Revista Turismo & Desenvolvimento | n.º 49 | 2025 |[302-322]

DOI 10.34624/rtd.v48i1.36640

e-ISSN 2182-1453

Digital communication of **museums** in **Porto** and **Northern Portugal**

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Abstract | In recent years, museums have seen an increase in the number of assistive technologies they use to engage visitors. Information and Communication Technologies (ICT) offer new opportunities in the museum environment, whether indoors or outdoors, by adopting interactive cultural experiences that are accessible to all visitors. In this sense, the main aim of this research was to identify and analyse the digital tools and communication techniques used by museums, both on the web and on-site, which promote Digital Communication. In the first phase, to analyse the museums' websites, a matrix of variables was created to define Digital communication based on the digital tools and communication techniques identified in the literature review. The analysis resulted in a matrix that defines Digital communication in three dimensions: visibility, usability, and interactivity. For each of these dimensions, variables were identified that could be observed and tested to be considered active on museum websites. In the second phase, an online questionnaire was applied to all the museums in the sample to gather additional information. The results obtained from the analysis of the websites are lower than expected, as none of the websites identified all the variables mentioned. Analysis of the questionnaires shows a more significant concern for the diversity of visitors due to the combination of multi-format communication techniques with digital tools.

Keywords | museum, communication, digital tools

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1. Introduction

Cultural heritage is regarded as a tourism product with significant potential, and museums have been among the most socially valued cultural institutions since the late 1980s, attracting an increasing number of visitors. These institutions offer experiential and social environments from which visitors can benefit (Fernandez-Lores et al., 2022). In recent decades, museums have undergone radical transformations since their mission was mainly focused on traditional activities such as preservation, interpretation, and knowledge of their collections. The transformation in the world of cultural heritage has meant that museums are no longer seen as the protectors of collections but have progressively become centres of education, information, and entertainment, with the expectation of offering different types of experiences to a diverse public. Contemporary museums increasingly rely on different types of Information and Communication Technologies (ICT) to transmit their stories and interact with visitors (Bertacchini et al., 2018).

According to Fernandez-Lores et al. (2022), the Internet has created a wide range of communication tools that facilitate interaction and promote the development of relationships between institutions and their audiences through interactive and collaborative platforms. The digital world has become an integral part of people's lives, particularly for young people (digital natives), who use new technologies and applications to access information on a daily basis. Thus, for museums, the digital world is justified by the opportunity to keep up with these phenomena, win over younger audiences, and remain competitive since digital and audiovisual enable more flexible and creative experiences that are necessary to satisfy the needs of new visitors and keep museums attractive (Carvalho et al., 2018). Digital communication seeks to enhance awareness and the attractiveness of museums, with the aim of increasing both physical and virtual visitor traffic. The emergence of new forms of interaction between museums and their users/visitors has prompted these institutions to reassess how they communicate and present information within their spaces (Pinto et al., 2019).

Over time, the concept of accessibility has evolved. It was once primarily associated with physical structures—namely, buildings adapted for individuals with reduced mobility. Today, however, accessibility is understood in a much broader sense, encompassing cognitive and sensory dimensions as well. Regardless of where people live or their economic circumstances, access to culture must be ensured through digital tools and platforms that make information

available to all, without discrimination (Cruz Franco et al., 2022). Increasingly, the services of cultural organisations are adapted to people who need some differentiation as website users due to their functional diversity. This concern has seen an increase in visitors to museum websites (Walsh et al., 2020). This research aims to identify and examine the digital tools used by museums in the Porto and North Region that are part of the Portuguese Museum Network (PMN). It explores how these institutions communicate and utilise digital resources to engage with their visitors, both online and in physical settings. The study also discusses the theoretical foundations of digital communication in museums and includes chapters dedicated to methodology, results, and conclusions.

2. Theoretical framework

The Internet has become a central medium of information in modern society, connecting millions of people across the globe and profoundly influencing daily life. As Sarmento et al. (2022, p. 119) observe, "the Internet is perhaps the greatest social shock humanity has ever experienced, considering the dynamics and evolution it has caused in all activities." The digital revolution has significantly enhanced almost every area of activity, including communication, transport, distribution, healthcare, finance, education, and business. The cultural sector must also follow this trend to ensure that citizens benefit from improved accessibility and greater cultural inclusion (Fanea-Ivanovici & Pana, 2020).

Museums are tourist attractions that offer visitors the opportunity to engage with the past. Increasingly, they are adopting digital technologies to enhance all aspects of their operations and visitor experience (Navarrete, 2019). The role of museums has changed from being solely concerned with protecting cultural heritage to reaching a wider audience, proposing new procedures for promoting and exhibiting their collections, and cooperating with collective cultural and social development (Solima et al., 2021). ICT has great potential to help achieve this goal, offering new communication channels to raise awareness among the general public about the importance of cultural heritage (Balducci et al., 2020) and making visiting the museum an increasingly pleasant and memorable experience (Sofia, 2019). The general public is increasingly more aware that cultural heritage must be preserved, promoted, and valued (Balducci et al., 2020).

Communication tools and the use of technology promote the development of innovations in tourist areas, manifesting themselves in various ways in the field of innovation, whether at the

level of process, product, marketing, or organisation (Mourão, 2021); they can, in fact, be considered the basis for structuring tourist flows, as they act as disseminators of information and knowledge about heritage, be it cultural, artistic or architectural (Parrinello & Dell'amico, 2019). Innovation should be perceived as implementing a process, a new organisational method that renews relationships and collaborations between institutions, with particular attention to those dedicated to research and experimentation with new technologies applied to cultural heritage (Sofia, 2019). By 2007, emphasis had shifted to personalised access, human-robot interaction, and the integration of education and entertainment. More recently, from 2017 onwards, the focus has expanded to include tourism and leisure applications, augmented reality, holographic technology, and mobile technologies.

ICT and digitisation influence the purpose and mission of museums in all their activities and practices, from the conservation to the enhancement and exhibition of cultural heritage. Their role has been reshaped in how they produce and distribute culture (Guccio et al., 2022), enabling more effective engagement with society, including vulnerable groups and individuals with special needs. ICTs are not just tools in the hands of today's artists but represent both a new language and a novel channel for dissemination. In this sense, cultural institutions, museums, and exhibition spaces have had to adapt to digitisation. Almost all museums have a website allowing access to their collections. The virtual museum concept emerges here, a space created to mediate between people and cultural and heritage content via the web. Therefore, an out-of-doors museum must engage with its virtual visitors, providing them with a dynamic and enriching experience that complements the actual visit and does not compete with it. It works as a promotional strategy: the more people who visit the museum's website, the greater the incentive to visit for real (Dos-Santos-Abad et al., 2023). Museums can use ICT in multiple ways: for administrative purposes and/or different functions in museums, on-site and online. The on-site services during the visit aim to enhance the cultural experience through applications for smartphones and tablets, multimedia devices, QR Codes, and PC/tablet devices. There is a website with a wide range of services - ticketing, general and collections information, databases, exhibitions, reconstructions, interactive kiosks, social networks, and a store. According to Guccio et al. (2022), it can be said that providing these services on-site improves the quality of the experience and attracts more new visitors, boosting the museum's efficiency. As far as online services are concerned, what is expected in terms of efficiency is twofold: on the one hand, to encourage physical visits, and on the other, to replace them.

Accessibility is the ease of access to the product/service in the interaction environment, regardless of individual capabilities. According to Pinto et al. (2019), accessibility is an ethical norm and a set of design rules that allow the most expansive use of any resource and make it available to the most significant number of people. Digital accessibility involves integrating tools that provide efficient access according to users' needs (Fernandes & Justo, 2022). Providing accessible products, services, and environments generates competitive advantages and enhances user and visitor satisfaction, consequently leading to loyalty (Domínguez Vila et al., 2018). Products and services with accessible designs are those that can be used by individuals with and without functional diversity, a concept referred to by the authors as universal design (Domínguez Vila et al., 2018; Lee et al., 2023). Accessibility involves ensuring access to information and services while minimising barriers related to distance and usability within the interaction environment.

A website is essential for any institution, especially museums, where visitors' curiosity can be aroused (Agostino & Costantini, 2022). The implementation of websites is the most common ICT tool used by museums, serving functions that range from practical tasks to the creation of cultural experiences (Guccio et al., 2022). The visualisation of the website is a factor in the decision to visit the physical space, as it reflects your digital communication strategy. The website is the visitor's first port of call, where they can obtain information, communicate with the museum, and purchase products/services, among other services. Increasing interest in the site and motivating physical visits indicate that the museum communicates well online (Nobre & Morais, 2021). "Accessibility and usability are two qualities that interact with each other" (Aizpurua et al., 2016, p.14). The usability perceived by users - a website with usability is related to practical, straightforward, clear, simple, and predictable aspects. In contrast, the perception of a website without usability is related to aspects such as impractical, undisciplined, cumbersome, confusing, complicated, and unpredictable. Websites that combine usability and accessibility are generally perceived as original, innovative, and engaging, whereas those without these qualities tend to be viewed as traditional, conservative, and incomplete (Aizpurua et al., 2016). Usability ensures that website use is attractive, practical, simple, and effective. Navigation is intended to be effective, efficient, and satisfying for the user. Usability guidelines aim to reduce errors during navigation and increase ease of use, benefiting the user and the website's objectives (Alonso-Virgós et al., 2018; Bonjisse & Morais, 2017). Usability is an important element of the user experience as it includes elements such as simplicity, objectivity, efficiency, informative quality, flexibility, ease of

learning, and user support (Bonjisse & Morais, 2017; Lee et al., 2023) because the first contact a visitor has with a museum is probably through its website (Garcia et al., 2017). The communication of a website or web page depends on its Usability, Interactivity and therefore its Visibility in the web environment (Table 1).

Table 1. Digital Communication Elements

Visibility	**Usability**	**Interactivity**
Social Networks Blogging Vlogs Influencers Newsletters Online Shop Merchandising Ticket Office	Simple Language or Writing Pictorial Writing Writing in Enlarged Formats Colour Inversion on Screen Sign Language Interlanguage Translation Subtitling Audio description	Remote Guide Tour (Videoconference) Automation and Robotics (Robot driven remotely by wifi) Virtual Tour (Sequence of photographs) Museum Educator (Selection of visit according to profile) Digital collection (Photos; Videos) Virtual Videos (Three-dimensional; 360º; Building modeling; Digital Twins) Avatars Holograms Interactive Games Mobile Applications

Source: Authors' summary and analysis

The variety and volume of goods consumed online have grown exponentially, promoting the development of high-quality and diverse content. Online consumption is driven by various motivations, foremost among them accessibility, as well as academic or educational research, commercial purposes, commemorative interests, and entertainment. In the case of museums, the most significant web traffic is associated with planning a visit to the physical space of the museum and/or cultural institution (Navarrete & Borowiecki, 2019; Walsh et al., 2020). On the other hand, museums are looking at these visitor-friendly channels, such as social networks, websites, or the use of mobile apps, to build loyalty and expand and/or attract new audiences (Hijazi & Baharin, 2022; Navarrete & Borowiecki, 2019). In this concept, the museum is centered on the visitor, and the contemporary trend will make museum collections widely accessible via the Internet (Hijazi & Baharin, 2022).

In recent years, some phenomena have led to the emergence of other paradigms that have changed what was highly regulated in museums. To understand it, we must look at society, technology, and the cultural changes digitalisation brings. The digital implosion to which culture and society have been subjected occurred with the emergence of social networks and personal devices such as cell phones, allowing anyone to be a broadcaster of information on the web. They generate new content, giving it their stamp and circulating it, generally to their contact communities and through massive platforms available to everyone connected. This creates a new figure of producer and consumer, referred to by the author as a prosumer (Amézaga, 2021). According to Parrinello and Dell'amico (2019), we are populated by thirsty, tech-savvy visitors who have driven a paradigm shift. The on-site exhibition is not enough to satisfy visitors' requests and expectations, as they want to be involved in the museum's activities and feel part of its history, heritage, and development. The visitor experience ranges from the accessibility of content to the value of the learning experience to social interactions with other visitors (Mason, 2013).

The way today's tourists consume information is constantly changing. Many users consult the Internet due to its innovative features associated with product promotion: video, sound, image, and text, which promote the dissemination of messages efficiently and instantaneously. From the perspective of Sarmento et al. (2022), easy access to information and numerous sales options have stimulated purchases and the desire to try out more tourist products and services available on the Internet, providing opportunities for emerging companies in the digital world, equipping them with innovative ideas, concepts, techniques, and tools that provide virtual experiences and consequently boost consumption according to their needs and tastes. The public becomes the central focus of the museum's activities, with exhibitions organised according to visitors' requests, preferences, and expectations (Sarmento et al., 2022). The availability of online collections and experiences has driven the emergence of this new visitor, the digital tourist/visitor. Online visitors can take museums outside their physical walls and explore new horizons in the digital information market. Their recognition can leverage additional innovations, strengthening the museum in the expanding online market (Navarrete, 2019).

Digital marketing strategies in the tourism sector have evolved significantly, not only in the hospitality sector but also in cultural institutions, such as museums, which face similar challenges in terms of attracting and retaining audiences. Recent studies have shown that the adoption of digital tools is perceived strategically by tourism managers, who value their

impact on the visitor experience and the visibility of organisations (Moura et al., 2023). On the other hand, from the consumer's perspective, there is a growing appreciation of digital tools in the preparation and experience of the tourist experience, highlighting the importance of online communication as a decision-making factor (Rosa et al., 2023). These contributions reinforce the relevance of analysing digital tools in museums as devices for communication and interaction with their audiences.

3. Methods

The present study employs a sequential mixed-methods approach, beginning with an analysis of museums' websites and web pages to identify the digital tools they use, followed by an online questionnaire featuring open-ended questions. The initial analysis of the websites and web pages was conducted first, reflecting the logical sequence of the study's objectives. This research aims to identify and analyse the digital tools used by museums in the Porto and North Region, as referenced in the Portuguese Museum Network (PMN), with the intention of promoting greater access. To meet the main objective, four specific objectives were formulated: i) identify and analyse relevant scientific literature on the use of ICT in museums; ii) identify and analyse relevant scientific literature on the subject of the digital visitor/consumer; iii) identify and analyse the websites of the museums of the Porto and North Region identified in the PMN; iv) analyse the digital tools used by the museums of the Porto and North Region identified in the PMN.

The museums belong to the Portuguese Museum Network (PMN), specifically within the Porto and North Region. The PMN comprises 165 museums across the mainland and islands, with 55 located in the study area, representing 33.3% of all museums listed in the network.

In the first phase, the museums were identified on the website of the Directorate-General for Heritage. When the analysis of the websites or web pages began, four museums were excluded due to inaccessibility, bringing the total sample to 51. To analyse the websites or web pages, a matrix of variables was drawn up to define "Digital Communication" according to the digital tools and communication techniques identified in the literature (Table 1). Data was collected by directly inspecting the museums' websites or the pages associated with each museum, and the authors carried out the evaluation, considering the variables in table 1, allowing for the identification of the presence or absence of specific elements within each component: visibility, usability, and interactivity.

In the next phase, an online questionnaire survey was carried out to obtain additional information, accompanied by an email addressed to the museum's director or the person responsible for communication. The questions asked sought to analyse: i) how museums communicate with their visitors in a web environment; ii) what channels they use to reach visitors; iii) what kind of information they disseminate; iv) who is responsible for the museum's communication; and v) what digital tools they use to make visiting the museum easier. Before sending out the questionnaire, all the museums in the sample were contacted by telephone to direct the email to the most appropriate contact to answer the questionnaire. For this analysis, 22 valid responses were obtained.

4. Results

4.1. Website Analysis

The website analysis was carried out using observation and experimentation techniques to validate the presence of the variables on the website. Table 2 quantifies the number of museums with their own websites and those featured as a web page within the websites of other organisations.

Table 2. Museums with a website or web page

Museums	Frequency	%
Website	31	60,8%
Web page	20	39,2%
Total Museums	51	100%

Source: Authors' Elaboration

Approximately 61% of the museums have their own website, while the remaining ones are represented by a web page integrated into another organisation's website. In many cases, information about museums appears on the website of the foundation or town hall to which they belong. The websites or web pages were analysed considering the dimensions of Digital Communication - Visibility, Usability, and Interactivity. In each of these dimensions, variables must be possible to observe/identify for them to be validated. Table 3 shows the results of the variables observed in the "Visibility" dimension.

Table 3. Results for the Visibility Dimension

Variables	Frequency	%
Vlog	0	0%
Influencers	0	0%
Blog	3	5,9%
Newsletter	17	33,3%
Merchandising	20	39,2%
Ticket office	21	41,2%
Online store	25	49,0%
Social networks	39	76,5%

Source: Authors' Elaboration

From the analysis, the first two variables are not at all representative. Of the 51 museums, 17 (33.3%) have a newsletter subscription; 88.2% of the websites have an online store and/or merchandising; sometimes, they are presented together. Only 21 museums (41.2%) were considered to have a ticket office because the websites only provide information but do not make it possible to buy tickets, and 39 museums (corresponding to 76.5%) have links to social networks. Of the eight possible variables corresponding to the "Visibility" dimension, 53% (n=27) of museums identify a maximum of two variables. The remaining museums (47%) identified up to five variables.

When analysing the variables related to the "Usability" dimension (Table 4), none of the websites include Pictorial Writing; Subtitling is present in 2.0% of cases; Sign Language in 7.8%; Colour Inversion on Screen in 15.7%; and both Writing in Augmented Formats and Audio Description are found in 21.6% of websites. Finally, Interlanguage Translation and Simple Language or Writing have the highest presence, at 49.0% and 51.0%, respectively.

Table 4. Results for the Usability dimension

Variables	Frequency	%
Pictorial Writing	0	0%
Subtitling	1	2.0%
Sign Language	4	7.8%
Colour Inversion on Screen	8	15.7%
Writing in Augmented Formats	11	21.6%
Audio description	11	21.6%
Interlanguage Translation	25	49.0%
Simple Language or Writing	26	51.0%

Source: Authors' Elaboration

Of the eight variables referenced for "Usability," 33.3% of museums (n=17) have not identified any variables, and 43.1% (n=22) have identified a maximum of two variables. In the remaining 23.5% (n=12), between three and six variables were identified.

The "Interactivity" dimension considered 12 analysis variables (Table 5). The figures presented show that the most common way the museum makes its space known to the virtual visitor on the website or web page are photographs and videos, with 70.6% and 33.3%, respectively. This is followed by 360º Video, with 17.6%, Mobile Applications, with 15.7%, and Interactive Games, with 13.7%.

Table 5. Results for the Interactivity Dimension

Variables	Frequency	Percentage
Holograms	0	0%
Robot Tour (remotely operated by Wi-Fi)	0	0%
Remote Guide Tour (videoconference)	1	2.0%
Museum Educator (selection of visit based on profile)	1	2.0%
Avatars	2	3.9%
3D; Modeling of buildings or parts; Digital twins	4	7.8%
Virtual Tour (sequence of photographs)	5	9.8%
Interactive Games	7	13.7%
Mobile Applications	8	15.7%
360º Video	9	17.6%
Videos (digital collection)	17	33.3%
Photographs (digital collection)	36	70.6%

Source: Authors' Elaboration

Of all the museums observed, 21.6% (n=11) of the websites and web pages did not identify any variables, 37.3% (n=19) identified one variable, and 17.6% (n=9) identified two variables. The group of museums in which between zero and two variables were identified represents 76.5% of the sample. In the remaining museums, which account for 23.6% (n = 12), between three and nine variables were identified.

From this analysis, it can be concluded that none of the 51 museums' websites or web pages identify all the variables mentioned in the three dimensions of Digital Communication (28

variables). Regarding the frequency in each of the Digital Communication dimensions, it can be concluded that museum websites have the highest frequency in the variables belonging to the Visibility dimension with 125 frequencies, followed by the Interactivity dimension with 90 frequencies, and finally, the Usability dimension with 86 frequencies. The Visibility dimension appears to have the highest number of total frequencies, possibly because it is the basis for the museum's information to be visible online. In the Usability dimension, it is evident that the variables with lower or zero frequencies are not implemented on the websites, likely due to a lack of specialised technical resources. As such, their development would require further investment. In contrast, the Interactivity dimension shows that the variables with the highest frequencies are likely those that require fewer technical resources and are less costly to implement.

4.2. Online Questionnaire

The questionnaires were designed to gather additional information on how museums communicate with their visitors in a web environment, what channels they use to reach visitors, what kind of information they disseminate, who is responsible for the museum's communication, and what digital tools they use to make visiting the museum easier. Of the 22 museums that collaborated, the most notable respondents were museum directors and senior museum technicians. In most cases, the position and training of the person responsible for communication show that museums have the aptitude and knowledge to adopt and/or evolve digital tools.

When asked if they had a communication plan, 45.5% of the museums answered yes, while the remaining 54.5% answered no. The answer to this question led to two additional questions: i) If yes, who organises and prepares the communication plan? ii) If no, how is the museum's communication carried out?

Regarding the teams that organise the communication plan (Table 6), there are teams within the museum and teams outside the museum, the latter being led by third parties (e.g., local councils) responsible for drawing up the communication plan. In both cases, the teams are made up of multidisciplinary people.

Table 6. Teams responsible for the museum's communication plan

Teams	**Frequency**
The Museum Team	1
The Communications Team	2
The Communication and Image Office	1
The Museologist with the Publications Office and the Marketing and Communications Department	1
The responsible for Communication with the Director and another museum technician	1
The Municipal Communication Office	1
The Marketing Department and the Museum Manager	1
The Municipality's Communications and Public Relations Office	1
The Communication and Image Division	1

Source: Authors' Elaboration

As for the museums that do not have a communication plan, it can be seen that communication is mainly based on a schedule of activities and events and is done "on the fly" on social networks or on the museum's website to reach the most significant number of actual and potential visitors. Table 7 shows the responses to the various forms of communication from museums that work without a communication plan.

Table 7. Other forms of communication used by museums

Other forms of communication	**Frequency**
There is no fixed plan; communication is carried out according to events (openings, conferences, concerts, etc.) or by providing information about the museum's collection.	1
The announcement is made by one of the museum's Technicians	1
We use social networks as a way of communicating with our visitors.	1
Through social networks and the official website.	1
Periodic meetings to define specific strategic plans (which are not formalised in written documents).	1
Regular communication of the Museum's activities and events via email, website, and social networks.	1
Periodic publications are made on social networks to make them more dynamic, particularly about the history, the buildings, and the works of art.	1
It follows a timetable for announcing activities as they are planned.	1

Source: Authors' Elaboration

Social networks and websites are the media most used by museums, both with and without a communication plan. However, a minority of museums referred to other means of communication, namely the digital newsletter, the mobile app, the municipal agenda, the cultural agenda, the printed agenda, posters, and the press.

The social networks most commonly used by museums are Facebook, Instagram, and YouTube. Regarding the frequency of posts, the responses were as follows: “Every week” (31.8%, corresponding to 7 museums); “Every day” and “Other frequency” (each 27.3%, or 6 museums). For those who selected “Other frequency,” the responses included: “Whenever there are events,” “More than three times a week,” “Several times a week,” and “Several days a week.” In terms of content, the most frequently posted items were events (95.5%; n = 21), followed by news and photos, both with the same proportion (90.9%; n = 20).

Since the website or webpage is the most commonly used communication channel by museums after social networks, questions were asked about how frequently the content is updated and the types of content published (Figure 1). Museums update their content monthly (n=11; 50%), quarterly (n=4; 18.2%), and more frequently, namely daily and weekly (n=4; 18.2%) and biannually (n=3; 13.6%). The highest percentage of content published on the museums' website is events, with 86.4%, followed by news/news items, 81.8%, and educational content, 72.7%. It should be noted that audiovisual content stands out with 45.5%, which may indicate that museums are paying attention to the evolution of communication and their audience's interest in different forms of interaction.

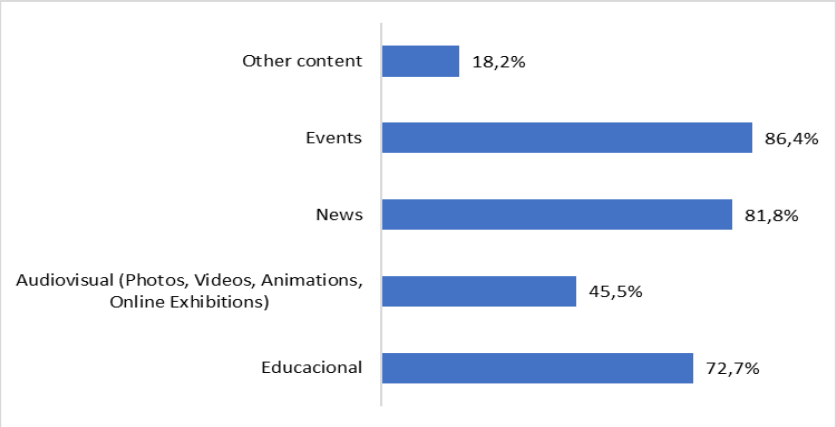

Figure 1. Type of content published on the website

Source: Authors’ Elaboration

To conclude the survey, the authors wanted to identify the digital tools that the museum uses to facilitate the on-site visit. Figure 2 shows the digital tools most used by museums.

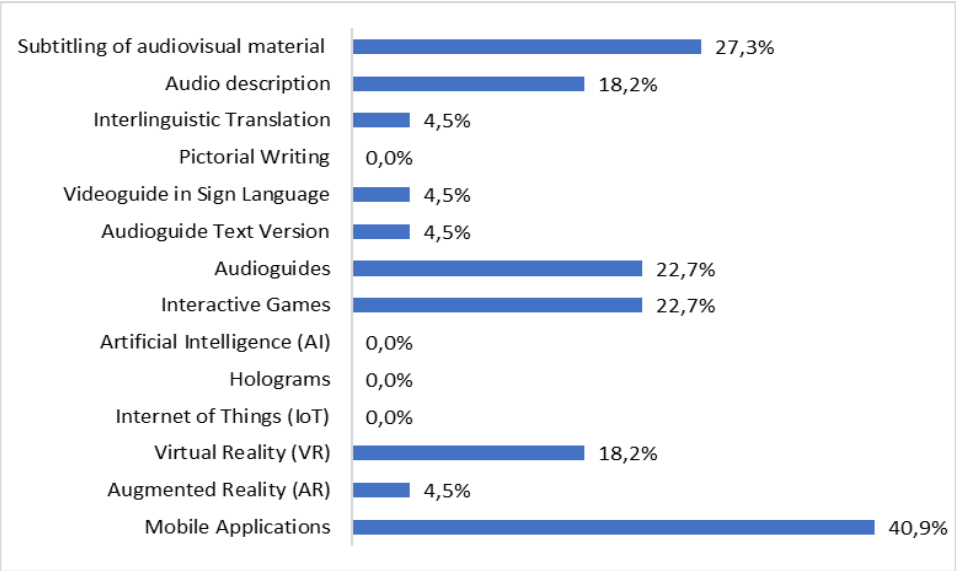

Figure 2. Digital tools used by museums

Source: Authors' Elaboration

Mobile Applications are the most used tool (40.9% - n=9), including QR Codes, the museum's APP, the Izi travel app, and the Actionbound app. This is followed by Audiovisual material (27.3% - n=6), Interactive Games, and Audio guides, with the same percentage (22.7% - n=5), Virtual Reality and Audio Description (images or text) with 18.2% each (n=4). The least mentioned digital tools are Augmented Reality, Text Version Audio guides, Sign Language video, and Interlingual Translation in Audio guides, with only 4.5% (n=1).

5. Conclusion

The literature review shows that museums in the Portuguese and international context provide and use tools to communicate and interact with their digital visitors effectively indoors and outdoors. These interactive techniques and new software and hardware technologies have piqued the interest of museums (Sánchez et al., 2018). ICT is not just a tool in the hands of today's artists but a new language and, at the same time, a new dissemination channel (Dos-Santos-Abad et al., 2023). This is the premise of Digital Communication, a new language with multiple formats that, combined with digital tools, allow the message/information to be

disseminated online and/or physically in the museum. An out-of-doors museum must be able to engage with its virtual visitors, providing them with a dynamic and enriching visit that complements the actual visit and does not compete with it. It works as a promotional strategy: the more people who visit the museum's website, the greater the incentive to visit for real (Dos-Santos-Abad et al., 2023). Some institutions may not keep up with this trend due to a lack of technical or monetary resources.

The general objective of the present research is to identify and analyse the digital tools used by museums in the Porto and North Region referenced in the Portuguese Museum Network (PMN) and to examine how these tools are used to communicate and interact with their visitors. In response to each of the study's specific objectives, the conclusions drawn from each of them are presented.

In response to the first specific objective, which was to identify and analyse the use of ICT by museums in the literature, it was possible to group two types of information that facilitate access to the museum: digital tools and multiformat communication techniques. In response to the second specific objective, which aimed to identify and analyse the digital visitor, it can be concluded that this visitor is not only the one who replaces the physical visit with the virtual one but is also the visitor who looks for information on the website to prepare for the physical visit and who needs digital tools on site to carry out the visit independently. As for the third specific objective, to analyse the websites of the museums of the PMN in Porto and Norte region, 51 websites or web pages were analysed. It turned out that 31 (60.8%) museums have their website, and the remaining 20 (39.2%) have a website integrated into another entity. In the second case, museum information is available on the websites of town halls, foundations, or other institutions or on portals explicitly created to group together the museums of that location. Finally, the fourth specific objective, which aimed to analyse and identify the digital tools present on the museums' websites or web pages, concludes that regarding the variables within Digital Communication across the Visibility, Usability, and Interactivity dimensions, none of the museums met all 28 variables in the web environment. Only three museums reached the 50% threshold, with just one exceeding 53.6%, corresponding to 14 or 15 variables.

About the analysis of websites and web pages, the following results were obtained in the three dimensions of Digital Communication:

Visibility Dimension: Of the eight possible variables, a maximum of 2 were identified in 27 museums/websites (52.9%). The remaining 24 museums (47.1%) identified a maximum of 5 variables. Two large groups were found: those where it was only possible to identify one variable on 14 websites and those where it was possible to identify four variables on 13 websites. It turns out that only five museums/websites identified a maximum of 5 variables.

Usability Dimension: Of the eight variables referenced, 17 museums/websites (33.3%) did not identify any variables; 22 museums/websites (43.1%) identified a maximum of 2 variables; the remaining 12 museums/websites (23.5%) identified between 3 and 6 variables. Only one museum/website identified a maximum of 6 variables.

Interactivity Dimension: Of the 12 variables referenced, 11 museums/websites (21.6%) did not identify any variables; 19 museums/websites (37.3%) identified one variable; 9 museums/websites (17.6%) identified two variables. This group includes the most significant number of museums/websites, 39 representing 76.5% of the sample, where between 0 and 2 variables are identified. In the remaining 12 museums/websites (23.6%) of the sample, between 3 and 9 variables were identified. It turns out that only one museum/website identified 9 of the 12 variables.

The analysis showed that of the 31 museums with a website, only one has a favourable accessibility/usability dimension, with six of the eight variables under analysis. Considering the importance of usability in the view of Bonjisse and Morais (2017) and Lee et al. (2023), museums should invest in improving the interaction between accessibility and usability (Aizpurua et al., 2016). The same is true for interactivity, with only one museum identifying nine of the 12 variables. The website is the most popular ICT tool used by digital visitors (Guccio et al., 2022) and the gateway to museums, which increases interest in the site and encourages physical visits (Dos-Santos-Abad et al., 2023; Nobre & Morais, 2021). Given this assumption, museums should invest in creating their website rather than web pages associated with other entities.

From the online questionnaires, 22 responses were obtained, indicating that those responsible for museum communication possess the training and skills necessary to adapt and develop digital tools. More than half of the museums (54.5%) do not have a communication plan, while 45.5% do. Museums with a communication plan typically have one of two types of organisation: internal teams within the museum or external teams managed by third parties (e.g., local councils). In both cases, it is evident that these teams are multidisciplinary and

responsible for developing the communication plan. In museums that do not have a specific communication plan, the museum is mainly publicised through its schedule of activities and events, on social media, or the museum's website.

The communication channels most used by museums are social networks and their website. There is a minority of museums that refer to other communication channels, which target two types of public: actual visitors and potential visitors. For actual visitors, sending digital newsletters, email, and access to the mobile app; for potential visitors, providing mass information, such as a printed agenda, cultural agenda, posters, and press. In the case of social networks, museums preferred Facebook (95.5%), Instagram (81.1%), and YouTube (50.5%). The frequency of publication on social media was reported as “every week,” with events being the most common type of content. Regarding the websites, content was updated monthly (50.0%) or quarterly (18.2%), with events (86.4%), news (81.8%), and educational content (72.7%) being the most frequently published types. Regarding the digital tools used to facilitate visits to the museum, Mobile Applications were reported by 40.9% of respondents, Subtitling of audiovisual material by 27.3%, Interactive Games and Audio Guides by 22.7% each, and Virtual Reality and Audio Description by 18.2% each. Museums employ ICT both on-site and online. The on-site digital tools used in the museums under analysis prove the assumption made by Guccio et al. (2022) about improving the visitor experience and boosting the efficiency of museums' digital communication.

This study aimed to show the reality of museums and, at the same time, promote and disseminate the best practices used to improve the services provided. Regarding the study’s limitations, the first arose when analysing the museums' websites, when it was found that a large part of the sample does not have its own website, but a web page integrated into another entity. These two forms of presentation are different in terms of the characteristics of the website and the way they present the museum's information. The second limitation concerns the application of the questionnaire, which affected the data collection period due to the limited time available to complete this research project. Given that the results are expected to differ significantly, it is suggested that future research apply this study to another region with museums belonging to the PMN—for example, the Lisbon Region, which has a high number of actual and potential visitors driving museums to invest in digital communication.

In future work, the authors intend to apply the study to other regions with museums belonging to the Portuguese Museum Network.

References

Agostino, D., & Costantini, C. (2022). A measurement framework for assessing the digital transformation of cultural institutions: The Italian case. *Meditari Accountancy Research, 30*(4), 1141–1168. https://doi.org/10.1108/MEDAR-02-2021-1207

Aizpurua, A., Harper, S., & Vigo, M. (2016). Exploring the relationship between web accessibility and user experience. *International Journal of Human-Computer Studies, 91*, 13–23. https://doi.org/10.1016/j.ijhcs.2016.03.008

Alonso-Virgós, L., Baena, L. R., Espada, J. P., & Crespo, R. G. (2018). Web page design recommendations for people with Down syndrome based on users' experiences. *Sensors, 18*(11). https://doi.org/10.3390/s18114047

Amézaga, B. R. (2021). Visiting museums today: Reflections on the new digital observer and its cultural practices in a transforming heritage. *Santander, Estudios de Patrimonio, 2021*(4), 131–150. https://doi.org/10.22429/EUC2021.SEP.04.04

Balducci, F., Buono, P., Desolda, G., Impedovo, D., & Piccinno, A. (2020). Improving smart interactive experiences in cultural heritage through pattern recognition techniques. *Pattern Recognition Letters, 131*, 142–149. https://doi.org/10.1016/j.patrec.2019.12.011

Bertacchini, E. E., Dalle Nogare, C., & Scuderi, R. (2018). Ownership, organisation structure, and public service provision: The case of museums. *Journal of Cultural Economics, 42*(4), 619–643. https://doi.org/10.1007/s10824-018-9321-9

Bonjisse, B. J., & Paulo Morais, E. (2017). Models for evaluating tourism websites. *Journal of Internet and E-Business Studies, 2017*, 1–16. https://doi.org/10.5171/2017.217014

Carvalho, A., Matos, A., & Pizarro, M. M. S. (2018). Competências para a transformação digital nos museus: O projecto Mu.Sa. *Midas, 9*, 0–10. https://doi.org/10.4000/midas.1463

Cruz Franco, P. A., Rueda Márquez de la Plata, A., & Gómez Bernal, E. (2022). Protocols for the graphic and constructive diffusion of digital twins of the architectural heritage that guarantee universal accessibility through AR and VR. *Applied Sciences, 12*(17). https://doi.org/10.3390/app12178785

Domínguez Vila, T., Alén González, E., & Darcy, S. (2018). Website accessibility in the tourism industry: An analysis of official national tourism organisation websites around the world. *Disability and Rehabilitation, 40*(24), 2895–2906. https://doi.org/10.1080/09638288.2017.1362709

Dos-Santos-Abad, J., Piñeiro-Naval, V., & Somoza-Sabatés, I. (2023). Digital communication in museums: A comparative analysis. *Anuario Electronico de Estudios en Comunicación Social Disertaciones, 16*(1), 1–25. https://doi.org/10.12804/revistas.urosario.edu.co/disertaciones/a.12316

Fanea-Ivanovici, M., & Pana, M. C. (2020). From culture to smart culture: How digital transformations enhance citizens' well-being through better cultural accessibility and inclusion. *IEEE Access, 8*, 37988–38000. https://doi.org/10.1109/ACCESS.2020.2975542

Fernandes, L. S., & Justo, C. S. P. B. (2022). Comunicação digital acessível: Reflexões, interfaces e tensões de um campo científico em construção. *Revista Alceu*, 216–239.

Fernandez-Lores, S., Crespo-Tejero, N., & Fernández-Hernández, R. (2022). Driving traffic to the museum: The role of the digital communication tools. *Technological Forecasting and Social Change, 174*(August 2021). https://doi.org/10.1016/j.techfore.2021.121273

Garcia, A., Mineiro, C., & Neves, J. (2017). Comunicação inclusiva em monumentos, palácios e museus ficha técnica. 104. http://www.patrimoniocultural.gov.pt/static/data/publicos/acessibilidade/guia_comunicacao_acessivel_inclusiva.pdf

Guccio, C., Martorana, M. F., Mazza, I., Pignataro, G., & Rizzo, I. (2022). Is innovation in ICT valuable for the efficiency of Italian museums? *European Planning Studies, 30*(9), 1695–1716. https://doi.org/10.1080/09654313.2020.1865277

Hijazi, A. N., & Baharin, H. (2022). The effectiveness of digital technologies used for the visitor's experience in digital museums: A systematic literature review from the last two decades. *International Journal of Interactive Mobile Technologies, 16*(16), 142–159. https://doi.org/10.3991/ijim.v16i16.31811

Lee, Y., Park, S., Park, J., & Kim, H. K. (2023). Comparative analysis of usability and accessibility of kiosks for people with disabilities. *Applied Sciences, 13*(5). https://doi.org/10.3390/app13053058

Moura, L., Fonseca, B. P., & Moreira, C. (2023). Digital marketing strategies and tools in hotels: Managers' perceptions. *Journal of Tourism & Development, 39*, 79–94. https://proa.ua.pt/index.php/rtd/article/view/38769

Mourão, L. (2021). Tecnologia como fator de inovação e competitividade. In *Portugal e o Turismo* (1a ed., pp. 290–321). Book Cover Editora.

Mason, M. (2013). The dimensions of the mobile visitor experience. *The International Journal of the Inclusive Museum, 5*(3), 51–72. https://doi.org/10.18848/1835-2014/cgp/v05i03/44404

Navarrete, T. (2019). Digital heritage tourism: Innovations in museums. *World Leisure Journal, 61*(3), 200–214. https://doi.org/10.1080/16078055.2019.1639920

Nobre, J. C. C., & Morais, E. P. (2021). Web communication strategies of Portuguese museums: National museums versus foundations. *Journal of Tourism & Development, 37*(May 2020), 125–136. https://doi.org/10.34624/rtd.v37i0.26362

Parrinello, S., & Dell'amico, A. (2019). Experience of documentation for the accessibility of widespread cultural heritage. *Heritage, 2*(1), 1032–1044. https://doi.org/10.3390/heritage2010067

Pinto, A. F. A., Vieira, T. de O., & Bittencourt, P. R. (2019). Acessibilidade informacional na Web: Um estudo da acessibilidade nas instituições arquivísticas nacionais da Ibero-América. *Páginas A&b: Arquivos & Bibliotecas, 12*, 148–162. https://doi.org/10.21747/21836671/pag12a9

Rosa, M. J., Gonçalves, A. M., & Ferreira, J. (2023). Estratégias de marketing digital no turismo: Um estudo sobre a perspetiva do consumidor turístico. *Journal of Tourism & Development, 39*, 281–296. https://proa.ua.pt/index.php/rtd/article/view/38781

Sánchez, L. C. E., Arias, J. V., Arias, A. V., & Arias, M. L. B. (2018). Evolution and research trends of museum interactive exhibits through ICTs. *Kepes, 15*(18), 45–80. https://doi.org/10.17151/kepes.2018.15.18.3

Sarmento, E., Abranja, N., & Carvalho, R. (2022). Perfil do consumidor. In *Plano de Marketing e Marketing Digital na Hotelaria e no Turismo* (1a ed., pp. 120–125). Lidel - Edições Técnicas, Lda.

Sofia, G. (2019). *Archeologia e Calcolatori* (pp. 423–438).

Solima, L., Tani, M., & Sasso, P. (2021). Social innovation and accessibility in museum: Some evidence from the SoStare al MANN project. *Journal of the Section of Cultural Heritage, 10*(23), 23–56. https://doi.org/10.13138/2039-2362/2518

Walsh, D., Hall, M. M., Clough, P., & Foster, J. (2020). Characterising online museum users: A study of the National Museums Liverpool museum website. *International Journal on Digital Libraries, 21*(1), 75–87. https://doi.org/10.1007/s00799-018-0248-8