Digital Accessibility in Art Museum Webpages and Virtual Tours

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Abstract. This article delves into the crucial and significant issue of digital accessibility on the websites of some of the world's most visited and renowned art museums and their virtual tour counterparts. The central objective and our guiding question are to explore the impact of digital adaptation, facilitated by technological innovation, on the infoaccessibility of virtual visit web pages. We aim to determine whether these digital adaptations outperform the pages that inform and publicize the respective museums for those who plan to visit in person.

Our quantitative and qualitative analysis of the digital accessibility of the museums under study was conducted to ascertain if the web content adheres to the accessibility requirements outlined in the Web Content Accessibility Guidelines 2.0 (WCAG 2.0) of the World Wide Web Consortium (W3C), as stipulated in Directive (EU) 2016/2102 of the European Parliament and in the European Standard EN 17161:2019. The final analysis revealed some shortcomings, as several pages do not fully comply with the principles of virtual accessibility. Notably, we found that virtual visit pages of museums generally underperform compared to information pages for in-person visits, although there are exceptions to this trend. These findings have the potential to significantly impact the digital accessibility of art museum websites and virtual tours.

Keywords: Technological Digital Accessibility, Art Museum websites, Virtual Tours.

1   Introduction and Contextualization

According to ICOM (International Council of Museums), the definition of a museum is a global reference, periodically updated to reflect contemporary practices and perceptions in the museum field. The new definition of Museum, presented on August

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24, 2022, at the Extraordinary General Assembly of ICOM in Prague, is of significant importance. *A museum is a permanent, non-profit institution, at the service of society, which researches, collects, preserves, interprets, and exhibits tangible and intangible heritage. Museums that are open to the public, accessible, and inclusive foster diversity and sustainability. Museums function and communicate ethically and professionally and, with the participation of communities, provide diverse experiences for education, enjoyment, reflection, and knowledge sharing.* This definition highlights several essential aspects of museums: the fact that they are non-profit, serving the public and not commercial interests; be permanent and open to the public; provide a service to society and have as fundamental functions the acquisition, conservation, research, communication, and exhibition of cultural heritage.

This definition, therefore, reflects a modern and inclusive view of museums, addressing both traditional and emerging aspects, such as the importance of intangible heritage and the social responsibility of museums. Digital accessibility on museum websites is crucial to ensure that everyone, regardless of their abilities, can access and enjoy the content and resources available online, thus being inclusive [7, 9,10]. They must have an updated and presented service offer so that the various audiences easily perceive it. To do this, it is crucial to understand how users will access the website and what they want when they access it [6].

Virtual tours and virtual museums allow museums a unique opportunity for individuals to explore cultural institutions and exhibitions from the comfort of their own homes [11]. They provide an inclusive experience for a wider audience, accessible to people who cannot visit in person due to physical disabilities, geographical location, economic restrictions, and museum hours. This flexibility allows people to engage with cultural heritage anytime and anywhere.

Many virtual tours offer interactive features such as 360-degree views, zoom capabilities, and multimedia content. Users can immerse themselves in the exhibits and get up close and personal with the artworks or artifacts. They foster technological innovation through virtual reality (VR), augmented reality (AR), and interactive multimedia to improve the user experience [12]. These technological advances continue to push the boundaries of how we interact with cultural heritage online.

They are also educational tools for students, teachers, and lifelong learners, as they offer opportunities for guided exploration, learning about historical events, artistic movements, scientific discoveries, and cultural traditions, among others, and promote intercultural understanding and appreciation. The preservation of cultural heritage through the digitization of museum collections and their online accessibility helps to protect artifacts and works of art for future generations [13].

Virtual museum tours can also facilitate community engagement and outreach initiatives. Museums can host virtual events, workshops, and tours to connect with the public and promote cultural exchange.

Virtual museum tours are valuable in democratizing cultural access, promoting lifelong learning, and fostering appreciation for the diversity of creativity and human knowledge.

The new visitor profiles continue to understand museum spaces as repositories of memories, revealing perennial community identities [1, 2]. Undeniably, "museums

can generate important economic benefits in areas such as employment, tourism, investment, and urban rehabilitation, and should therefore be considered by public authorities as catalysts for local economic development" [5].

As society becomes increasingly dependent on technologies, particularly in the recent pandemic, it stimulates a more efficient and agile relationship, incorporating new contemporary forms of communication that stimulate greater knowledge-sharing about museum spaces.

The main objective of this article is to investigate whether the digital adaptation, resulting from the technological innovation implemented, allows better performance in terms of info accessibility/virtual accessibility on the virtual visit web pages or on those that inform and publicize the respective museums for those who intend to visit in person. To do so, we compared the problem of digital accessibility on the websites of some of the most visited and renowned museums in the world with the websites of the virtual tours of the same museums.

We also intend to understand how the Web content of the museums under analysis meets the accessibility requirements contained in the Web Content Accessibility Guidelines 2.0 of the World Wide Web Consortium (W3C) as enshrined in Directive (EU) 2016/2102 of the European Parliament and in the European Standard EN 17161:2019 [3, 4].

This article is organized as follows: in addition to the introduction and conceptual contextualization of the issues addressed, the second section presents the methodology used and explains the data collection, the third section presents the results, and the discussion and conclusion with future perspectives.

2   Method and Data Collection: case study

The methodology followed in this research was based on data provided by ICOM, according to the Statista database [8], regarding the most visited art museums in the world, of which we selected the top ten. The virtual visit web pages and those that inform and publicize the respective museums for those who intend to visit in person were analysed, so the sample is related to twenty web pages.

The sample of the ten selected museums, in order of the most visited, includes Louvre (Paris), Vatican Museums (Vatican City), British Museum (London), Metropolitan Museum of Art (New York), Tate Modern (London), National Museum of Korea (Seoul), Musée d´Órsay (Paris), National Gallery of Art (Washington, D.C.), Museo Nacional del Prado (Madrid) e State Hermitage Museum (Saint Peterburg). We carry out a quantitative and qualitative analysis of these twenty museums' websites, always from the user's point of view.

We have prepared observation grids to comply with virtual accessibility requirements. After collecting the URLs, we conducted quantitative and qualitative analyses of the information disclosed on the respective websites.

Regarding the quantitative analysis, the degree of compliance with the recommendations of WCAG 2.0, currently implemented by the acessibilidade.gov.pt Ecosystem Project [3], was verified. We use the AccessMonitor Plus automatic validator, version

2.1. This software is an automatic Web Accessibility Practices Validator (WCAG 2.1) that verifies the application of accessibility guidelines in HTML content on a scale of 1.0 to 10.0. The three types of results are stratified by three priority levels: 'A' (basic web accessibility features), 'AA' (deals with the most significant and most common barriers for disabled users), and 'AAA' (the highest and most complex level of web accessibility). The accessibility categories are divided into Acceptable (fully meets the accessibility criteria), To view manually (requires some manual intervention or checking to ensure accessibility), and Non-Acceptable (does not meet the accessibility criteria).

3   Case Study – Results and Discussion

To guarantee digital accessibility, specific requirements must be met. From the user's point of view, there must be a descriptive alternative text for all images on the website. In this way, it is possible to adapt to the needs of each user, such as printing in enlarged characters, braille, the possibility of reading aloud, symbols, and more straightforward language. All content must be adaptable, discernible, and accessible via the keyboard. It is also essential to have a help option, and the multimedia elements must provide correctly identified content and texts, with subtitles or audio description [4].

HTML semantic markup should be used to structure the web page in a logical and meaningful way, which helps users interpret the content correctly. All interactive elements of the website, such as links, buttons, and forms, must be accessible by keyboard so that users can navigate and interact with the website using only the keyboard. The colour contrast between the text and the background colours should ensure readability for users with low vision or colour blindness. Fonts should be clear and have adequate font size to improve readability, especially for those who are visually impaired. Also, videos must have subtitles and transcripts to make the content accessible to users who are deaf or hard of hearing. They should be paused and controlled using keyboard commands. By incorporating these accessible practices into the design and development of museum websites, it is possible to create inclusive online experiences involving all visitors.

Given the diversity of the websites analysed, we can't carry out a qualitative detailed study within the scope of this type of publication. Thus, we privilege the qualitative analysis related to the elements that we list below and whose results we present in Table 1, existence of reference or explanation of accessibility; search functionality, partnership with Google Arts & Culture for the absence of a virtual tour of museums and, finally, a 360º virtual tour. All websites have pages in English, which were selected for the study.

Table 1 – Characterization of some elements of the websites analysed.

Museum	Website	Index AcessMonitor	Acessibility reference	Search functionality	Google Arts & Culture	360° virtual visits
Louvre Museum	https://www.louvre.fr/	9.7	X	X	X	
LV Online tours	https://www.louvre.fr/en/online-tours	9.7		X		X
Vatican Museums	https://thevaticanmuseums.com/	7.9	X		X	
VM Virtual	https://www.museivaticani.va/content/museivaticani/en/collezioni/musei/tour-virtuali-elenco.html	7.5	X	X		X
British Museum	https://www.britishmuseum.org/	8.8	X	X	X	
BM Virtual visits	https://www.britishmuseum.org/learn/schools/samsung-digital-discovery-centre/virtual-visits	8.9	X	X		X
Metropolitan Museum of Art	https://www.metmuseum.org/pt	8.2	X	X	X	
MET Virtual	https://artsandculture.google.com/partner/the-metropolitan-museum-of-art	8.4				
Tate Modern	https://www.tate.org.uk/	7.6	X	X	X	
TM Virtual	https://www.tate.org.uk/about-us/collection	7.9	X	X		
National Museum of Korea	https://www.museum.go.kr/	7.5			X	
NMK Online Exhibition	https://www.museum.go.kr/site/eng/exhiOnline/list	6.9				
Musée d´Órsay	https://www.musee-orsay.fr/	9.0	X	X	X	
MO Virtual	https://artsandculture.google.com/partner/musee-dorsay-paris?hl=fr	8.3				X
The National Gallery	https://www.nationalgallery.org.uk/	8.7	X	X		
NG Virtual tours	https://www.nationalgallery.org.uk/visiting/virtual-tours	9.3	X	X		X
Museo Nacional del Prado	https://www.museodelprado.es/	9.7	X	X	X	
MNP Virtual tour	https://www.museodelprado.es/actualidad/multimedia/presentamos-la-visita-virtual-a-la-coleccion-del/2053acbd-7dd4-43c3-bda6-012b87103866?searchMeta=visita%20virtual	8.9	X	X		X
The State Hermitage Museum	https://www.hermitagemuseum.org/	7.1		X	X	X
SHM Virtual tour	https://hermitagemuseum.org/wps/portal/hermitage/panorama	7.1		X		X

The tests carried out on the museum pages, the first user interface, in AccessMonitor Plus were compiled between the 3rd and 15th of May 2024. This is important as websites are constantly being updated, so the validity of the analysis is short-lived.

Virtual tours of some museums are often the extension of the leading websites. However, the results of the web accessibility practice reports are always different, except for the Louvre Museum. These results are not linear because, in some cases, they are inferior and, in others, superior. Being extensions of the former, they maintain the functionalities of search and accessibility. The only museums with a 360º visit on the website are those of the Louvre Museum and the State Hermitage Museum. In the virtual tours of Google's *Arts and Culture* platform, the pieces are presented statically, in the format of an image gallery of pieces or in a dynamic way, interactive view, embedded videos, or redirected to YouTube and, in some cases, 360º visits. 360º visits on *Google Arts and Culture* are available at the museums: British Museum, Metropolitan Museum of Art, Tate Modern, National Museum of Korea, Musée d'Órsay and The State Hermitage Museum.

Regarding the State Hermitage Museum and SHM Virtual tour, we did not find information on accessibility. However, on the website itself, it is possible to adjust the way of viewing: background, font size and type, letter spacing, and show/hide images. This museum also presents other options for virtual spaces, with 360º visits, but whose performance in terms of the accessibility index is similar to those presented or even lower, such as the one dedicated to the jubilee of Queen Elizabeth II and commemorating her 70 years of reign (https://jubilee.moyosaspaces.com/) with 7.8.

The compliance of the websites analysed with the various levels, although variable (Table 1; Fig. 1), presents high and medium values, with none reaching the desired value of 10. The results reveal that these websites do not fully comply with the guidelines of European legislation, made public on March 21, 2019, and enshrined in the European Accessibility Law and the *Design for All Standard*.
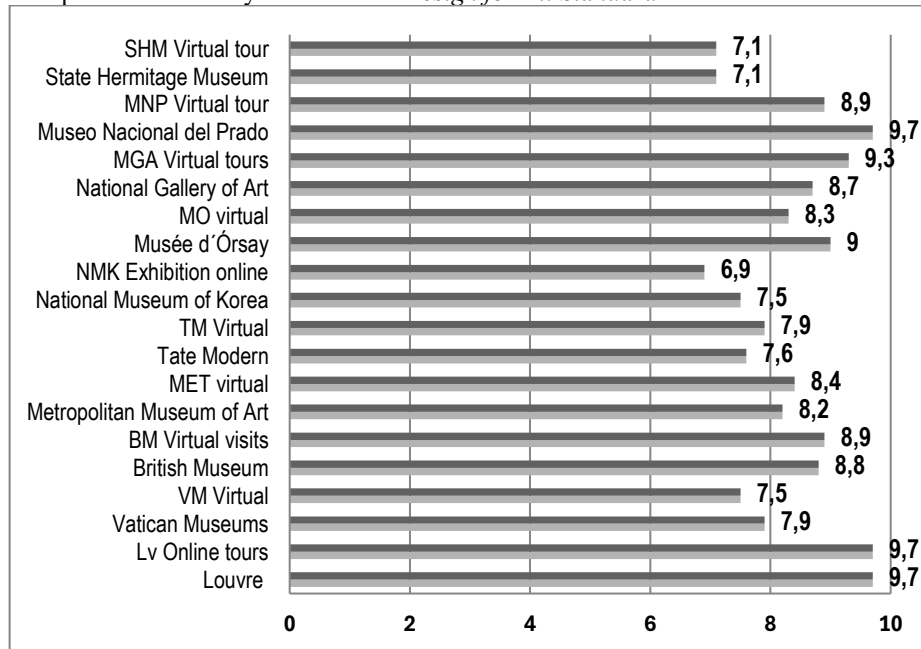

Fig. 1 – AcessMonitor Plus indexes for the websites analysed.

Since this was not one of the main objectives of the preparation of this article, the data for the quantitative analysis resulting from the study of the websites using AccessMonitor Plus version 2.1, only the quantifiable results of level A, AA, and AAA errors were chosen for the analysis (Fig. 2).
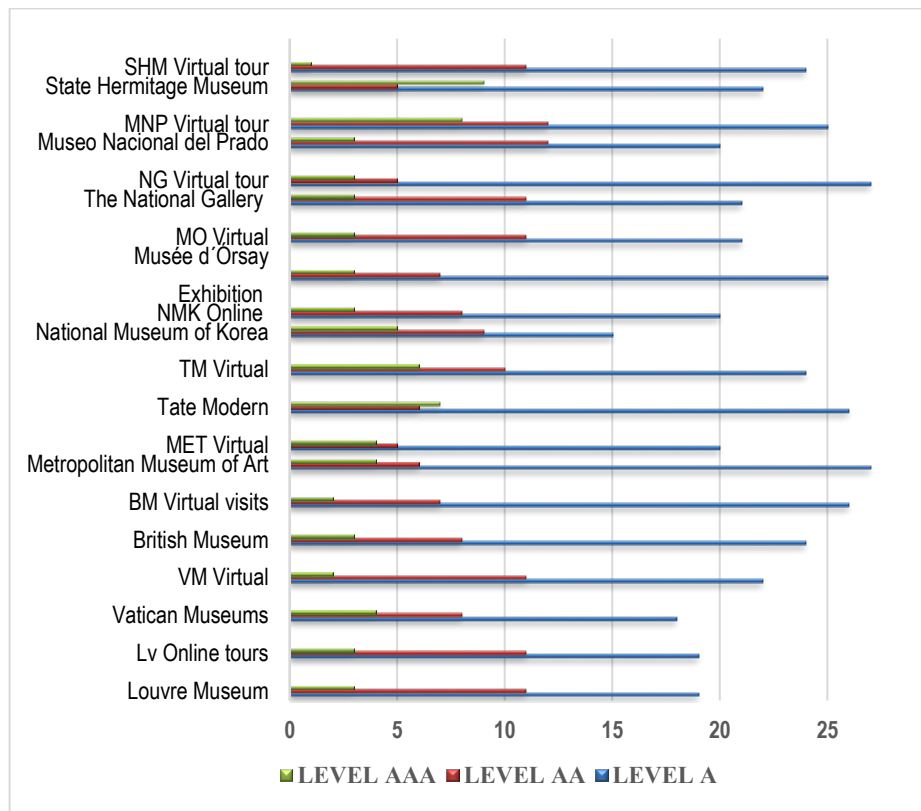
Figure 2 – Total level test errors "A", "AA" and "AAA".

The websites with the best degree of accessibility for face-to-face visitors are those of the Louvre Museum and the Museo Nacional del Prado, with 9.7. However, only the Louvre maintains the same performance on the virtual page, while the Prado significantly lowers the level of accessibility on the opening page of the virtual tour to 7.4. Some of the websites of the museums analysed are manifestly deficient, as we verified, with low values in terms of performance when analysing their virtual accessibility (Table 2).

Table 2. Index AcessMonitor "A", "AA", and "AAA" error level results.

Museum	Index AcessMonitor	LEVEL A				LEVEL AA				LEVEL AAA			
		Acceptable	*To view manually*	*Non-Acceptable*	**TOTAL**	*Acceptable*	*To view manually*	*Non-Acceptable*	**TOTAL**	*Acceptable*	*To view manually*	*Non-Acceptable*	**TOTAL**
Louvre Museum	**9.7**	15	4	0	**19**	10	0	1	**11**	0	3	0	**3**
Lv Online tours	**9.7**	15	4	0	**19**	10	0	0	**11**	0	3	0	**3**
Vatican Museums	**7.9**	13	3	2	**18**	7	0	1	**8**	0	3	1	**4**
VM Virtual	**7.5**	16	3	3	**22**	7	1	3	**11**	0	2	0	**2**
British Museum	**8.8**	17	7	0	**24**	5	1	2	**8**	1	2	0	**3**
BM Virtual visits	**8.9**	17	9	0	**26**	4	1	2	**7**	2	0	0	**2**
Metropolitan Museum of Art	**8.2**	18	9	0	**27**	3	0	3	**6**	3	1	1	**4**
MET Virtual	**8.4**	14	6	0	**20**	2	0	3	**5**	2	1	1	**4**
Tate Modern	**7.6**	16	8	2	**26**	4	0	2	**6**	4	3	0	**7**
TM Virtual	**7.9**	17	4	3	**24**	8	0	2	**10**	2	3	1	**6**
National Museum of Korea	**7.5**	10	5	0	**15**	5	1	3	**9**	1	3	1	**5**
NMK Online Exhibition	**6.9**	12	4	4	**20**	6	1	1	**8**	0	3	0	**3**
Musée d´Órsay	**9.0**	15	10	0	**25**	4	0	3	**7**	2	1	0	**3**
MO Virtual	**8.3**	15	4	2	**21**	10	0	1	**11**	0	3	0	**3**
The National Gallery	**8.7**	15	4	2	**21**	11	0	0	**11**	1	1	1	**3**
NG Virtual tour	**9.3**	15	11	1	**27**	4	0	1	**5**	2	0	1	**3**
Museo Nacional del Prado	**9.7**	16	4	0	**20**	10	1	1	**12**	0	3	0	**3**
MNP Virtual tour	**7.4**	13	10	2	**25**	3	0	1	**12**	0	0	0	**8**
State Hermitage Museum	**7.1**	14	8	0	**22**	4	1	3	**5**	7	1	0	**9**
SHM Virtual tour	**7.1**	14	4	6	**24**	8	0	3	**11**	0	1	0	**1**

The quantifiable results of level A, AA, and AAA errors present very high values, especially in the results of level A errors, highlighting the acceptable errors, as seen in Table 2 and Figure 2. As the AcessMonitor Plus index is higher, the closer to the ideal value, the acceptable error values decrease. For other level AA or AAA errors, the values fluctuate considerably. In this quantitative analysis of errors by level, we found the existence of values ranging from 15 to 27 for level A, 5 and 12 for level AA, and

1 and 9 for level AAA, with the State Hermitage Museum having the worst performance, since the websites of both physical and virtual visits have several areas that require manual checks or are unacceptable.

Generally speaking, while most museums perform well at the basic level of accessibility (level A), the higher levels (AA and AAA) often require more manual checks and have unacceptable elements, indicating that there is room for improvement.

4   Final considerations

The computer analysis of the results of the websites allowed the obtaining of measurable data, capable of enhancing the qualitative analysis of twenty websites and suggesting improvement needs that the analysed sites need, from the perspective of any user and also those that present, permanently or temporarily, limitations of various kinds. Unfortunately, we found that the virtual visit pages of museums perform worse than the information pages for face-to-face visits, although there are cases where this is not the case, which would not be expected.

To implement accessibility improvement, we suggest adopting simple menus that can be navigated by the keyboard, organizing the content logically and consistently, and creating a website map to facilitate navigation, considering the main principles of interaction design and user experience. Regarding text content, we suggest adding detailed descriptions to all images, ensuring adequate contrast between the text and the background, and using fonts that are large and easy to read. For multimedia content, subtitles should be provided for all videos and transcripts for audio content, as well as sign language interpretation for videos and alternative descriptions for interactive features.

Other essential elements for improving websites are the need for all interactive elements to be used with a keyboard, form controls must have clear labels and instructions, and users must manually control movement within the virtual tour. These virtual tours must be compatible with screen readers. Of course, adapting to existing standards is essential, so the Web Content Accessibility Guidelines (WCAG) 2.1 should be followed, aiming at levels AA or AAA.

Implementing website improvements and updates should be continuous and carried out regularly concerning digital accessibility features based on feedback and new models. Accessibility audits of existing web pages and virtual tours should be carried out, as well as developing a plan to solve problems. In this sense, users should be involved in the testing and feedback, emphasising people with disabilities. Museum staff should be trained on accessibility best practices and made aware of the importance of digital accessibility.

The poor digital accessibility in art museums and their virtual tours excludes a significant part of the public. Improving accessibility is essential not only to comply with legal requirements but also to ensure that everyone, regardless of their abilities, can enjoy and appreciate art. By implementing improvements, and in this case, in access to virtual museums, they can offer a more inclusive and enriching experience for all visitors.

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