visual representation, e.g. illustrations. Regarding the user navigation, the author suggests the use of symbols and icons to improve the recognition of different sections on the website, and thus, assist users in the exploration of the webpage content. However, symbols and icons should be employed only upon important section/menus of the page, otherwise, the layout page may become crowded and unpleasant for any types of users.

Abreu [9] maintains that certain recommendations such as user interface adaptation for the Deaf, alternative texts for images, and how to present the content in a comprehensible fashion. The author reinforces that the creation of content requires not only the adaptation of interface resources for the Deaf, but also the division of large information blocks in smaller groups, to enhance the comprehension of the content by the Deaf. In addition, the author suggests that users should be provided with meaningful information so they are able to acquire documents according to their preferences.

Kosec et al. [10] find out that, to create accessible video to the Deaf, the speed of execution should be slow, so the user is able to follow the gestures of the Sign Language interpretation. The author also highlights that, for the same reason previously mentioned, the use of content (for creation, presentation or utilization) has to be mild and clear. Kosec et al. [10] also recommend that, to improve the visual presentation of the content, it is important to provide mechanisms to enable users to increase the screen size of the video, and as a result, they are able to easily recognize facial expressions and gestures presented in the videos, as long as the quality of the video is not compromised when the screen size is increased.

e-MAG [11] identifies recommendations focusing on the presentation of Web pages. The author recommends that a standard of page division should be applied in order to assist not only the visualization of the target audience, but also the reading and comprehension, not requiring substantial prior knowledge. In addition, supplementary information must be provided to illustrate the main content when the reading of complex text is necessary. The author restates that besides alternative texts and subtitles, video content should also provide Sign Language support. Moreover, in order to present the content, it is recommended that information areas should be divided in groups to simplify the management of the content. Generally, the information areas are divided in four groups: “top”, “content”, “menu”, and “footer”.

WCAG 2.0 [12], W3C guideline, recommends the control and temporization of media, so deaf-users are able to clearly and comprehensively read and utilize the content. The author also highlights ways to facilitate the navigation of deaf-users, to locate contents and determine the location of the user itself on the web page. To appropriately create content, the content should be allowed to be present in distinct ways, without affecting the information presented in the content or structure of the content. To visually present the content, the foreground and background should be separated to facilitate the visualization of the content. Moreover, media resources should provide users with sufficient time to read and make use of the content.

Mostly, usability problems on the web concern finding, reading, and understanding the information [13]. The diverse situations and features are required to be taken into account by the content creators during the web page conception.

### **3 Methodology of the Accessibility Evaluation**

To develop the present analysis, the following steps were necessary: 1-Selection of development tools to assess the environments developed from such tools, aiming the evaluation of accessibility; 2-Selection of mechanisms to support the evaluation of accessibility; 3-Evaluation of E-commerce environments using the previously selected

mechanisms of evaluation; 4-Combination of results obtained from the analysis of the recommendations provided in the literature review and also from the evaluation of the E-commerce environments (performed in the previous item).

### 3.1 E-Commerce Development Tools

The most popular tools to develop E-commerce web pages have been selected and analyzed. They are OpenCart [14]; PrestaShop [15]; OsCommerce [16]; and Magento [17].

Opencart is a E-commerce solution of easy use containing a friendly and intuitive interface. Opencart presents the function of expanding its functionalities via extensions (plugins and add-ons) and customizing its design using templates. The main functionalities provided by the tool are: free documentation, open source platform, security socket layer (SSL) support, users are able to rate and comment products, among others.

PrestaShop is an Open Source tool. The tool provides an interface in which the administrators of the store are able to manage their products in stock, orders, clients and payments. There are no boundaries regarding the number of categories, sub-categories, and images, among others. As mentioned, the tool is open source, thus, the user is provided with access to the source code of the virtual store.

OsCommerce is also an open source solution, providing a large set of functionalities. The tool allows users of the online page to keep their stores at no cost, taxes or limitations. The tool is simple and relatively fast, however, being familiarized with the tool is preferable to configure the OsCommerce.

Magento is an E-commerce platform built under an open source license that provides users with flexibility, design management, content management, among other functionalities. Magento is also distributed under an Enterprise version. The tool presents hundreds of extensions and an open architecture allowing users to add even more functionalities. Moreover, additional features are: friendly URL, URL rewrite, 100 % customizable design, and multilingual support, among others.

The aforementioned tools present limitations regarding accessibility in general, especially towards the deaf community. Therefore, it is proven that improvements could be proposed in order to provide the accessibility required by the Deaf, which would allow them to access the environments built upon such tool without negatively affecting the content and information access.

### 3.2 Support Mechanisms to the Accessibility Evaluation

In order to analyze accessibility of E-commerce websites, four evaluation mechanisms have been chosen. The mechanisms are based on accessibility guidelines proposed by W3C/WAI and allow us to evaluate all pages contained in a website, indicating page errors in contrast to accessibility features. In the set of analyzed mechanisms, four have been chosen to perform the evaluation: CynthiaSays [18], Hera [19], Examiner [20] and DaSilva [21].

CynthiaSays is a mechanism focused on web accessibility and is considered the most used mechanisms by disable people. The mechanism is intended for personal use

and not commercial use and it is mainly used to demonstrate how satisfactory web designs and accessible content are achieved. Cynthia also assists users to identify content errors concerning the Section 508 of accessibility guidelines in WCAG Web, which presents accessibility standards of the USA government to a vast variety of sources and information technologies. The mechanism not only allows users to test individual pages in their website, but also provides feedback in a clear and straightforward report format.

HERA is a mechanism to review the accessibility of Web pages according to the recommendations of the WCAG/W3C. HERA performs an automatic pre-analysis of the page and provides information of the errors presented by the page (errors detected automatically) and in which points of verification should be reviewed manually. The HERA mechanism returns a summary containing the quantity of errors found, the verification time, how long the analysis takes and the total of analyzed elements. In addition, HERA returns a table containing the name of the “state of the verification points” showing all errors, rights, and the points that should not be changed in the page.

eXaminator is an automatic validator in accordance with Web Content Accessibility Guidelines 1.0, developed by W3C targeting a given page on the Internet. The tool is developed by the UMIC – Agency to the Knowledge Society, and could be utilized in the accessibility evaluation of all web pages of a website. This mechanism analyzes the webpage and returns a log screen containing information on errors and provides a quantitative report using tables to demonstrate accessibility errors and rights in the page.

DaSilva, web version, is a mechanism developed by Brazil Accessibility in partnership with the company W2B Internet Solutions. DaSilva is the first evaluator of accessibility of sites in Portuguese, based on principles of the E-MAG document, which is developed by the Brazilian electronic government in partnership with Brazil Accessibility. This mechanism not only allows us to analyze all pages contained in a website, but also indicates page errors in contrast to accessibility. The accessibility verification in the tool DaSilva is not greatly different than the previous tools, however, as opposed to the previous tools; users are able to choose priorities for the evaluation, so the tool returns accessibility reports focusing on errors and warnings conforming the elected priorities.

According to Queiroz [1], the aforementioned automated tools generally are fast, although not capable of identifying all features of accessibility. Therefore, the validation of accessibility should also be performed by direct revision. The human validation may assist to ensure language clarity and navigation easiness [1]. As a consequence, after the use of such tools, it was necessary to complement the evaluation by directly reviewing the analyzed websites aiming to check additional accessibility features.

### 3.3 Accessibility Requirements

The present evaluation process elects the following accessibility requirements: language, visual representation, interpreter mediation, technologies adopted in videos, content language, media duration, alternative text in images and other elements,

destination addresses of links and keyboard utilization. The previous requirements have been identified according to data collected from accessibility guidelines. The mechanisms for automatic analysis, in general, allow us to evaluate all the aforementioned requirements. Certain mechanisms may not present results for a given requirement nevertheless, such details will be cited throughout the present paper.

**Table 1.** The relevancy of each requirement in E-commerce websites

<b>Aspects evaluated</b>	<b>Environment implications</b>	<b>Relevancy</b>
<b>Language</b>	When the website does not indicate the language in use, usually, the user is not able to determine the language of the website.	Low
<b>Visual Representation</b>	Deaf people may encounter hindrances when interpreting plans, thus, the page format should be easily perceived, and as a result, the user may familiarize with the website structure quickly. Thus, it is important to discern colors on different contents and visited links and the text should be divided in information blocks.	High
<b>Interpreters Mediation</b>	Deaf people are pleased to recognize other members, thus, they may feel confident when accessing a website that endorses their communication in Sign Language. As a consequence, the interpreter mediation is quite important in web pages.	High
<b>Technologies Adopted in Videos</b>	It is important to ensure a satisfactory video quality, in order to maximize the comprehension by deaf people, namely, ensuring a satisfactory visual detection of gestures and facial expressions. The image delay should be the lower than 1,2 seconds when employing video resources in Sign Language.	Medium
<b>Content Language</b>	Clear language assists deaf people to better interpret the content, thus, the content of the text should be well structured and with simple language. It is also important to employ titles, subtitles, paragraphs, and lists. The excessive information blocks may hinder the comprehension of the content. Thus, information blocks should be divided in convenient and small groups.	High
<b>Media Duration</b>	Deaf people need sufficient time to read, interpret and utilize the content in a way that the users are able to establish control under the media execution. In addition, it is important to provide controllers for the media execution such as: stop, continue, cancel, start, previous, next, among others.	Medium
<b>Alternative Texts</b>	Deaf people requires subtitle to associate images and elements of the page.	Medium
<b>Aspects evaluated</b>	<b>Environment implications</b>	<b>Relevancy</b>
<b>Destination Addresses of Links</b>	Links should clearly indicate their destination addresses. Users are not able do distinguish links once they are bind to each other, without any separator in between them. Furthermore, navigation bars comprised by link lists should be provided to organize links and facilitate their location.	High
<b>Keyboard Utilization</b>	Shortcuts and additional functionalities should be made available from the keyboard.	Low

A relevancy parameter regarding accessibility has been attributed to each requirement. These requirements assisted the classification of development tools. Thus, three relevancy parameters are taken into account for each requirement: low, medium, and high. Table 1 demonstrates the environment implications and relevancy of each requirement.

#### 4 Accessibility Evaluation for the Deaf in E-Commerce Systems

According to the methodology, an accessibility evaluation has been performed on websites developed using the aforementioned E-commerce tools. Namely, six E-commerce websites have been analyzed, in addition, each website was developed from a different development tool, aiming to identify the accessibility requirements offered by each tool. The evaluated websites embrace distinct trading categories, such as books, supplements, clothes and men's and women's accessories. Diversified websites have been chosen in order to achieve the manifold interests of the deaf community.

As the aforementioned websites are comprised by most of the resources provided by the development tools, the analysis of the accessibility issues became possible. Next, our analysis results are described. The results are grouped by the E-commerce development tools and highlight the most relevant positive and negative points found.

- **OpenCart:** systems developed using OpenCart present several positive points, such as: the indication of language is present in all information blocks, all images are captioned, all images and links are clearly discerned (character separators are employed); links alter colors to indicate a visit, which assists the navigation of deaf people, the user is informed about moving information in displacement or in automated update before the time expires, furthermore, the user has at least 20 s to extend the time limit and pause, stop or hide if necessary; information blocks are appropriately summarized, and in average 9 words are highlighted in each block, which facilitates the comprehension by deaf people, the content language is declared via Doctype (DTD), indicating a satisfactory page structure. In contrast, the main negative points of OpenCart are: the aspect of visual representation of the page, as notation of structure for visual formation effects should not be used; interpreter's mediation is not adopted and certain links containing equal content lead to distinct destination addresses; no shortcuts for important links on the keyboard; no media synchronization during multimedia presentations.
- **PrestaShop:** the main positive points are: style control for page presentation, which assists the comprehension by deaf people; 72 % of the links are organized in lists, helping on the navigation by deaf people; every link is clearly discerned; the words are separated in information blocks; the content language is declared on the DTD; tables are not used to format the page (important to users who utilize browsers based on text and read line by line, which is the deaf people's case. The main negative points are: the language in use is not presented; titles for the frames are not employed; no interpreter mediation; the language is not presented in a clear and



simple way in order to facilitate the comprehension by deaf people; images are not captioned; and the shortcuts for important links are not enabled.

- **OsCommerce:** the positive points presented by the systems are: simple header, facilitating the comprehension and identification of the language in use. The main negative points highlighted are: images not containing alternative texts, elements are presented and arranged without control attributes; printable characters are not used in links; no keyboard shortcuts for links; no interpreter mediation; media are not synchronized; and the Doctype is not provided.
- **Magento:** the main positive points presented by the systems are: visual presentation of the page using the correct structure and the elements arrangement present appropriate controls; main language identified; information blocks are summarized using in average 8 words, which facilitates the comprehension by deaf people; DTD is properly declared; images are captioned; and all adjacent links contain printable characters. The main negative points addressed are: the use of pop-up images; no keyboard shortcuts are presented; certain icons of the page are useless; no interpreter mediation; links containing equal content lead to distinct destination addresses; captions are not used in 36 % of the images; and media is not synchronized.

Table 2 presents a summary of evaluated aspects, described above, and classified in: (0) Bad – the page fails in the given aspect; (1) Regular – the aspects are ordinarily met; (2) Good – the aspect are mostly met and (3) Great – the page fully met the evaluated aspect.

**Table 2.** Summary of the accessibility evaluation of the E-commerce tools

Aspects evaluated	OpenCart	PrestaShop	Magento	OsCommerce
Language	3	0	3	3
Visual representation	1	1	1	1
Interpreter mediation	0	0	0	0
Technologies adopted in videos	–	–	1	–
Content language	2	1	1	0
Media duration	2	–	1	1
Alternative texts	0	0	0	1
Destination addresses of links	2	1	1	–
Keyboard utilization	1	1	1	1

After the evaluation of the websites developed using the development E-commerce tools, OpenCart presented the most satisfactory results in terms of accessibility for deaf people. OpenCart presents the requirements of higher relevancy and lower percentage of negative points. The functionalities of the tool are the most appropriate to obtain an accessible system, accordingly to the way deaf people interact: in a visual way. It is also important to reiterate that deaf people present several difficulties to use Portuguese, thus, certain requirements are essential to their inclusion in computational environments.

In the analysis, the mechanism HERA has been shown to be the most complete, as the tool presents a straightforward table, which is complete and easily comprehended. Figure 1 presents an evaluation performed via the mechanism HERA. The results are presented by the tool in Portuguese (Brazil).

The Hera mechanism presents results according to three WCAG priory levels. Priority 1 (P1) implies that web developers must satisfy the guidelines of level 1, otherwise, groups of disable users (e.g. deaf, bling, among others) will be unable to access web content. Priority 2 (P2) implies that once the guidelines are not satisfied, the access to web content is hindered and Priority 3 (P3), once satisfied, infers greater ease on the content access. The Hera shows positive points, negative points, points not applied and the points that require manual verification in the context of accessibility to the Deaf. Figure 1 highlights one of the three identified negative points regarding P1.

Furthermore, the tool details all aspects concerning each accessibility requirement, pointing out the rights and wrongs (when clicking on the point). Hera also presents a summary containing the total of errors found and the total of verified elements.

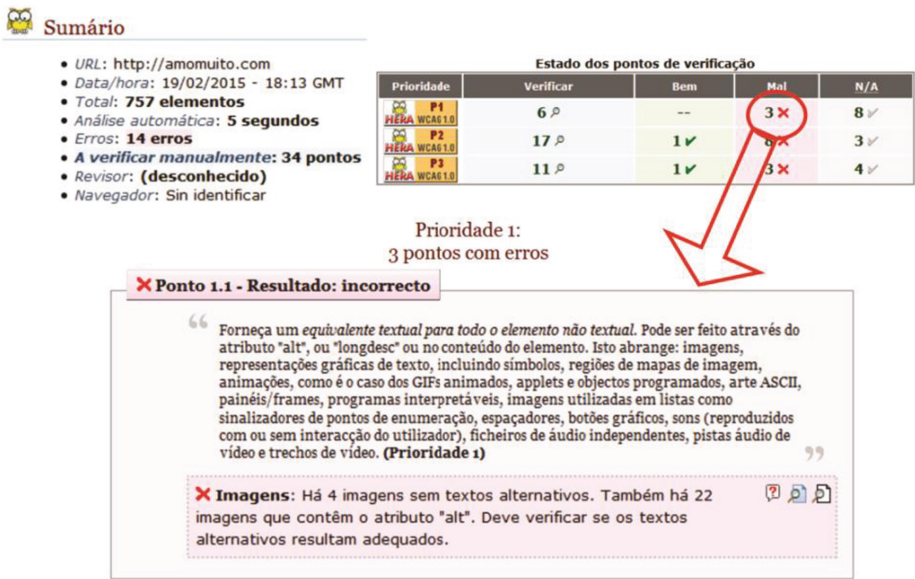


Fig. 1. Accessibility analysis via HERA

## 5 Conclusion

Deaf people require computation environments that take into account their peculiarities aiming to leverage the inclusion of the Deaf in such environments. Interactions via activities leveraged by computers are relevant to the development of the Deaf and may contribute to their identity creation.

Based on the results of the present evaluation, it is observed that the accessibility towards deaf people in the E-commerce websites is minimum, thus, the need of not only promoting reforms focusing on accessibility features, but also awareness of

accessibility features is evident. The promotion of reforms and accessibility awareness is vital for the deaf community to be able to access computational environments.

It is also important to highlight that the E-commerce tools have been analyzed from websites developed through them. Therefore, the E-commerce tool may present resources or features not utilized, which may prejudice its evaluation regarding accessibility.

The fact that the deaf community fully and solely communicates using Sign Language is a valid presupposition and, as long as the computational environments meet the special language condition of the Deaf, such environments are more likely to include the deaf community. In this sense, an ideal accessibility condition would imply in the mediation of an interpreter fluent in Libras, allowing effective interaction in computational environments.

Regarding the visual representation, providing strong visual mechanisms to provide feedback to participants, enhancing their comprehension on the progress of the activities and increase the cohesion, presenting information via videos, Sign writing and images. The difficulties of deaf people concerning Portuguese could also be minimized by structuring information through the use of information blocks and graphic objects (lists, graphs, maps, sections, among others).

As future work, it is intended to not only perform complementary analysis, but also implement adjustments to tool OpenCart based on the results of the present research.

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