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Abstract

Purpose: This paper presents an exploratory study on the accessibility of Spanish World Heritage website homepages in the Spanish language.

Methodology: The study sample comprised 78 homepages from the institutional websites of the 47 cultural, natural and mixed assets considered as World Cultural Heritage by The United Nations Educational, Scientific and Cultural Organization (Unesco). These homepages have been analysed using online accessibility validator tools, following the Web Content Accessibility Guidelines (WCAG) 2.0 recommendation for the different levels of priority. The compiled data were employed in a quantitative study on adherence to WCAG guidelines. Furthermore, the types of errors made using the perspective of accessibility and usability were identified, and the application rate was calculated for these accessibility guidelines according to the type of entity managed by the websites and pages.

Findings: The results show that more than 25% of the cases analysed had 10 accessibility errors or fewer. Moreover, it was only necessary to correct one or two types of errors in close to 40% of them. The paper draws the conclusion that, despite technological and legislative advances that make public entity websites accessible, there is still much to do before complete web accessibility and usability at AA and AAA level can be achieved.

Practical implications: Identifying accessibility problems on institutional websites constitutes the first step towards creating web content that is easy to access and manage for users with disabilities. In this regard, this study contributes to improving web content according to objective guidelines such as those encouraged by the WCAG 2.0.

Originality/Value: This article provides information on how accessibility and usability guidelines are implemented by institutional websites for Cultural Heritage deemed especially important. This is an issue with significant implications for users

and for which, however, there is a lack of prior studies. As a result, the value and originality of this paper can be considered evident.

Keywords: *Web accessibility, World Heritage, Accessibility analysis, WCAG 2.0*

1. Introduction

On 21 May 2018 Unesco (The United Nations Educational, Scientific and Cultural Organization) held the World Day of Cultural Diversity for Dialogue and Development with a debate on ways to guarantee the right to access culture for all. The role of institutional bodies like Unesco focuses on promoting, identifying, protecting and conserving assets located throughout the world that, due to their exceptional universal value, are recognised as Cultural Assets of world interest according to the criteria of the convention on the protection of world cultural and natural heritage (Unesco, 1972).

In recent times the way in which information is transmitted, that is, the way we communicate, has evolved dramatically (Alfonso Sánchez, 2001). The websites of institutions are the foremost means of communicating and transmitting their information.

1.1. Web Accessibility

The evolution in universal access to information through the World Wide Web has created a greater variety of user types with particular needs. For instance, some people require text recognition for audio description of the website, to increase font size or to have the option of putting subtitles on videos. All accessibility improvements allow more people to be integrated and make universal access to information more comfortable and attractive. Tim Berners-Lee drew attention to this idea when he stated that “The power of the Web is in its universality. Access by everyone regardless of disability is an essential aspect." (Berners-Lee, 2017). As a result, the concept of "usability" in the Web environment normally goes hand in hand with accessibility (Gulliksen and Harker, 2004; Gulliksen *et al*., 2001). In fact, sometimes

these terms are used interchangeably. Both base on the user experience with the aim to make easy the perception and navigation in websites. Thus, on one hand usability works on the design of products to be effective, efficient, and satisfying all types of users. On the other hand, accessibility focuses, solely and exclusively, on improving the experience of people with disabilities. In effect, only an accessible piece of information or resource can be used, to which it is necessary for the design of the web page (Kurniawan and Zaphiris, 2006) and the website itself to permit this accessibility (Brophy and Craven, 2007; Richards and Hanson, 2004). Against this background of the evolution of web accessibility (Bradbard and Peters, 2010), this perspective is a fundamental pillar for any webmaster. With the aim of maintaining this link with citizens, public institutions should not remain at the periphery (Yuan *et al*., 2012).

There have been different criteria and methods for assessing web quality (Agrawal *et al*., 2019; Brajnik, 2008). Numerous studies have been carried out to evaluate websites of different institutions -such as ministries (Karaim and Inal, 2019; Ismailova and Inal, 2016), councils (Inal and Ismailova, 2019; Karkin and Janssen, 2014), universities (Ismail and Kuppusamy, 2018; Kurt, 2017) – and thematic fields – such as biomedicine, (Bermúdez-Tamayo *et al.*, 2006; Hidalgo *et al.*, 2010), education (Olvera-Lobo and Aguilar-Soto, 2011; Olvera- Lobo *et al*., 2012) and tourism (Chung and Law, 2003; Law *et al*., 2010). There have also been studies on web applications (Fernandes *et al*, 2012). If we start from the premise that web accessibility is the group of functions contained in a product, tool or service with the purpose of it being used by the greatest number of interested parties, we can conclude that it is a measureable concept. Along this line, the Web Accessibility Initiative (WAI), a branch of the World Wide Web Consortium (W3C), has issued a number of internationally recognised standards that include the accessibility criteria websites are expected to fulfil.

1.2. WCAG 2.0 guidelines

The WCAG 2.0 (Web Content Accessibility Guidelines) were created by the World Wide Web Consortium (W3C), by the Web Accessibility Initiative (WAI) sub-group, with the purpose of designing websites to make them completely accessible.

The W3C is the most recognized international association, and pioneered the first specifications for World Wide Web and accessibility guidelines (Hackett *et al*., 2005). More and more countries have implemented these guidelines -initially WCAG 1.0 and, since 2008, WCAG 2.0-- in their laws for e-government website design. The WCAG 2.0 are, at present, the most endorsed standards in web accessibility and broadly adopted by public and private bodies (Moreno and Martinez, 2019). In this regard, and by way of example, the European Commission has made it obligatory since January 2010 to create all new EUROPA websites in compliance with WCAG 2.0, level AA (European Union, 2014).

They are adopted worldwide and are based on four principles, subdivided into different numbered sections:

- Principle 1: All content, including text information, multimedia, video and audio must be presented to users in a way they can perceive easily (Perceivable). They include: 1.1 Alternative text, 1.2 Time-based media (with just audio or video, subtitles, audio description, alternative media), 1.3 Adaptable (in a way that the content is understood thanks to structure, sequence and presentation) and 1.4 Distinguishable (with the use of color, audio, contrast, text resizing and text images).
- Principle 2: The components of user interface and navigation must be operable (Operable). In a way that they are keyboard accessible (2.1), timing adjustable (2.2) and do not provoke seizures (2.3); and easy to navigate (2.4)
- Principle 3: User interface information and operation must be understandable (Understandable). To comply with this it must be readable (3.1), predictable (3.2) with a homogenous context and facilities identified on all pages under the same symbols; and with input assistance (3.3)

- Principle 4: Enable contents, which are to be interpreted reliably by a wide variety of user agents including assistive technologies, must be robust (Robustness). Refers to aspects relating to tags, to make them compatible (4.1) with all browsers.

Web developers follow WCAG 2 guidelines as a priority. This means that a website can be accessible to a number of groups of people but at lower level, and some groups are excluded.

- Priority 1 (level A): Impossible for a particular user or group to easily access the website content.
- Priority 2 (level AA): Some user groups have difficult accessing the website content.
- Priority 3 (level AAA): The web content of these sites is more easily accessible even for specialised groups.

According to the level of priority reached a logo certifying this can be included on the website. At present, and following a development of both hardware and software technologies, we consider that the priorities that web developers should aspire to are those of the highest level.

In parallel with technological advances, WAI has published new guides and standards, adapting to new changes. So, since 2014, the Accessible Rich Internet Applications Working Group (ARIA WG) with WAI published the Accessible Rich Internet Applications Suite of web standards (WAI-ARIA) to improve the accessibility of dynamic content and advanced user interface controls, with WAI-ARIA 1.1 appearing in December 2017 (Cooper, 2016).

These WCAG guidelines make it easy to verify the accessibility of a site and have given rise to a number of different research projects. Some of these studies focused on the two versions of the WCAG guidelines (Akram and Sulaiman, 2019), with others concentrating more on user experience (Song *et al* 2018, Song *et al* 2017). The evaluation methods have also been studied (Nuñez *et al*, 2019) and can be divided into analytical and empirical methods (Masri and Luján-Mora, 2011).

With the entry into force in 2002 of the Law on Information Society Services and E-Commerce, public administrations are obliged to adopt "the measures necessary for the information available on their respective Internet pages to be accessible to people with disabilities and senior citizens in accordance with the criteria of accessibility to generally recognised content" (España. Ley 34, 2002). This challenge is undoubtedly relevant in the case of institutional websites whose objective is to promote and disseminate heritage. The dissemination of information implies good web accessibility that, in these cases, is affected by the type of entity or administration it belongs to, its budget and sensitivity regarding the transmission of information. In addition, in the dissemination of heritage at an international level, particular attention must be paid to the intellectual accessibility of both text and audio-visual content, which also involves the language in which such content is communicated.

Therefore, based on inferences from a review of the literature, it is important to investigate and identify the issues regarding the web accessibility of official World Heritage Websites.

2. Objectives

The main objective of this study is to determine to what extent the dissemination of web information on heritage takes into account aspects relating to accessibility in Spanish language. The following have been considered as specific objectives (SE):

SE1: Carry out a quantitative analysis of the application of accessibility guidelines established by the Web Accessibility Initiative (WAI). That is, determine the application of the WCAG 2.0[1] web accessibility guidelines, focusing our attention on the AA and AAA levels given the existing technical sophistication that now exists.

SE2: Identify the errors made from the perspective of accessibility and usability according to WAI criteria.

SE3. Identify the application rate for the accessibility guidelines according to the type of entity that manages these web sites and pages.

[1] https://www.w3.org/TR/WCAG20/ and http://www.sidar.org/traducciones/wcag20/es/

3. Methodology

3.1. Study sample

At world level, Spain is third in terms of the number of recognised inscriptions (Unesco, 2018) and second in Europe, behind Italy. Unesco has declared, up to October 2018, 47 assets in Spain as heritage of humanity in their categories of cultural, natural and mixed heritage. To establish the study sample we identified the institutional websites that manage world heritage assets in Spain.

With the aim of only selecting official web pages we took the criterion that these had to have their authorship identified and be supported by some type of institution that accredited their authenticity. Given that the proximity of the heritage varies, this can involve a public, private or mixed entity. Furthermore, the duality in the management of some heritage has provoked the compiling of more than one web page for a Unesco-adjudicated denomination. These URLs respond to a whole or a part that is representative of the combined heritage studied.

In this work we have identified nine types of institutions responsible for some of the heritage of humanity assets and manage the website analysed herein (figure 1).

Figure 1: Representation of the sample of each type of institution (%)

3.2. Analysis Tools

A quantitative analysis has been carried out in order to determine whether or not the obligatory standards are being met by the Spanish public administrations regarding web accessibility. As pointed out, WCAG 2.0 accessibility guidelines, issued by the WAI, put forward different levels of requirement when creating an accessible web page. Rather than being based on language, the parameters studied focus on WCAG 2.0 “priorities” on a sample that should “a priori” have very good accessibility (via official body and through dissemination of information of world

interest). This study focuses on the so-called 2 (AA level) and 3 (AAA level) priorities, given we consider it clearly insufficient to concentrate solely on the basic level of content adaptation (level A) to make them accessible.

AA level establishes some requirements that are more advanced than A level on significant barriers to accessibility for a large audience group to be able to access the content. As a result, AAA level increases these requirements with the aim of facilitating access to even more people.

We have opted for an automatic method using web tools (Abascal et al, 2019) and a manual method for more in-depth examination.

To carry out this stage, we have employed the automatic, free of charge web validators TAW and HERA in Spanish and AChecker in English.

- TAW[2] (*Test de Accesibilidad a la Web*, figure 2): The first accessibility verification tool for websites in Spanish, which appeared at the end of 2001. This program was created by the *Fondo Formación Asturias* (Asturias Training Fund) for the *Centro estatal de Autonomía Personal y Ayudas Técnicas/CEAPAT* (State Centre for Personal Autonomy and Technical Aids) in the *Instituto de Migraciones y Servicios Sociales/IMSERSO* (Institute of Migrations and Social Services) in Spain. It can be used online, downloaded as a stand-alone program, and installed as a Firefox extension that allows you to review the page being viewed on this popular browser (Segovia, 2007). Up until mid-November 2018 it was only possible to carry out the accessibility analysis for levels A and AA. However, with the latest TAW update, it is now possible to analyse AAA level.

Figure 2: Example of TAW analysis (18-nov-2018)

[2] https://www.tawdis.net/index

- HERA[3] (Style Sheets for Accessibility Review): It was created by the Spanish SIDAR foundation, and facilitates reviews of website accessibility in accordance with quality control standard 139803:2004 (AENOR, 2004) and the recommendations of the WAI Accessibility Guidelines for Web Content 1.0 for each of the three priorities. It automatically analyses elements and attributes and reports on the identification of errors and the points of the page subject to manual verification (figure 3). At the same time, it carried out general valuations that record up to 10 errors, which impedes comparison with the other analysis programs.

Figure 3: Example of validation with the HERA program

- AChecker[4] is the open-source code tool created mainly by the Inclusive Design Research Centre, part of the Ontario College of Art and Design University (Ontario, Canada). It tests the accessibility of a single web page (Dirección de Tecnologías de la Información y las Comunicaciones, 2014). The URL can be input but it also allows the possibility of uploading the source code file and even directly pasting code from the page (figure 4). There are additional checking options according to different standards. You can also request that it validate HTML and CSS code via the W3 validator.

Figure 4: Example of AChecker analysis

[3] http://sidar.org and http://www.hera.flexit.fr/
[4] https://achecker.ca/checker/index.php

The program AChecker has the greatest analytical power as it managed to test 100% of the cases studied, followed by TAW, with a 97% capacity for analysis.

That is, it was possible to analyse 71 of the 78 homepages with the three validators. Furthermore, we discovered the coincidence of many cases analysed by AChecker without finding a single error; they were either not validated by the other two programs, or they produced a message saying the URL cannot be analysed (figure 5).

Figure 5: Case without errors

Perhaps this is one reason why AChecker has a high proportion of cases, 24%, which have between 0 and 2 types of errors, compared with the 5% identified by TAW at double AA level (figure 6).

Figure 6: Cases according to the number of errors identified at an AA or priority 2 level (%).

The rate of errors identified by the HERA program follows a trend similar to the other two validators (TAW and AChecker) for the priority 3 or WAI AAA level, although on another scale as HERA checks a maximum of 10 errors (figure 7).

Figure 7: Percentage of cases in relation to the number of errors identified in HERA with a priority 2 and 3 level.

HERA is an effective program but its technical capacity to carry out this analysis results in the following error message on 9% of cases. The majority of the web pages analysed were normally the home pages of a website. However, three cases identified with an error by HERA were web pages that form part of a website dedicated to information on the province or the region. Two further cases, also identified as having

errors by TAW (figure 8), were web pages that make up part of the www.españaescultura.es website. It is highly likely that the format of these URLs fails to adjust to the format readable by the validator as indicated by the TAW program (figure 9).

Figure 8: TAW error message

Figure 9: Non accepted format of URL

The three programs mentioned allowed us to list the errors identified for the AA accessibility level, and which are usually referred to as "Known problems or errors". For the AAA level we took the data from Achecker and HERA at the moment of the collection for the study. Only the HERA program also identifies the elements that are correctly presented on the web pages. The combination of these tools permitted the technical limitations that one of them could present on data collection to be solved. In addition, we were able to discover the size or number of existing elements on each page in 95% of the cases in our sample.

The results shown below were reached from the registration and analysis of the data offered by the automatic validators, relating to the application of the accessibility guidelines on the web pages in our study sample according to the WCAG 2.0 standard.

4. Results

4.1. Quantitative analysis of the application of the guidelines (WCAG2.0)

These programs are undoubtedly of great help in order to provide a general illustrative picture of accessibility of content included on the web page. Although it must be taken into account that the number of errors varies depending on the program

used, our analysis shows that TAW and AChecker are those that show most similarities in terms of number of errors detected.

Figure 10: Known errors detected by Achecker

In general (figure 10) a relatively low number of accessibility errors was identified (table 1). 50% have fewer than 9 errors at AA level, according to AChecker and 4 according to HERA; this is even lower for AAA level, where just 2 errors were found. The difference between these data and those facilitated by the program TAW particularly stands out, where the errors stood at 19 for half of the sample. Particularly of note is the difference between these data and those facilitated by the TAW program, where the errors stood at 19 for half of the sample. We also draw attention to the heterogeneity of cases, which produces a greater variability in the results and is reflected in a high variance and arithmetical mean. Two results stand out in the table, those identified as 10 and 20 which, due to the reduced number of elements, provoke two very extreme relative values. As a result, this situation slightly increases the variance and standard deviation (31 TAW and 42 AChecker) and also the average (23 errors according to AChecker and 4 for HERA).

Table 1: Descriptions of the sample of 78 cases (Number of errors according to WCAG 2.0 guidelines)

According to the evaluation made by the TAW validator, over a quarter of the homepages (31%) have fewer than 10 errors (figure 11) and over 50% have up to 20 errors. It must be borne in mind that an automatic validator counts the number of errors to be corrected. This group of errors, however, can fall within a single category (within the hierarchy established by the WCAG 2.0 guidelines) and, in turn, located in one of the aforementioned principles. It is usual (21%) for websites to present

between 11 and 20 accessibility errors. However, up to 31% make less than 10 erros. On the contrary, only 7% have more than 81 errors at an AA priority level.

Figure 11: Percentage of Priority 2 TAW errors

This numbers mix-up is justified by the variation in the amount of elements that are identified by the program carrying out the examination itself. It is logical to think that a web page with a greater number of elements has more possibilities of returning a higher number of accessibility errors if it is not designed with a template or revised with an established protocol. For this reason we have calculated the ratio of errors based on the number of elements that each case had. The number of elements of each page has been extracted thanks to the HERA validator. Figure 12 represents the quotient calculated between the errors identified by each program and the number of elements of each URL, and they have been represented in descending order based on the volume of components on the page in question.

Figure 12: Ratio of errors/total number of elements on the web page.

There is a clear parallel between all of the analysers when identifying homepage errors. With a priority 2 (AA level), both AChecker and HERA identify more errors in proportion to the amount of elements contained by the web page. The conclusion has been drawn that there is no relationship between the number of elements and the number of errors.

A similar phenomenon occurs for the AAA level when the data are extracted from the HERA validator where the standard deviation is reduced with extreme cases (table 2). As already mentioned, it involves two cases with a very limited number of elements of between 1 and 6. The results at this level are much more positive as 50% of the cases increase to 1% of errors according to HERA (0.6%) and only 4% for

AChecker. At AA level, the variations are minimal in the case of HERA (1.2%) and AChecker (4.3%) compared to TAW (5.7%).

Table 2: Descriptives of the error averages (69 cases)

4.2. Identify the errors made from the perspective of accessibility and usability according to WAI criteria.

Looking at the type of errors identified according to WCAG 2.0 in more detail, figure 13 shows that it is principle 1 relative to the information provided and the components of the interface that require greater attention. 50% of the errors made when designing a web page are related to facilitating a better view of the content.

Figure 13: Classification by principles (1, 2, 3 and 4) and sections of errors according to WCAG

A total of 179 errors have been counted for the general points of the guidelines. At a deeper level of study, repeated errors were identified within the same category, s 198 errors in total have been identified (table 3, figure 14).

Table 3: List of errors

Figure 14: Classification by error criteria according to the WCAG

The more specific diversification and identification of errors, brings to light that principle 2 corresponding to operability is more susceptible to errors in category 2.4.4 Link Purpose (In Context) (A) and 2.4.6 Headings and Labels (AA). Errors in these levels make impossible or very difficult to access the website content for a particular

user. The errors are habitually studied globally at a statistical level but figure 14 breaks down the types of errors in a more specific form with the purpose of identifying the most common types of erroneous patterns of design, and which may be various aspects within one principle, or even within the same section within one principle. This may be the case for something of simple appearance such as the option of resizing text. Special mention must be made of the lack of alternative texts (nearly 25%) when the element is not text based (e.g. image, embedded element, etc.). This point 1.4, denominated "Distinguishable" already mentioned in the section on WCAG guidelines includes a contrast that can be minimal (1.4.3) or improved (1.4.6), color (1.4.1) and the possibility of resizing text (1.4.4). This point confirms prior studies which, from the beginning of this decade, have been carried out on this aspect (Alahmadi and Drew, 2017).

In contrast, the study by Ahmi and Mohamad (2015), technical/hardware access via the keyboard (point 2.1 of the guidelines) has an error rate of 1.7%. As in the case of Abid and Kuppusamy (2016), a repeat of errors at A and AA level is identified (table 3),

On the other hand, we detected an increase in errors relating to efforts to make the content legible and understandable (section 3.1) in 13% of cases. This specifically refers to the criterion 3.1.1 relating to the identification and recognition of the language predetermined by a program in the web page

4.3. Types of entities and application rate of accessibility standards.

The public administrations in numerous countries have adopted a commitment to accessibility, considering the fulfilment of certain obligatory regulations for institutional web information. Although this does not guarantee their fulfilment, it

does point to a greater awareness regarding inclusive information or inclusive websites.

This analysis, carried out manually by checking the inclusion of the WAI (WCAG AA) logo and identifying alternative accessibility elements, corresponds to the data returned by the web validators. An overview by type of institution confirms that the public administrations obliged by law to comply with accessibility standards are those that most apply these guidelines (figure 15).

Figure 15: Relationship between type of institution and number of accessibility errors identified by AChecker (AAA level)

From the comparison between figures 15 and 16, a correspondence is observed between the type of institution and the volume of errors identified. Only the University is in absolute homogeneity between the two levels of accessibility and the number of errors detected, always between 6 and 15. To explain the data, it is necessary to take into account the fact that the national, regional and municipal administration are the only ones that must observe, in Spain, the accessibility guidelines by law (España. RD 1112/2018). In general, both for the AA level and for the AAA, in these institutions the error rate is less than 15 per website in 80% of the cases analyzed within the regional administration and in 71% in the central administration. These good results are also observed in 33% of the websites of the municipalities, which do not present any type of accessibility error. This is also the case with 20% of the websites of the regional administration and 12% of the national administration. At the other end is 7% of the websites of municipalities that exceed 50 accessibility errors. This high number of errors is also observed in 12% of the websites of the national administration regarding the AA level of accessibility. However, no website in this group has more than 50 errors in relation to the AAA level.

On the other hand, the consortiums, which make up a group of public and private entities, present a great disparity in the number of errors as well as the town halls. While in some cases they have a minimum error rate (29% from 1 to 5 errors), in others they include up to more than 50 (21%). In addition, unlike associations, consortia have less than 15 errors at an AAA level (figure 15) by 57% compared to 33% of associations. And this despite the fact that associations have fewer errors at the AAA level than at the AA level.

Figure 16: Relationship between type of institution and number of accessibility errors identified by AChecker (AA level)

A relationship exists between the ownership of the entity that manages the web and the application of some type of accessibility standard (figure 17).

Figure 17: Accessibility by institution

It appears that there is a certain relationship between the type of entity and the application of the AA protocol. The total number of universities and between 60 and 71% of the public entities include the AA logo on their web pages. Likewise, usage of other accessibility mechanisms is included, despite them not being recognised by the W3 (for example the inclusion of an audio file of the text on the page, or sign language videos) in religious and municipal entities, and the central administration. There is a gap between institutions in the same sphere or sector that are involved in the design of accessible pages, compared with those that are not. In 10% of cases, corresponding to private entities of a religious nature, technical accessibility, for instance the possibility of text resizing, is minimal. It is also rare to include another type of accessibility tool not contemplated by the WCAG such as sign language, audioguides, subtitles, and so on.

Despite compliance with accessibility guidelines, not all web pages include the logo that identifies this benefit. Awareness is greater in bodies such as universities and entities connected to the central administration of the country (figure 18).

Figure 18: Relationship between type of institution and inclusion of WCAG AA logo.

Finally, we identify the types of errors produced on each homepage, segmenting them by type of institution (table 4).

Table 4: Types of errors by type of institution

Those errors relating to principle 1 corresponding to perception particularly stand out, especially those relating to text and its size. As regards principle 3 on understanding, particular attention may be drawn to language.

5. Conclusions

Web accessibility is becoming increasingly important, along with its respective social, legal and economic implications, especially as regards ecommerce, with growing awareness of the fact that the more accessible a website is, the more possibilities exist for knowing what potential clients want (Sohaib and Kang, 2016; Richards et al, 2012). However, there is still a wide margin for improvement of web accessibility for cultural heritage of humanity as occurs with other cultural websites (Stable-Rodríguez and Sam-Anlas, 2018). It is time for webmasters and developers to become more aware of usability and accessibility as critical quality criteria, and as tools for the effective spread of information.

In this work, we carried out a quantitative analysis based on three automatic web accessibility evaluation tools in order to avoid the biases in results studied in other research (Vigo *et al.*, 2013), along with a characterization of errors and a categorization by entities. In contrast to other studies, these websites correspond to institutions that can be public in any of the possible categories (municipal, regional or national level entities) or private. In relation to a study on web content in other languages, the multilingual character of institutional websites has been reviewed (García-Santiago y Olvera-Lobo, 2017).

In line with other studies, web accessibility is considered as a civil right and public service (Inal and Ismailova, 2019). Regarding our specific aim about the application rate for the accessibility guidelines according to the type of entity that manages these web sites and pages, it appears that there is a certain relationship between the type of entity and the application of the AA protocol.

Our analysis is based on a notable lack of studies focused on the evaluation of website accessibility through automatic validators (ex. HERA, TAW and AChecker). Previous works such as Ismailova and Inal (2017), focused solely on websites of ministries, reached similar conclusions regarding the type of errors present on the websites. In this way we can asseverate that the most frequent errors are found in sections 1.1.1 and 1.4.6.

The results of our study confirm that the institutions that comply with accessibility levels in greater levels are public universities and governmental institutions, both at national and autonomous regional level. This current takes in municipalities and consortiums with participation by public administrations. Notwithstanding, special attention should be heeded to this percentage of public entities at a national level that do not yet correctly follow the guidelines, and make over 50 errors on their web pages (12%). It would be, furthermore, beneficial to create awareness amongst half of the municipal entities studied in this investigation in order to achieve improved accessibility and reduce their high rates of errors and inconsistencies (over 50) in the design of their web contents. Moreover, the accelerated updating and awareness-raising in the dissemination of information in an accessible manner on the part of religious organisations, wherein over 50% of their homepages included in the same

within this category have fewer than 5 errors identified by AChecker and TAW, also stands out.

The current validators are useful and convenient tools for quickly identifying the weak points of web pages analysed by this type of program. TAW and AChecker have greater capacity for analysis, of between 95% and 100% of the web pages studied. HERA, despite not being as powerful in this regard, counts the number of elements of the web page that allows us to know the ratio between the errors identified and the volume of the page in relation to the number of elements that form part of the file.

On occasions it is a repeated error and on which, as such, affects various elements of the web page but is actually easy to fix and avoid in future designs for the dissemination of the contents of the web page.

Following the quantitative analysis, we reflect the effort made by these institutions that promote cultural heritage of humanity for their web pages to be accessible. At WCAG 2.0 AA level, the proportion of errors on each page is on the whole low with a mean not exceeding 10% and this confirms previous evaluations of government websites (Baowaly and Bhiyan, 2012; Karaim and Inal, 2019). Furthermore, it can be said that 50% of cases have an error rate of 5.7% according to TAW, 4.3% according to AChecker and 1.2% according to HERA.

There are many reasons for this: from those cases where no guidelines have been followed to improve accessibility, up to the extreme opposite for those cases where great efforts have been made in order to exceed the obligatory levels of compliance, with low or very low AAA level error rates.

This paper has shown those elements to which particular attention should be paid at the web design stage, and those that should be the object of revision in subsequent updates. The results demonstrate that Spanish World Heritage Websites behave in the same way as websites evaluated in previous studies (Ismailova and Inal, 2017; Isa *et al.*, 2010). On the whole, the most repeated error is 1.1, which would be solved by including complementary elements in the case of images, due to that fact it refers to the lack of alternative text for each non-text element. In addition, the study confirms the evolution in tasks for achieving more accessible web pages via the keyboard, where errors and warnings by validator programs are scarce. Other types of error are

relatively simple to correct, such as the inclusion of information, providing different text sizes, and a better processing of content via markup language (success criterion 4.1.1).

The good results obtained in some of the public institutions are a clear consequence of the obligation to follow the law that obliges them to comply with accessibility standards. Besides, other public institutions, such as universities, are clearly sensitized on these issues. It is observed that, little by little and thanks to a phenomenon of imitation, the websites of public institutions become role models for other entities.

The guidelines have different levels of demand regarding accessibility and web usability. The results of the analysis performed show that compliance with some AAA level requirements does not imply that all AA recommendations are met. That is, the requirements of both guidelines are not summative, which means that even more errors can be found at level AA than at AAA. This fact causes paradoxes such as that within the operable interface principle, conditions of labels and headings present at the AAA level are met but the guidelines for the title of the page (level A) are not observed. Each principle includes elements so varied that you can follow some related to color such as 1.4.3 relative to the minimum contrast (AA level) and to the improvement of that contrast (1.4.6 at the AAA level) and not to follow other aspects related to resize text found in section 1.4.4 of the same principle and corresponding to level AA.

It is noteworthy that 18% of the cases produce 5 or 6 types of different errors on the same web page. This means that these institutions should really undertake a global revision and monitoring of all accessibility guidelines. In contrast, almost 40% of the cases need to revise and correct one or two types of accessibility error which would probably be solved with the inclusion of alternative texts on audiovisual elements, or by increasing the variety of facilities to improve text reading by for example color contrast, size, etc. Based on the type of repeated errors we think it would be highly recommendable to create content that can be presented in different ways without losing the message or information structure. Tags such as are useful for this task. Besides, there should be an increase of resizing and contrast adaptation functions with. Special attention should also be paid to two other aspects: firstly, facilitating identification both of the page with a title, and the language of the page with codes

and tags and, secondly, helping users with the web page via tags, instructions and autocorrect.

In this study we confirm the efforts made by Spanish entities which manage universal cultural heritage according to Unesco, above all public institutions, towards making their websites more accessible. There is, however, much work still to be done in order to achieve total web accessibility and usability both at AA and AAA level.

An interesting study in term of language would be to compare websites in a language in different countries in a synchronous and asynchronous manner. We agree with Tashtoush (Tashtoush *et al.*, 2016) about the necessity of user feedback for knowing if the highest degree of web accessibility has been reached. Nevertheless, we have demonstrated a quick and effective evaluation for scanning the current situation of cultural heritage websites in terms of usability and accessibility.

Lastly, future research projects could focus on the evolution of the accessibility of these homepages, and the sample could be extended to other activity sectors.

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	AA Level			AAA Level	
	TAW	AChecker	HERA	Achecker	HERA
Mean	30	23	4	20	2
Median	19	8.5	4	8.5	2
Variance	982.2	1726.2	2.9	1033.8	0.7
Standard deviation	31.3	41.5	1.7	32.2	0.8

Table 1: Descriptions of the sample of 78 cases (Number of errors according to WCAG 2.0 guidelines)

	AA Level			AAA Level	
	TAW	AChecker2	HERA2	Achecker3	HERA 3
AVERAGE	8%	7%	2%	6%	1%
MEDIAN	5.7%	4.3%	1.2%	4.1%	0.6%
STANDARD DEVIATION	7.3%	12.1%	4.1%	5.9%	1.8%
VARIANCE	0.5%	1.5%	0.2%	0.3%	0.0%

Table 2: Descriptives of the error averages (69 cases)

Types of errors	Total	%	
Principle 1: Perceivable interface information and components			**57.6%**
1.1 Alternative texts	44	24.6%	
1.3 **Adaptable to simpler presentation formats** without losing information	18	10.1%	
1.4 Distinguishable: **Make it easier for users to see and hear content**			
1.4.1 Use of color	5	2.5%	
1.4.3 Minimum contrast (AA)	8	4.0%	
1.4.4 **Resize text** (AA)	24	12.1%	
1.4.6 Enhanced contrast (AAA)	15	7.6%	
Principle 2: Operable Interface			**15.2%**
2.1 Keyboard accessible	3	1.7%	
2.2. Enough reading time	2	1.1%	
2.4 Navigable	21	11.7%	
2.4.2 Page Titled (A)	4	2.0%	
2.4.4 Link Purpose (In Context) (A)	11	5.6%	
2.4.6 Headings and Labels (AA)	10	5.1%	
Principle 3: Understandable information and user interface operation			**20.2%**
3.1 Understandable text content	24	13.4%	
3.3 Input assistance.	16	8.9%	
Principle 4: Robust content			**7.1%**
4.1 Content compatible with applications.	14	7.8%	
			100%

Table 3: List of errors

Error type	Association	Consortium	Foundation	Governmental state	National Government	Municipality	Private	Religious	University	Total
1.3.1 Info and Relationships (A)	1%	3%	1%	1%	2%	3%	1%	1%	0%	**12%**
1.4.1 Color	1%	1%	0%	0%	0%	1%	0%	1%	0%	3%
1.4.3 Contrast (minimum)	1%	1%	1%	1%	1%	0%	1%	0%	0%	5%
1.4.4 Resize text (AA)	1%	3%	1%	2%	3%	1%	2%	2%	1%	**16%**
1.4.6 Contrast (Enhanced) (AAA)	0%	4%	1%	1%	1%	1%	1%	2%	0%	10%
2.1.1 Keyboard (A)	0%	1%	0%	1%	1%	1%	0%	0%	0%	3%
2.2.1 Timing Adjustable (A)	0%	0%	1%	0%	0%	0%	0%	0%	0%	1%
2.4.2 Page Titled (A)	0%	1%	0%	0%	0%	1%	0%	1%	0%	3%
2.4.4 Link Purpose (In Context) (A)	0%	3%	1%	1%	1%	1%	0%	1%	0%	7%
2.4.6 Headings and Labels (AA)	0%	3%	1%	1%	1%	1%	0%	0%	1%	6%
3.1.1 Language of Page (A)	1%	3%	1%	1%	2%	3%	1%	4%	0%	**16%**

3.3.2 Labels or Instructions (A)	1%	3%	1%	1%	1%	2%	0%	1%	0%	10%
4.1.1 Parsing (A)	0%	2%	0%	2%	3%	2%	0%	0%	1%	9%

Table 4: Types of errors by type of institution

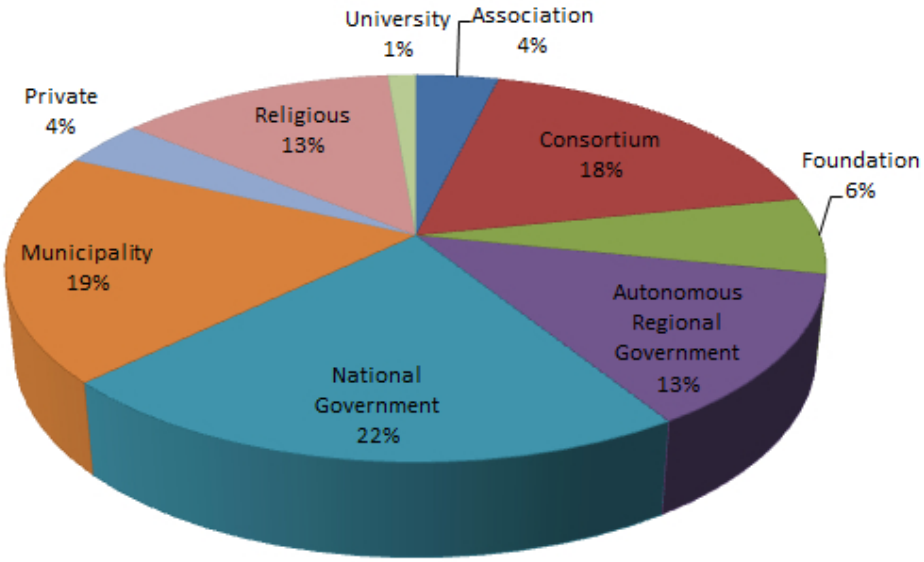


Figure 1: Representation of the sample of each type of institution (%)

140x84mm (96 x 96 DPI)

Figure 2: Example of TAW analysis (18-nov-2018)

415x196mm (96 x 96 DPI)

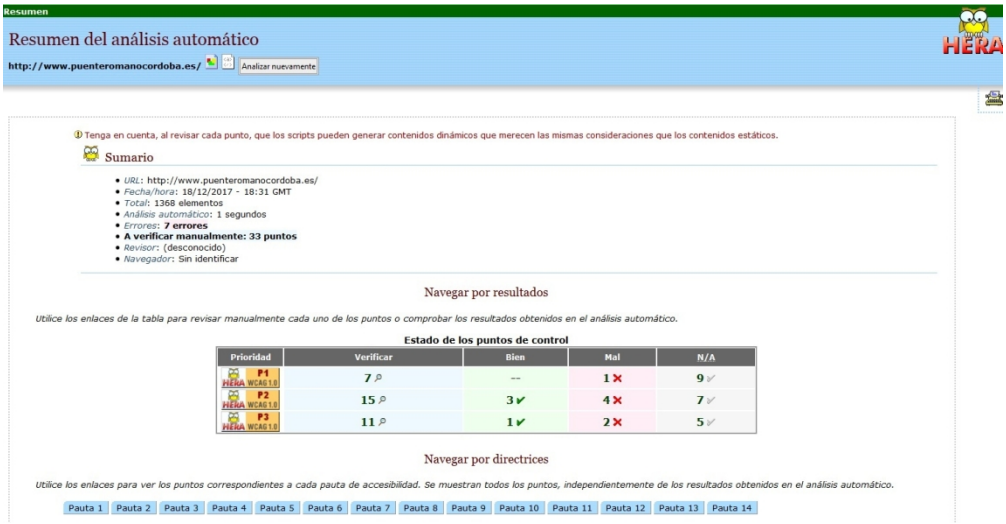


Figure 3: Example of validation with the HERA program

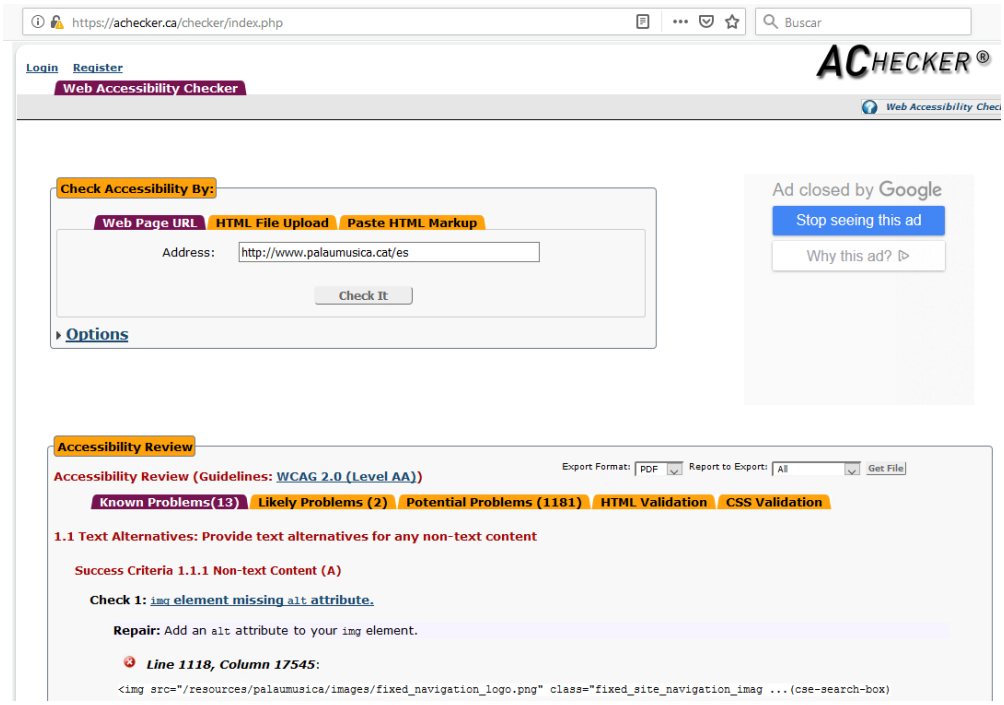


Figure 4: Example of AChecker analysis

286x200mm (96 x 96 DPI)

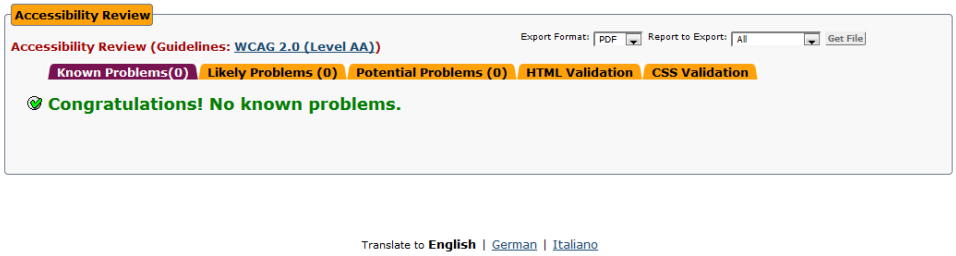


Figure 5: Case without errors

286x76mm (96 x 96 DPI)

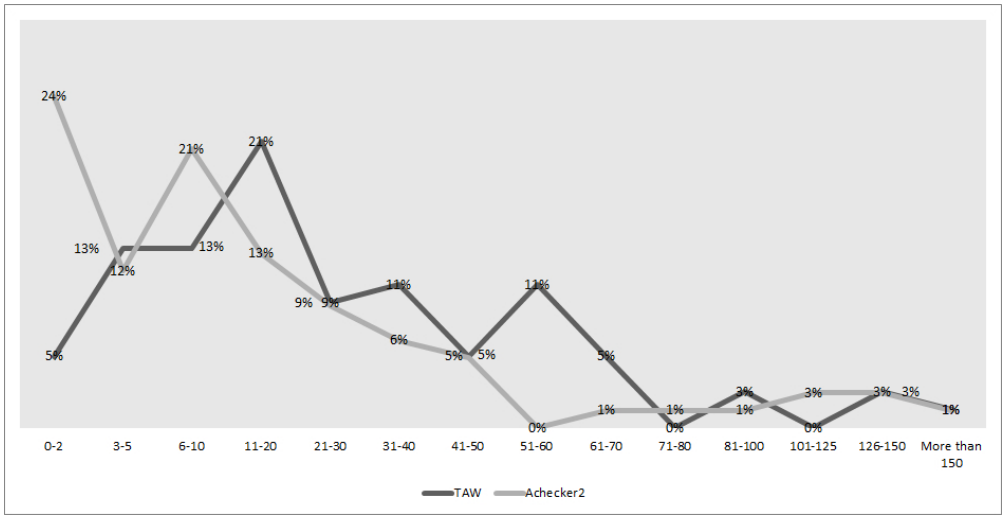


Figure 6: Cases according to the number of errors identified at an AA or priority 2 level (%).

249x127mm (96 x 96 DPI)

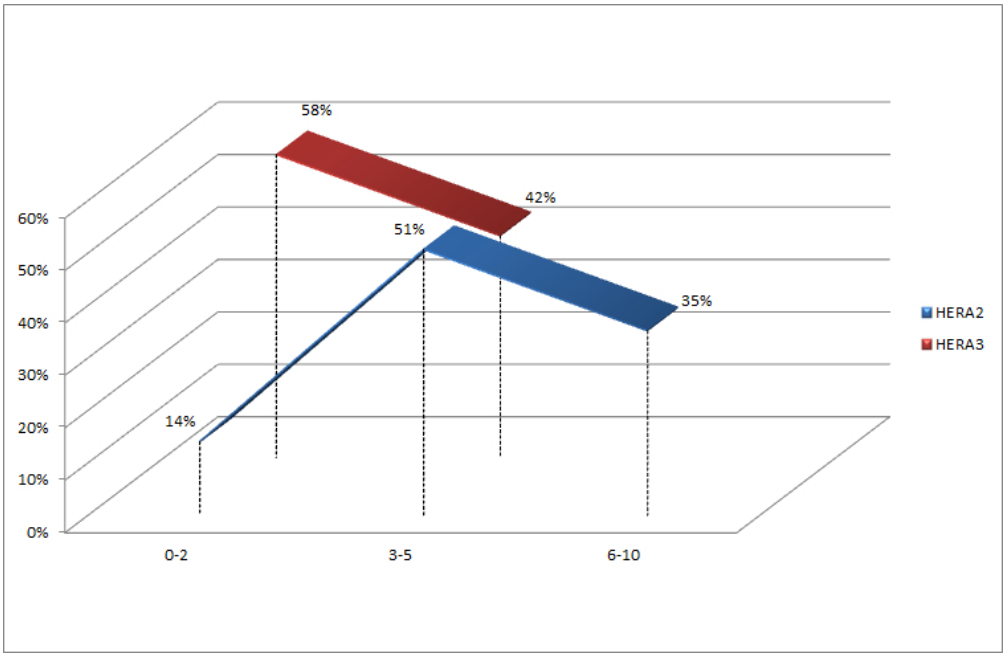


Figure 7: Percentage of cases in relation to the number of errors identified in HERA with a priority 2 and 3 level.

199x129mm (96 x 96 DPI)

Figure 8: TAW error message

114x40mm (96 x 96 DPI)

Figure 9: Non accepted format of URL

410x146mm (96 x 96 DPI)

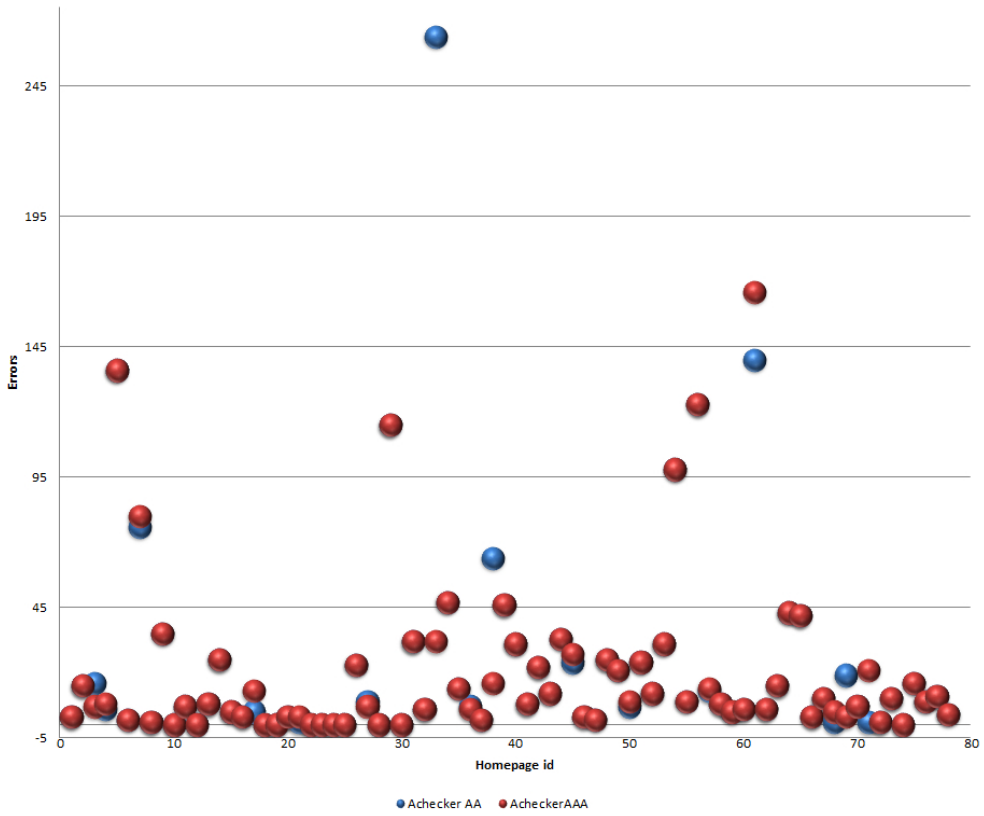


Figure 10: Known errors detected by Achecker

245x202mm (96 x 96 DPI)

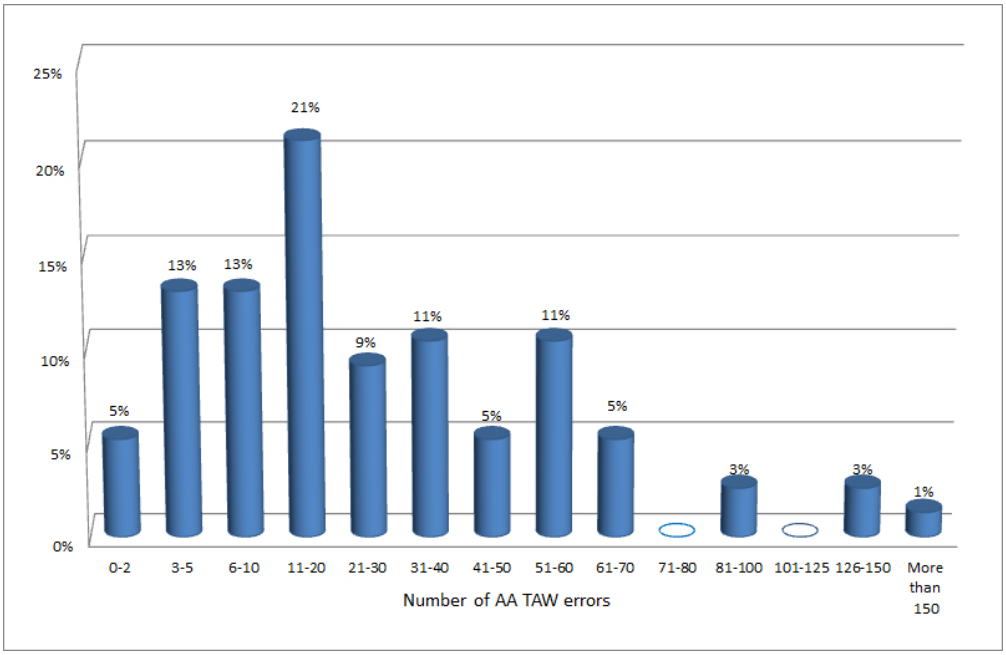
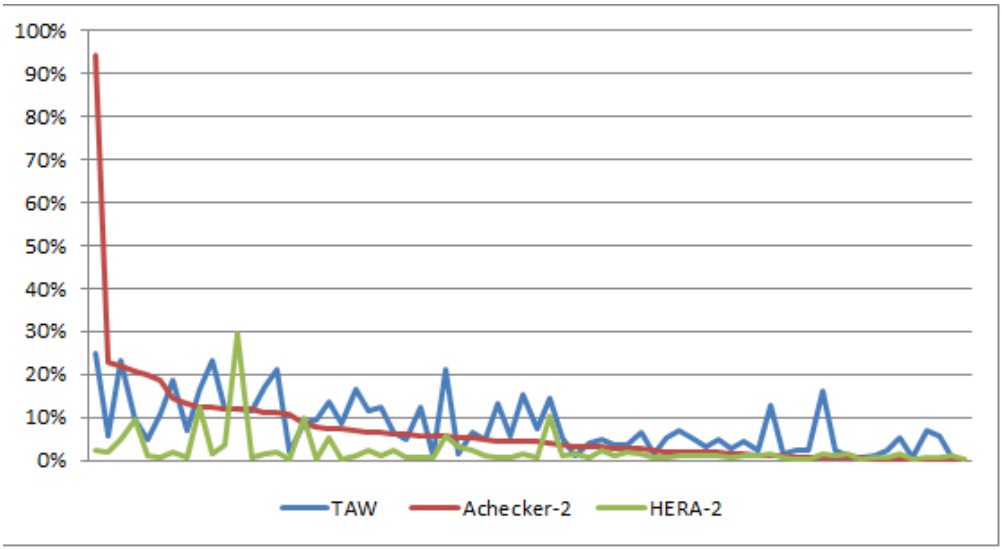


Figure 11: Percentage of Priority 2 TAW errors

212x137mm (96 x 96 DPI)



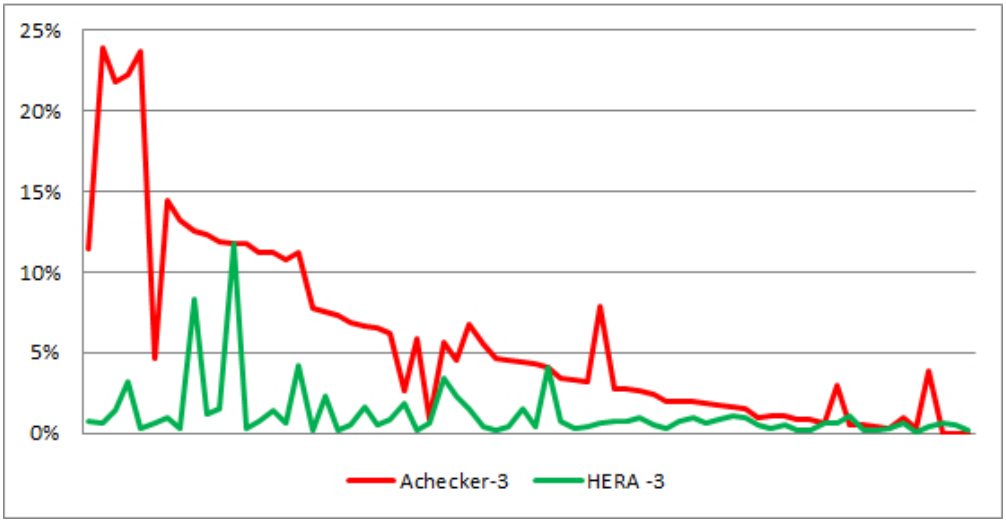


Figure 12: Ratio of errors/total number of elements on the web page.

147x164mm (96 x 96 DPI)

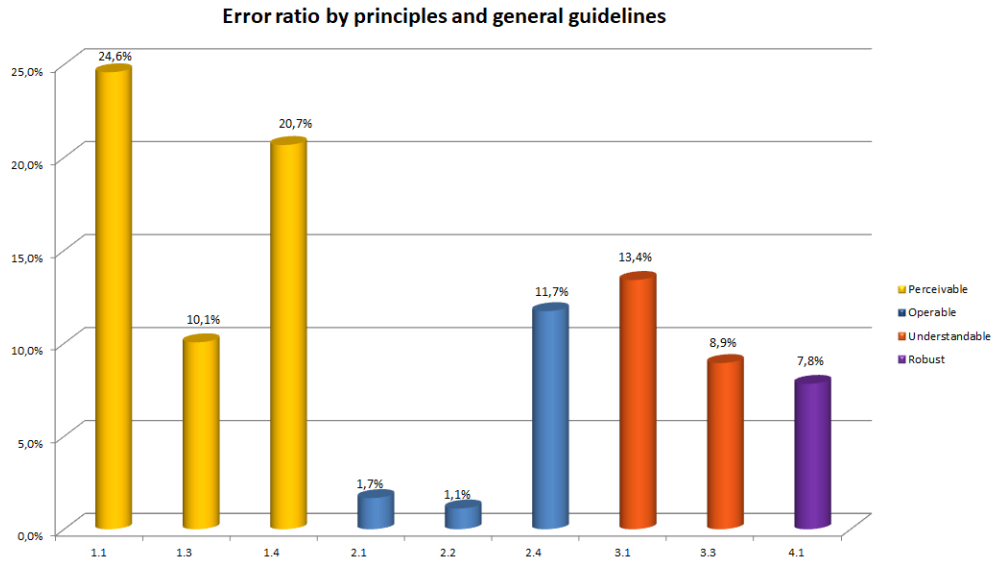


Figure 13: Classification by principles (1, 2, 3 and 4) and sections of errors according to WCAG

275x156mm (96 x 96 DPI)

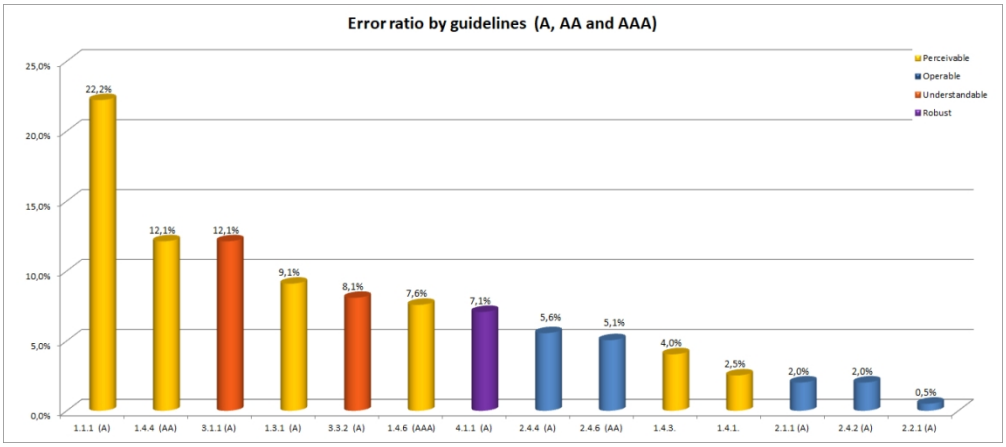


Figure 14: Classification by error criteria according to the WCAG

353x154mm (96 x 96 DPI)

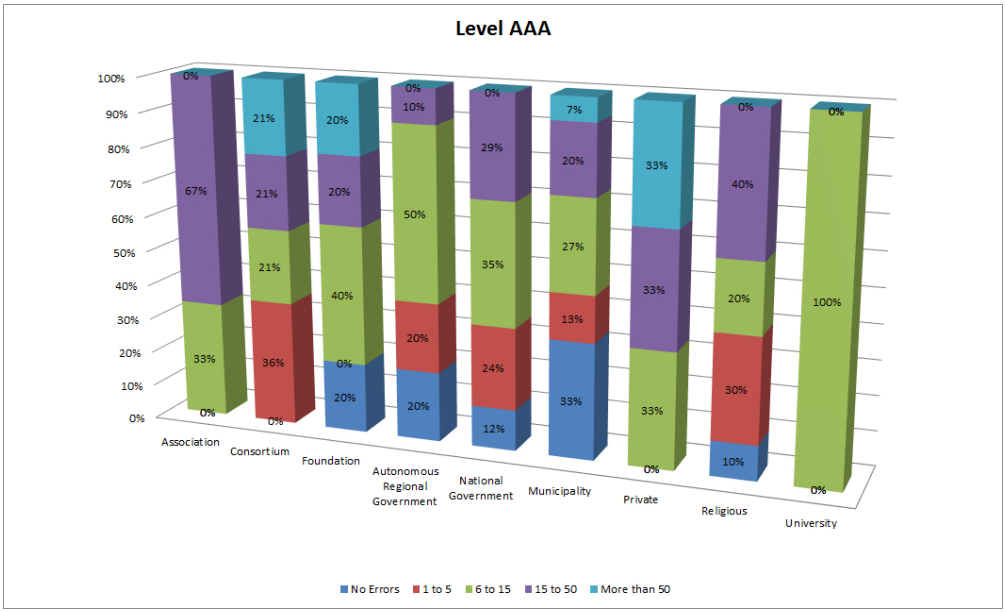


Figure 15: Relationship between type of institution and number of accessibility errors identified by AChecker (AAA level)

280x169mm (96 x 96 DPI)

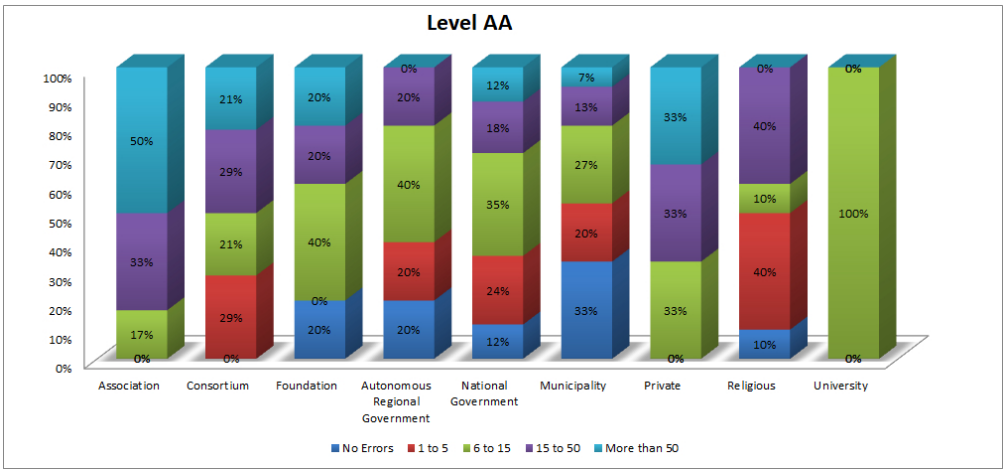


Figure 16: Relationship between type of institution and number of accessibility errors identified by AChecker (AA level)

266x123mm (96 x 96 DPI)

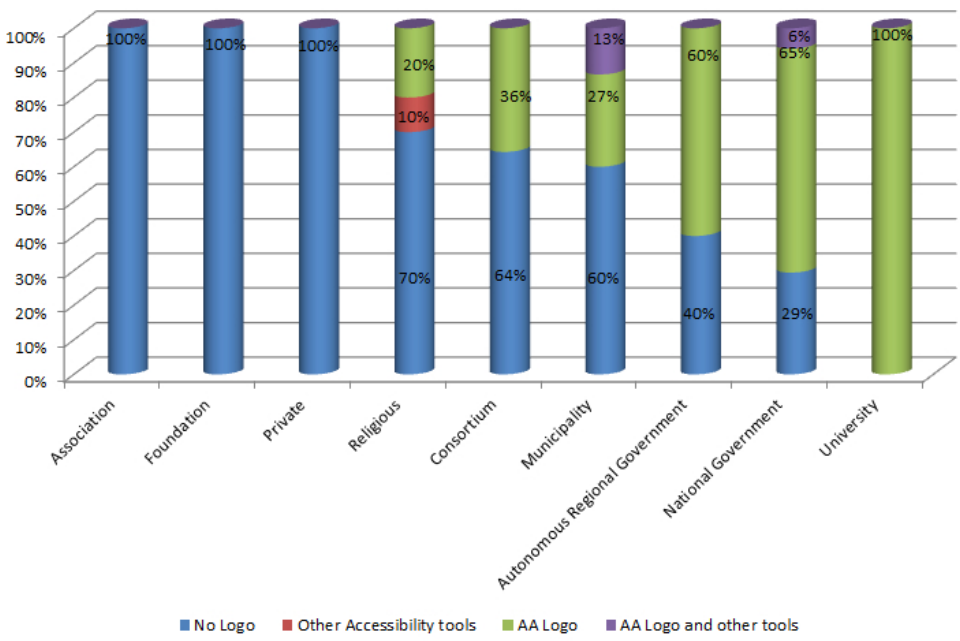


Figure 17: Accessibility by institution

193x125mm (96 x 96 DPI)

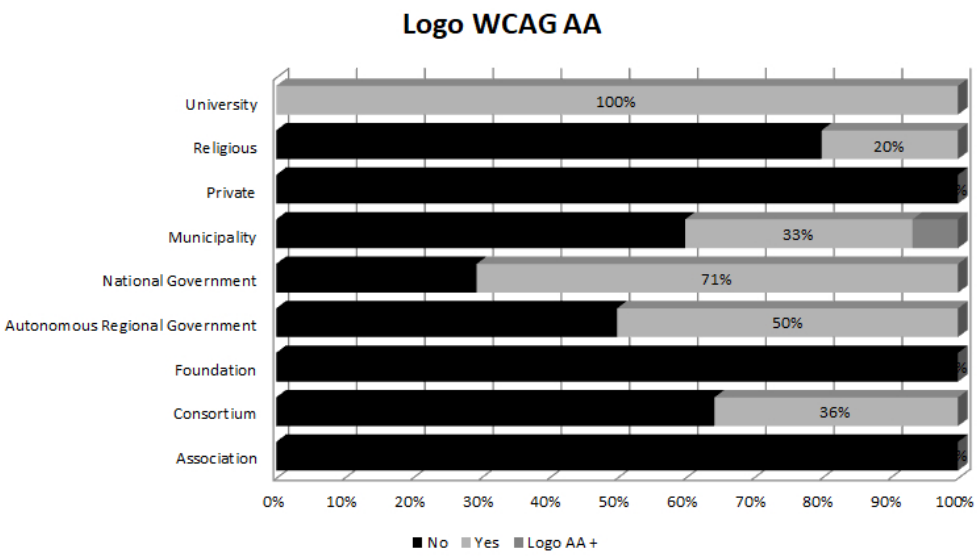


Figure 18: Relationship between type of institution and inclusion of WCAG AA logo.

201x112mm (96 x 96 DPI)