A Review of Web Accessibility Issues in Rich Internet Applications

Manuel Jesus Rivas Sandez

Abstract

Rich Internet Applications (RIAs) are a relatively new technology which have experienced a rapid growth in recent years while making the web content more dynamic and interactive, allowing sites to combine new features in different ways. Web applications based on RIAs are more visual and work with a wider variety of devices, satisfying the current customer needs, who are increasingly demanding ubiquitous access to their applications. In this way this technology is becoming an indispensable part in the success of Software as a Service (SaaS) cloud service model.

However, RIAs not only introduce technological and economic opportunities but also pose several challenges in the area of web accessibility due to their dynamic and interactive nature.
Keywords: RIAs, Rich Internet Applications, accessibility,

1. Introduction

The appearance of the World Wide Web is thought to be one of the greatest events of recent history. The original World Wide Web was designed for allowing the user access static or dynamic content, using hypertext mark-up language (HTML) as the encode language (Fraternali, Rossi & Sánchez-Figueroa, 2010). Since its introduction, the web has been growing not only in size but also in complexity. In recent years, web content has been rapidly shifting, becoming more dynamic and interactive. They also mention the importance of multimedia support and ubiquity in order to cover the new needs of the users.

The introduction of Rich Internet Applications (RIAs) has had an important role in that change. Garrigós, Meliá & Casteley (2009) state that RIAs are replacing the previous web applications due to the increasing demand for a richer user experience in these applications. Web applications are now becoming more popular, and hence they are being used by a wider variety of users. Thus, it is essential to guarantee the accessibility to these applications to ensure that the information and services are accessible to everyone.

There are different accessibility guidelines available for both developers and users, such as Web Content Accessibility Guidelines (WCAG), Authoring tool Accessibility Guideline (ATAG), Web Content Accessibility Guideline (WCAG 2.0) and the Web Accessibility Initiative - Accessible Rich Internet Application (WAI – ARIA). However, their existence doesn´t mean that they are being accurately followed and successfully applied (Power et al., 2012). The accessibility testing is another important aspect; Doush et al. (2013) suggest that it is a difficult task in RIAs due to its event-driven principle. Although research up to now has proposed many different frameworks and tools (Fogli, Provenza & Bernareggi, 2010) (Zitkus, Langdon & Clarkson, 2013), a number of studies indicate that accessibility testing still remains an important issue in RIAs (Casteleyn, Garrigós & Mazón, 2014).

As a consequence of these problems, web accessibility is still immature. Studies conducted in different countries, regarding the accessibility of their web applications, demonstrated that almost the totality of the web analysed didn´t comply with the minimum levels of accessibility addressed by WAI (Miranda, Martin & Gaetan, 2013).

The aim of the paper is to review the impact that RIAs technologies have had on web accessibility. Much of the work will be focused on reviewing the existing literature with the intention of providing a comprehensive analysis. The paper is organized as follows; Section 2 introduces the concept of RIAs. Section 3 provides an overview of accessibility and the challenges associated with RIAs. In section 4 we discuss the issues related to the accessibility evaluation in RIAs. Section 5 presents our conclusion and possible future areas of investigation. Section 6 contains the references that have been used in this paper.

2. Rich Internet Applications

It was Allaire (2002) who first introduced the term of RIAs in a Macromedia white paper. In the paper, the authors refer to RIAs as a new generation of online applications, which, by combining a range of technologies, is able to provide the user with a better and more sophisticated experience. Linaje, Preciado & Sánchez-Figueroa (2007) say that RIAs offer the benefits of the combination between the interactive multimedia features of desktop applications and the web distribution model.

On the other hand, at the same time that the use of World Wide Web increases in society, both the business and end-user demand a higher degree of usability and powerful interactions, capabilities which a traditional web application fails to provide (Fraternali et al., 2010). These growing users' needs and the new capabilities provided by this new technology are the reason for the rapid increase in the use of RIAs technologies.

Casteleyn, Garrigós & Mazón (2014) point out that although it has not formulated a standard definition of RIAs, it is possible to characterize this technology as web applications whose functionalities and features are close to desktop applications. They add that the purpose of RIAs is to improve characteristics such as interaction capabilities with the aim of offering a more dynamic and interactive presentation of the web contents. In order to achieve this goal, RIAs depend on asynchronous communication combined with client-side technologies.

It is now thirteen years since the term of RIAs was introduced. Academic research has focused on different areas of the topic during this period. As a result,

an important amount of research has been performed. It is important to mention how the only area that has suffered growth during the years is “accessibility and usability”, as shown in Figure 1; which seems to indicate that web accessibility in RIAs is still immature.

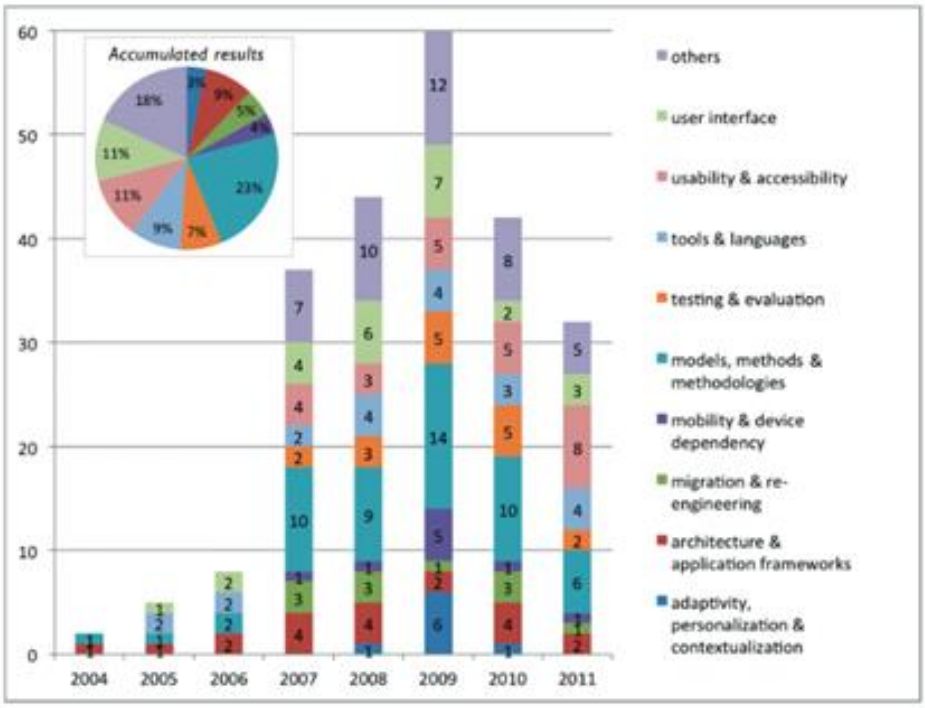

Figure 1 Bar chart representing the research topics facet over the time (Casteleyn, Garrigós & Mazón 2014)

3. Web Accessibility Evolution and Challenges in RIAs

The World Wide Web Consortium (W3C) is an international consortium founded in 1994, which is responsible for establishing web standards. In 1997, this organisation launched the Web Accessibility Initiative (WAI) with the aim of promoting wider access to the web. The WAI group says that an accessible web is when people with disabilities can navigate, understand, perceive, and interact with its content. The definition includes the different disabilities that web accessibility embraces, ranging from visual, auditory, physical, speech, and cognitive, to neurological disabilities. Finally, the necessity of taking into consideration elderly people too is also mentioned, because their abilities are usually reduced due to aging (Henry, 2006).

In 1999 the WAI released the first version of the Web Content Accessibility Guidelines (WCAG 1.0). The guidelines contain a series of 65 checkpoints (CPs)

in which is explained how developers can make web content more accessible. Different levels of accessibility are established, level A, AA and AAA, each one having a number of CPs. The level of accessibility of a website depends on the number of CPs satisfied, level AAA being the maximum level (Chisholm, Vanderheiden & Jacobs, 1999). However, a few years later many researchers evaluated its effectiveness using different methodologies, claiming the low level of success of this guide. In their findings, they also agree in saying that one of the main problems is the rapid advance of web technologies; at the same time that the web content is shifting from static to dynamic and the current guidelines are becoming irrelevant (Lazar, Meiselwitz & Norcio, 2004) (Petrie, Badani & Bhalla, 2005) (Hackett & Parmanto, 2005). The years of this research correspond with the emergence of RIAs technologies. Cooper (2007) refers to the potential of the semantic web as a possible solution for most of the accessibility challenges that RIAs pose.

In an attempt to solve the problem of the rapid technological advances, in the following version of these guidelines the technical information of how to implement accessibility in existing web technologies, is provided in separate documents aiming to be more technology-neutral. In 2008, an updated version of the WAI accessibility guidelines, WCGA 2.0, was published. The new guidelines are organised around four main principles, the web content should be Perceivable, Operable, Understandable and Robust. This version uses the same levels of accessibility, but Success Criterias (SCs) are included instead of CPs (Termens et al. 2008). The WAI also created a specific guide for Accessible Rich Internet Applications (ARIA) (Craig, et. al, 2009). The emphasis of WAI-ARIA is not in design principles as previous guidelines, but to improve the syntactic content in pages with dynamic nature, focusing on Ajax, HTML, JavaScript, and related technologies. Developers can now use the latest technologies ensuring themselves that the web content is accessible. The guide describes the way to add semantic information to each of the elements presented in RIAs such as roles, properties and states (Doush et al., 2013).

However, Power et al. (2012) say that in spite of the changes applied, the issues from WCAG 1.0 still remain as an important problem. The researchers conduct a practical study of the problems addressed by a group of disabled users on the web. They find that using WCGA 1.0, 57.1% (Figure 2) of the accessibility

problems encountered are not covered in the guide, whereas with WCGA 2.0 the percentage of uncovered problems only decreases to 49.6% (Figure 3). It is important to mention that only a small percentage of the covered problems are implemented by developers; 5.7% in the first case (Figure 2), and 8.4% in the second one (Figure 3).

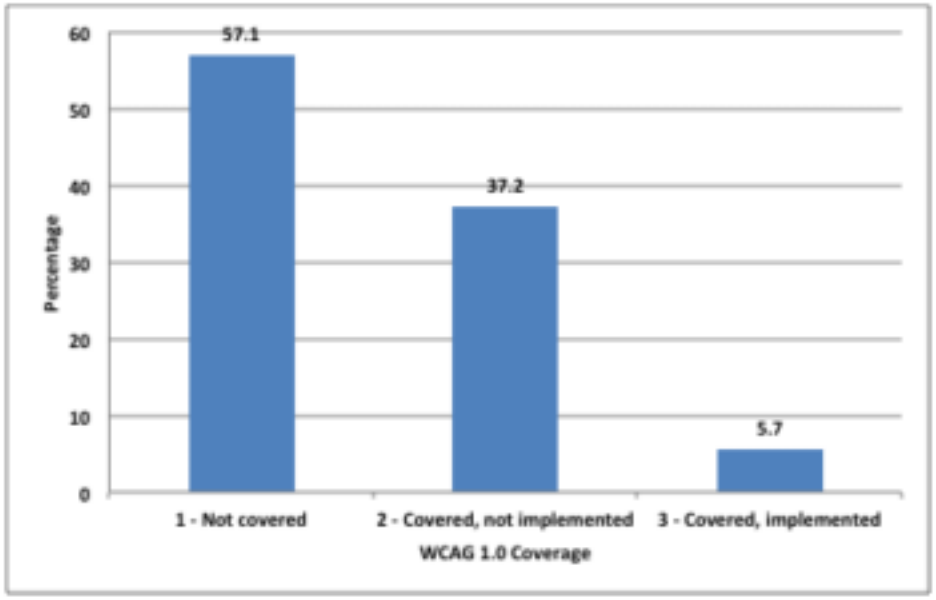

Figure 2 Categories of user problems divided by relevance of WCAG 1.0 CPs and implementation. (Power et al. 2012)

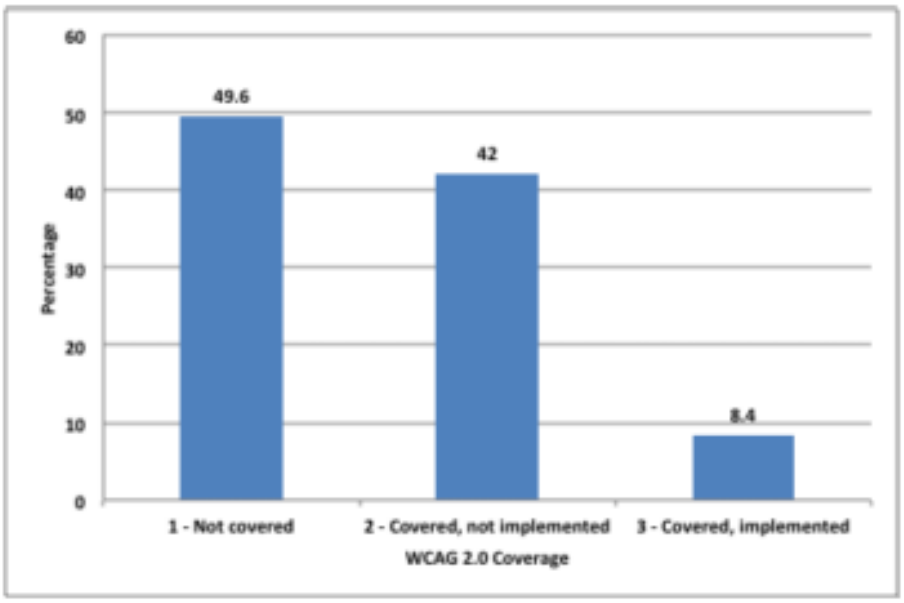

Figure 3 Categories of user problems divided by relevance of WCAG 2.0 SCs and implementation (Power et al., 2012)

Three different problems can be identified from their results. Firstly, the high number of accessibility issues WCAG 2.0 fails to cover (49.6%). Secondly, only a small percentage of developers are implementing the current guidelines. Finally, only 8.4% of the covered problems are implemented but they fail to provide good accessibility to the users. Only 16.7% of all the problems addressed for the users and covered in the guidelines are being implemented on websites.

We think that the first two issues are related to the effectiveness of the guidelines and the last one is related to the accessibility evaluation process. Due to constraints we focus on the evaluation process in this paper.

4. Accessibility Evaluation Challenges for RIAs

Regarding the process of testing web accessibility, Brajnik (2008) defines accessibility as a strongly user-centered concept. In the same definition, they mention an accessibility barrier as any condition which prevents a specific user from achieving its goal. The researchers emphasize the importance of the user in the evaluation process when they say that in order to evaluate the seriousness of a barrier, we need to take into consideration the content, type of user and its goal. In further research, many authors have agreed with that fact, saying that it is essential to consider the user perspective to evaluate web accessibility (Eisma et al., 2004) (De Couvreur & Goossens, 2011) (Henka & Zimmermann, 2014). Hence, as Fernandes et al. (2013) state, the accessibility evaluation process implies the simulation of a real situation, users interacting with the web application running in a browser.

On the other hand, studies have identified that developers have usually difficulties not only to gain a good understanding of accessibility guidelines, but also to comprehend how disabled users interact with web applications. Hence, they fail to provide good accessibility to their applications (Freire, Russo & Fortes, 2008) (Greeff & Kotzé, 2009). This is the reason why increasing emphasis has been placed on investigating the issues related to evaluating website accessibility. During these years, a wide range of evaluation methods have been used, ranging from guidelines and user participation to automatic simulation tools

(Zitkus, Langdon & Clarkson, 2013). These three methods are analysed in the next sections.

4.1 Guidelines

In order to identify the user necessities, there is an extensive list of standards and guidelines developed by experts (Abascal & Nicolle, 2011). Furthermore, since 1997 the W3C has also been working on the development of both standards and guidelines with the aim of increasing web accessibility (see above section 3). It has been suggested that these guidelines can be used in different stages of the development process. Firstly, they can help to define the general requirements, which should be taken into account in the design of the application. Secondly, the designers can use them as a checklist with which the level of compliance of the web application can be evaluated (Zitkus, Langdon & Clarkson, 2013).

However, their existence doesn´t mean that they are being applied. Indeed, Brajnik (2008) points out some of the accessibility guidelines limitations, such as the testing and validation processes. Power et al. (2012) claim the low use web authors make of the accessibility guidelines. They indicate their complexity as the possible problem. Henka & Zimmermann (2014) say that the difficulties that developers and designers have to understand the guidelines, which they say is due to the fact that the content is excessively technical. Both sets of authors agree in saying that guidelines should focus on providing support for problem solving instead. In addition, past studies demonstrate that the format in which accessibility guidelines present their data, such as tables and descriptive texts, is not efficient for designers (Macdonald et al., 2007).

On the other hand, Henka & Zimmermann (2014) argue that web developers can also have problems understanding how a person with disabilities interacts with web applications, which is the reason why they fail to provide good accessibility to their applications. Bose & Helmut (2014) add that web designers are not aware about the problems that disabled users have on the internet. They do not implement accessibility unless a client includes it in the specifications. The researchers suggest that much education needs to be applied to solve the situation.

4.2 User participation

The positive effects the participation of end-users have in any design process is well known. It enables the designers to understand their real necessities.
(Green & Jordan, 1999). This could be extrapolated to the design of web applications, helping the designers to make their applications more accessible.
Eisma et al. (2004) mention the advantages of observing how the users interact with similar products before designing their own product. This helps the designer to understand the user needs and preferences. De Couvreur & Goossens (2011) not only agree with them but also recommend user participation in the process of testing and evaluating a prototype. Newell et al. (2011) also recommend the development of an "emphatic relationship" between designers and disabled users instead of relying on guidelines.

At this stage, it seems to be clear the benefits of involving disabled users to create more useful and meaningful web applications. However, it is also a challenging process. (Rupprecht, Blum & Bomsdorf, 2014)**.** For the participation of disabled users in the development of a web application both training and time is required, which is usually the main constraint of a developer (Gordon, 2014)**.**

4.3 Automatic Tools

There are a large amount of automatic tools available to evaluate web accessibility in RIAs. The benefits of automatic evaluation tools are scalability and objectivity, allowing the evaluator to perform more evaluations in less time (Fernandes et al., 2013). However, as Zitkus, Langdon & Clarkson (2013) say, they have not received a wide acceptance in the industry. Hence, they are not exempt from issues. Indeed, in Mankoff, Fait & Tran (2005) it was proved how automated tools are not able to evaluate human actions.

Vigo, Brown & Conway, (2013) conducted a practical evaluation of 6 automatic tools with the capacity to test against the WCAG 2.0 guide. The researchers found that less than 50% of the SCs are covered by automated tools, corroborating that designers cannot only rely on automatic tools. They state that

automatic tools fail to properly assess accessibility due to the extremely interpretive nature of WCAG 2.0.

5. Conclusion and Future Work

With the arrival of RIAs technologies, web applications have become more complex and dynamic in nature, offering richer interfaces. Unfortunately, as usually happens with the adoption of a new technology, RIAs not only offer advantages but also pose some challenges. It has been identified how the use of this technology decreases web applications' accessibility. Although both academic research and W3C have focused on improving web accessibility, according to a Bose & Helmut (2014) survey, only 35% of those surveyed declared that websites are becoming more accessible. Hence, accessibility in RIAs seems to be still immature.

Another important problem came with the necessity of evaluating the accessibility. The result of the review indicates that there is no clear methodology or technique widely adopted by industry. The three different approaches previously analysed; Guidelines, User participation and Automatic tools, all present both advantages and disadvantages. However, it seems to be clear that the use of the current automatic tools without taking into consideration the human judgement is not recommended. As Vigo, Brown & Conway (2013) argue, even choosing the right tool, 60% of the SC would be missed.

It is worth mentioning that according to Casteleyn, Garrigós & Mazón (2014), more than half (55%) of the accessibility papers published are related to visual disabilities. However, as Fogli, Provenza & Bernareggi (2010) say, visually impaired people are only one part of the RIAs users who need support. Other disabled users need to be taken into account such as those with auditory, physical and cognitive disabilities, or those who experience changes in dexterity, and memory due to aging. Indeed, these disabilities are included in the previously mentioned WAI accessibility definition.

Finally, it seems pretty obvious that further research needs to be done in order to make RIAs more accessible. However, until that time, we think that the level of accessibility of a web application should be included in its specifications by the designer. Hence, while developing a browser extension, a disabled user could be informed about which level of accessibility it has or even for which

disabilities the application is certified. The aim is to save time for those users who are not able to use a non-accessible web application.

6. References

Abascal, J., & Nicolle, C. (2011) 'Inclusive Design Guidelines for Human-computer Interaction'. Taylor & Francis.

Bose, R. & Helmut, J., (2014) 'Accessibility of e-commerce websites for vision-impaired persons'. In *Computers Helping People with Special Needs.* Springer International Publishing, pp. 121-128

Brajnik, G., (2008) 'A comparative test of web accessibility evaluation methods'. *Proceedings of the 10th international ACM SIGACCESS conference on Computers and accessibility*, pp.113

Casteleyn, S., Garrig'os, I. & Maz'on, J., (2014) 'Ten Years of Rich Internet Applications'. *ACM Transactions on the Web*, 8(3), pp.1–46

Cooper, M., (2007) 'Accessibility of Emerging Rich Web Technologies : Web 2. 0 and the Semantic Web'. *Proceedings of the 2007 international cross-disciplinary conference on Web accessibility (W4A)*, pp.93–98

Craig, J., Cooper, M., Pappas, L., Schwerdtfeger, R., & Seeman, L. (2009). 'Accessible rich internet applications (WAI-ARIA) 1.0'. W3C Working Draft.

De Couvreur, L., & Goossens, R. (2011) 'Design for (every) one: co-creation as a bridge between universal design and rehabilitation engineering'. *CoDesign*, 7(2): pp.107-121

Doush, I. A., Alkhateeb, F., Al Maghayreh, E., & Al-Betar, M. A. (2013) 'The design of RIA accessibility evaluation tool'. *Advances in Engineering Software*, 57: pp. 1-7

Eisma, R., Dickinson, A., Goodman, J., Syme, A., Tiwari, L., & Newell, A. F. (2004) 'Early user involvement in the development of information technology-related products for older people'. *Universal Access in the Information Society*, 3(2): pp. 131-140

Fernandes, N., Batista, A. S., Costa, D., Duarte, C., & Carriço, L. (2013) 'Three web accessibility evaluation perspectives for RIA' In *Proceedings of the 10th International cross-disciplinary conference on web accessibility*, pp.12

Fogli, D., Provenza, L.P. & Bernareggi, C., (2010) 'A design pattern language for accessible web sites'. *Proceedings of the International Conference on Advanced Visual Interfaces*, pp.307

Fraternali, P., Rossi, G. & Sánchez-Figueroa, F., (2010) 'Rich Internet Applications'. *IEEE Internet Computing*, 14(3): pp.9–12.

Freire, A.P., Russo, C.M. & Fortes, R.P.M., (2008) 'A survey on the accessibility awareness of people involved in web development projects in Brazil'. *Conference on Web accessibility*, pp.87–96

Garrigós, I., Meliá, S. & Casteleyn, S., (2009) '*Personalizing the interface in rich Internet applications'*. Springer Berlin Heidelberg, pp.365–378.

Gordon, M. (2014) 'Web accessibility evaluation with the crowd: using glance to rapidly code user testing video'. *In Proceedings of the 16th international ACM SIGACCESS conference on Computers & accessibility,* pp. 339-340. ACM.

Greeff, M. & Kotzé, P., (2009) 'A lightweight methodology to improve web accessibility'. *Proceedings of the 2009 Annual Research Conference of the South African Institute of Computer Scientists and Information Technologists on - SAICSIT '09*, pp.30–39

Green, W., & Jordan, P. W. (Eds.). (1999) 'Human factors in product design: current practice and future trends'. CRC Press

Hackett, S. & Parmanto, B., (2005) 'A longitudinal evaluation of accessibility: higher education web sites'. *Internet Research*, 15(3): pp.281–294

Henka, A. & Zimmermann, G., (2014) 'Persona Based Accessibility Testing Towards User-Centered Accessibility Evaluation', pp.226–231

Henry, S. L. (2006). Introduction to Web accessibility. Retrieved April, 9.

Lazar, J., Meiselwitz, G. & Norcio, A., (2004) 'A taxonomy of novice user perception of error on the web'. *Universal Access in the Information Society*, 4, pp.285–291

Linaje, M., Preciado, J.C. & Sánchez-Figueroa, F., (2007) 'Engineering rich internet application user interfaces over legacy web models'. *IEEE Internet Computing*, 11: pp.53–59

Macdonald, A. S., Loudon, D., Rowe, P. J., Samuel, D., Hood, V., Nicol, A. C., (2007) 'Towards a design tool for visualizing the functional demand placed on older adults by everyday living tasks'. *Universal Access in the Information Society*, 6(2): pp.137-144

Mankoff, J., Fait, H. & Tran, T., (2005) 'Is Your Web Page Accessible ? A Comparative Study of Methods for Assessing Web Page Accessibility for the Blind'. In *Proceedings of the SIGCHI conference on Human factors in computing systems*, pp. 41-50. ACM.

Miranda, M.G., Martin, A.E. & Gaetan, G., (2013) 'Mejora de la Accesibilidad Web mediante el Uso de Agentes Inteligentes Una Revisión del Estado del Arte'. *Informes Científicos-Técnicos UNPA*, *5*(2), pp.133-160

Newell, A.F., Gregor, P., Morgan, M., Pullin, G., Macaulay, C., (2011) 'User-Sensitive Inclusive Design'. *Universal Access in the Information Society*, *10*(3): pp. 235-243

Petrie, H., Badani, A. & Bhalla, A., (2005) 'Sex, lies and web accessibility : the use of accessibility logos and statements on e- commerce and financial websites'. In *Proceedings of Accessible Design in the Digital World Conference*. pp. 23-25

Power, C., Freire, A., Petrie, H., & Swallow, D. (2012) 'Guidelines are only half of the story: accessibility problems encountered by blind users on the web'. In *Proceedings of the SIGCHI conference on human factors in computing systems*, pp. 433-442. ACM.

Rupprecht, D., Blum, R. & Bomsdorf, B., (2014) 'User Centered Inclusive Design for People with Dyslexia : Experiences from a Project on

Accessibility' *Human-Centered Software Engineering*. Springer Berlin Heidelberg, pp.307–314.

Termens, M. et al., (2008) 'Web Content Accessibility Guidelines 2.0'. *World Wide Web Internet And Web Information Systems*, 27: pp.1171–1172.

Chisholm, W., Vanderheiden, G., & Jacobs, I. (2001). 'Web content accessibility guidelines 1.0'. *Interactions*, *8*(4): pp. 35-54.

Vigo, M., Brown, J. & Conway, V., (2013) 'Benchmarking web accessibility evaluation tools: measuring the harm of sole reliance on automated tests'. *Proceedings of the 10th International Cross-Disciplinary Conference on Web Accessibility*, pp.1–10.

Zitkus, E., Langdon, P., & Clarkson, P. J. (2013) 'Inclusive Design Advisor: Understanding the design practice before developing inclusivity tools'. *Journal of Usability Studies*, *8*(4): pp. 127-143