



Museum reinvention in the face of the pandemic challenge: digitization strategies, heritage, and audiences

Reinvención museológica ante el desafío pandémico: nuevas estrategias, patrimonio y públicos

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ABSTRACT The pandemic period served as a catalyst in the museums' adaptation, leading them to embrace innovation, collaboration, and resilience. As they emerged from the covid-19 crisis, these institutions found themselves in a unique position to play a vital role in society's rebuilding and in preserving cultural heritage in an ever-changing world. The article aims to explore the main measures adopted, review the scientific literature on the subject, highlight some relevant cases in European, Asian, and American museums, and identify the challenges and dynamics driven in the post-pandemic period. The text stems from a thorough literature review to determine how the museum field should reconfigure its presence, considering three factors: technology, heritage, and audience. A landscape in which the presence of social networks, the rise of online exhibitions, and other digital resources are considered fundamental.

RESUMEN El periodo pandémico supuso un catalizador en la adaptación de los museos, llevándolos a abrazar la innovación, la colaboración y la resiliencia. A medida que emergieron de la crisis del covid-19, dichas entidades se encontraron en una posición única para desempeñar un papel vital en la reconstrucción de la sociedad y en la preservación del patrimonio cultural en un mundo en constante cambio. El artículo busca conocer cuáles fueron las principales medidas adoptadas, conocer la literatura científica al respecto, reseñar algunos casos relevantes en museos europeos, asiáticos y americanos, y señalar los retos y las dinámicas impulsadas en el periodo postpandémico. El texto nace de una atenta revisión bibliográfica para delimitar de qué modo el ámbito museístico debe reconfigurar su presencia atendiendo a tres factores: tecnología, patrimonio y público. Un panorama en que la presencia de las redes sociales, el auge de las exposiciones en línea y otros recursos digitales se consideran fundamentales.

Received: 01/03/2024
Revised: 29/05/2024
Accepted: 03/06/2024
Published: 31/07/2024

KEYWORDS covid, exhibitions, museums, pandemic, social media

PALABRAS CLAVE covid, exposiciones, museo, pandemia, redes sociales



Cómo citar este artículo/How to cite this article: López López, Y., Cisneros Álvarez, P., Ávila Rodríguez, M. y Delage González, I. (2024). Reinvención museológica ante el desafío pandémico: nuevas estrategias, patrimonio y públicos. *Estoa. Revista de la Facultad de Arquitectura y Urbanismo de la Universidad de Cuenca*, 13(26), 181-190. <https://doi.org/10.18537/est.v013.n026.a12>

1. Introduction

The transformation that museums have undergone during and in the months following the COVID-19 pandemic is crucial for understanding the new guidelines in cultural consumption, both in terms of the technological potential in the challenges of confinement and in the adaptation and redefinition of their role in the new normal. Before 2020, the presence of technologies in museum exhibitions had been evidenced by the incorporation of audio guides and touch screens to provide additional information during visits, as well as the rise of digitizing collections or spreading information through social media. With the pandemic, the situation demanded an acceleration of their use.

1.1. The closure of museums and contactless culture

The presence of these practices already demonstrated, even before the pandemic, that art museums needed to employ science and technology to exhibit and interpret their pieces (Wang & Yu, 2020). The benefits of proper technological implementation are reflected in various cases such as Nantou County (Taiwan), where since 2002, the transformation of leisure spaces into museums of local culture and arts has been funded (Hsu & Chao, 2019); or the heuristic evaluation of forty-seven websites of Medicine and Anatomy museums (Kiourexidou et al., 2019) to determine which elements of an interface, from the effective design of a museum website, needed to be reformulated.

During and especially after the hardest months of lockdown, the use of technology in museums multiplied exponentially. This went hand in hand with a reflection on the new possibilities these technologies offered, leading to the redesign and revision of museographic and museological proposals. The immediate impact of the pandemic on the museum sector resulted in closures, restrictions, loss of revenue, financial challenges, and adaptation to virtual platforms to maintain public connection. The so-called contactless culture, characteristic of the hardest months of the crisis, had to align with the influx of metaverse technologies, virtual reality, augmented reality, and the use of artificial intelligence (Sánchez-Amboage et al., 2023). The digital revolution in museums had already been unfolding with the increase in virtual experiences and tours, the use of emerging technologies (such as virtual or augmented reality), and the development of interactive applications to enhance public engagement. The pandemic accelerated many of the changes driving the transformation of museums amid a social and cultural revolution (Giannini & Bowen, 2022).

It is estimated that approximately 90% of the sixty thousand museums worldwide closed fully or partially due to COVID-19 (Delgado, 2020). Such an extraordinary and unprecedented situation led, from the early months, to studies, analyses, and reflections on museum management, exhibition design, collection

conservation, and, above all, the dissemination and outreach of collections and activities to the public. Reports from UNESCO (United Nations Educational, Scientific and Cultural Organization) and the International Council of Museums (ICOM) are key documents from which researchers and professionals established lines of debate. To this end, cases of online exhibitions and display spaces were analysed from different perspectives. The aim was to establish interior architectural design strategies for the proper exhibition and visualization of pieces in museums (Oh, 2020). It is considered necessary to analyse how the pandemic affected museology studies, which is why ICOM focuses its analysis through the evaluation of official websites, actions on social media, webinars, and conferences organized by experts. Additionally, other authors (Akyol, 2020) focused on entities such as the ICH Museum of Ankara, universities, and non-governmental organizations.

However, the disruption of everyday life not only halts the daily activities of institutions and user visits but also affects the lives of their workers and conservation policies. With reduced maintenance and cleaning of museums, insect and pest populations have been altered, as studied by Brimblecombe & Querner (2023) in the case of fifteen Viennese museums. Additionally, the formation of the workers' union, the United Auto Workers (UAW) of the Lower East Side Tenement Museum in New York, was put on hold. Disagreements and accusations of unfair labour practices, and the subsequent dismissal of over 90 workers following the closure declaration, are documented by Urban et al. (2021).

1.2. Reflections on the new scenario

The immediacy and urgency of the situation require rapid adaptation, sharing, and examining how to leverage resources, reimagining the visitor experience, strategizing to ensure everyone's safety, and adapting exhibitions and spaces to the new normal. Efforts focus on gathering testimonial voices and conducting interviews with museum institution workers to gain firsthand insight into how uncertainty was managed. A study of three museums and art galleries in the United Kingdom and the United States (Noehrer et al., 2021) draws on consulted bibliography and documentary research, analysing ten conversations with their directors. This work concludes that digital engagement with museum content and institutional practices alters traditional audience profiles, compelling these institutions to find ways to accommodate new forms of participation. This objective is seen as fundamental: to connect with the community to establish active exchange and discussion (Hong, 2021). The goal is to overcome the blockage and distance in exhibition halls by applying digital technology, disseminating online content, virtual exhibitions, live performances, and live streams (Koo, 2021). As such events increase, the

debate intensifies over the social role, direction of museums, and communication through hyperconnectivity.

Sometimes, interviews with managers working in museums and heritage sites (Mackay, 2021) reveal that the sector was not prepared to face a pandemic of this nature—at least in the case of the United Kingdom—and indicate that the emotional impact was profound, and how the lack of information from official channels affected decision-making. Shen et al. (2022) examine the daily visit data of the National Palace Museum of Taiwan between 2016 and 2021 and conclude that outdoor artistic events are a highly useful strategy for museums that have traditionally depended on indoor art exhibitions. However, beyond the externalization of activities, the main concern lies in the immediate studies on the impact of the pandemic and how refocusing on digital means becomes the primary way to avoid closure. There is an emphasis on the necessity for institutions to work towards innovation, not only in terms of language but also in the messages to be conveyed, in a context that has changed deeply and rapidly, where content and missions merge. This implies reorienting technological means according to these objectives and expanding the communication field, which until now has been confined to the physical “place” of the museum, into a broader context (Lerario, 2022).

The peculiarities of the moment are utilized to reflect deeply on museographic or museological decisions. For example, by evaluating visitors to two art museums in Catalonia, the Dalí Theatre-Museum and the Picasso Museum, efforts are made to understand exhibition circumstances during pandemic times and to research the reopening of museums as physical spaces (Galí et al., 2023). This is evident in the analysis of online content from twenty-one museums with temporary exhibitions in the United Kingdom between March and June 2020, highlighting how digital content should be conceptualized, presented, and valued during a crucial moment for the sector (King et al., 2021).

The health crisis itself becomes an exhibition theme (Roigé, Canals & Rico, 2023), with archives and museums documenting the outbreak of the pandemic in Spain through exhibitions, online initiatives, and physical and virtual elements. The evolving role of museums in society is more than evident, and reflection on their role as storytellers seems undeniable. In this reconfiguration, values such as inclusivity and diversity in the representation of history and culture must be paramount. Museum professionals must work to ensure that new practices become opportunities to enhance accessibility and inclusion, and museum institutions are called to identify the long-term effects of the physical and digital presence of visitors with disabilities (Cecilia, 2021).

No less important is their role as entities where social responsibility and commitment to contemporary issues prevail. This is reflected in both the strategies adopted to assist communities in Romania and Italy in better coping with the pandemic (Zbucnea et al., 2020), and in the virtual channels through which they engaged with the youth population in Greece (Tranta et al., 2021). Their function as educational entities is evident, as attested by a survey of over ninety museum professionals on online learning (Ennes et al., 2021).

The article aims to answer what proposals, competencies, and threats have fostered the origin and outcome of the metamorphosis following the COVID era, accelerating the implementation of these changes in the museum field. It poses the following questions: What were the main measures adopted by museums? What role do social media and online exhibitions play? Which relevant cases from European, Asian, and American museums are noteworthy? To address these questions, the scientific literature is examined to evaluate the changes from 2020 onward, through the following specifics:

- Verify the diversity of solutions according to cultural contexts in response to the pandemic.
- Organize proposals and motivations that have shaped changes in museographic and museological developments.
- Confirm the importance of cultural experience (in-person or virtual) for the well-being of the public, considering the emotional and cognitive effects of these experiences.
- Identify the challenges, conflicts, and potential evolutions of dynamics stimulated during pandemic times, including the long-term implications of implemented changes.

2. Methodology

A mixed-method approach has been employed to address such a broad and complex subject, studying various dimensions of the interaction between museums and the public and combining different research approaches. This methodology is qualitative in nature, as it treats phenomena with a global perspective and emphasizes transferability, aiming to transform reality despite the neutrality of the results. The purpose is to understand phenomena and contexts within the museum field following the pandemic.

A thorough literature review has been conducted using publications and journals from 2019 to late 2023. These articles and documents are housed in the Web of Science database and have been indexed in the Journal Citation Reports for impact factor. The analysis is qualitative and based on search results obtained from the SCOPUS and JCR databases. The search terms "Museum" and "covid" yielded over 98 references, of which 74 were filtered, representing a 75,5% selection rate. Four key criteria were essential in the selection process: the breadth of sources (from scientific and academic texts to reports and analyses from museum institutions), the diversity of approaches and methodologies, the inclusion of international studies reflecting rich cultural diversity, and the temporal aspect of the research, providing continuous and updated tracking from the onset of the pandemic to the present.

These four vectors are also the criteria used to discard and exclude minimally significant works, accounting for 24,4% of the total. Similarly, case studies and experimental proposals have been selected based on geographic and thematic diversity, as well as the relevance of the museums and projects analysed. Criteria such as the representativeness of different world regions, the variety of museum types (scientific, artistic, university, among others), the originality of implemented strategies, and the availability of data for analysis have been considered.

The nature and focus of the results have brought together both case studies and experimental proposals, as well as evaluation reports and theoretical dissertations. The heterogeneity of the texts combines a mix of interviews, surveys of museum professionals, and evaluations of both physical and virtual museums. Noteworthy methods applied include: STEAM Education (Science, Technology, Engineering, Arts, and Mathematics): This interdisciplinary model addresses social and labour changes. PEST Analysis (Political, Economic, Social, and Technological): Evaluates external factors affecting museum organizations. AIDA Methodology (Attention, Interest, Desire, Action): Studies consumer behaviour to understand their thoughts, needs, and desires. ANOVA (Analysis of Variance): Compares levels of a study factor within an experimental design.

3. Results

The filtered references can be organized into several themes and contexts. Notable among these are analyses of online exhibitions, live streaming of workshops and activities, and reflections on the museum experience, both in virtual settings and concerning the diversity of audiences and abilities. These discussions highlight that new digital services, applications, and games will be key elements in this equation.

3.1. The use of social media

During periods of lockdown, capacity limitations, and the absence of physical visits, social media became a powerful tool through which museums maintained their connection with their audience. Not only did museums interact more effectively through these platforms, but they also solidified their role as a key instrument in 21st-century communication (Worobey, 2022).

The scientific literature brings together mixed-method research, such as that conducted in museums and galleries in the United Kingdom between 2020 and 2021, where over nine thousand tweets were analysed, and interviews were conducted with more than nineteen digital workers (Kidd, 2022). This research questioned how institutional approaches and perceptions of social media changed and what practical challenges they will present in the future. The volume of data is substantial because museum activity did not stop, as evidenced by the profiles and websites of a hundred of the main state museums in Italy (Agostino et al., 2020), which stimulated interesting reflections on the future direction of digital approaches to culture. However, other authors (Larkin et al., 2023), after examining a large database of over 3,300 active museums in the UK to understand Facebook usage, indicated that there was no substantial increase in its use.

The Chinese case requires analysis of social media platforms and native email platforms, as these are prioritized. The evolution of official museum websites, live video streaming platforms (Kuaishou, Douyin, and Bilibili), audio platforms (Himalayan), social media platforms, and e-commerce platforms (WeChat, Vlog, Taobao, Tianmao, Jingdong, Meituan, and Tence) was studied. Researchers (Jin & Min, 2021) exemplified this through their work at the Shaanxi History Museum, analysing not only streaming activities but also conducting online surveys, interviews, and data analysis as communication strategies. However, most studies focused on the usage of four social networks: Facebook, Instagram, YouTube, and Twitter—renamed as X since July 2023.

Rivero et al. (2020) investigated how major museums and archaeological sites in Spain used Twitter as an edu-communicative tool, analysing their hashtags and promoting the creation of cyber-communities. They asserted that social media platforms forge new ways of

teaching, learning, and interacting, while also promoting heritage sustainability and conservation. In the same context, the authors examined the social media reactions of Spain's most visited art museums, distinguishing between the lockdown period and one year after the declaration of the health crisis, focusing on Twitter and Instagram posts (de las Heras et al., 2022). The authors highlighted the importance of active listening and proficiency in these channels to create experiences beyond physical visits. They also underscored the role of museums in providing entertainment and social support during crises.

Instagram was one of the most used platforms, as evidenced by the analysis conducted at the Museum of Art of the Federal University of Ceará in Brazil (Chagas & Pereira, 2023). This study confirms how these resources, which facilitated interaction across diverse cultures, should be examined for their essential role in individual education during the post-pandemic period. The existence of online exhibitions in various countries was examined to gather insightful reflections on the use of Facebook and YouTube (Oh, 2020). Notable examples include 360-degree videos with explanations by curators and professionals, the development of content through augmented reality and virtual reality—such as in exhibitions like “Mona Lisa: Beyond the Glass” and “Modigliani Studio”—and invitations to participate in challenges like those launched by the Getty Museum.

In other instances, the analysis provided interesting socio-economic and demographic indicators, such as those from over 162 museums registered in the Museum Documentation Centre of Zagreb, Croatia (Bursic et al., 2023). They concluded that museums with a stronger online presence, lower regional unemployment rates, and lower tourism development indices were more likely to engage in activities during the pandemic. Beyond studies focused on a single museum or cultural context, an international survey conducted in three languages examined the use of Facebook profiles in four countries: France, Japan, Luxembourg, and the United States (Morse et al., 2022). The research included interviews with professionals, confirming that social media served as a temporary substitute for the museum experience and fostered a sense of community and invitation for visitor self-expression. It also highlighted a lack of digital training as a limiting factor in the implementation of ICT (Information and Communication Technologies).

3.2. Museographic and museological changes

As noted, the pandemic crisis generated a series of changes and adaptations to address the challenges, restrictions, and uncertainties, quite evident in the realm of museography and museology. The four types of online exhibitions were examined: museums, art, virtual reality, and metaverse (Kim & Yong, 2020), in order to profile changes and dynamics: supportive exhibitions - used to promote and educate about the museum - and parallel, independent, or alternative exhibitions - which induced visitors to participate in various ways. Other

studies (Kwon et al., 2021) established phases in non-face-to-face museum education: the preparation period - from April to August 2020 - which was characterized by “continuous chaos,” the transition period - from August to December 2020 - marked by “expansion of connectivity,” and the leap forward period (from January to June 2021) summarized as “new possibilities for museum education.” Therefore, they concluded that non-face-to-face education had become a new and expanded route for visitors to access the museum. Additionally, as quarantine restrictions eased, the intensity of people's interest in virtual museums also decreased (Pourmoradin et al., 2021).

All these considerations will be taken into account to define new lines of work, for example, modifications in blockbuster exhibition models, those that receive significant loans and use an aggressive marketing plan. The research conducted by the Dutch Museum Association between 2020 and 2021 was divided into a documentary phase and an interaction phase, with fourteen interviews with representatives of entities in the Netherlands (Jurcisinova et al., 2022). The document predicted that the crisis could serve as a catalyst for ongoing changes, as the constant growth in the sector seemed unsustainable, especially if museums focused on competing for visitor numbers rather than user experience. The pandemic could have facilitated a positive transformation; however, the research demonstrated the opposite.

Works such as Grimme and Nowak (2022) evidenced how accelerated digitization following the pandemic could also impact the epistemological approach adopted by institutions like the Ethnological Museum of Berlin. The focus was on discussing how digital exchange and networking could facilitate the permanent inclusion of postcolonial perspectives to overcome unequal power relations. Cárdenas (2021) also advocated for redefinition with new postcolonial demands, pinpointing the pandemic as the moment to question museum practices. Debates on empathy towards others and the recreation of museums as “contact zones” opened up new possibilities for working with collections. Moreover, the pandemic heightened awareness of climate and environmental emergencies. Drawing from their experience at the MUSE (Science Museum of Italy), Bernardi (2022) provided insights into the need for revising museum policies and activities more aligned with the United Nations' Agenda 2030.

Other voices advocated seizing the post-pandemic scenario to reflect on the potential of digital transition in Cultural Heritage, particularly with digital facsimiles (Clini & Quattrini, 2021). Contributions from museums in crisis highlighted the need to promote digital literacy skills and increase investment in such technologies (Marty & Buchanan, 2022). The emergence of the World Language Museum at Shanghai International Studies University (Bai & Nam, 2023), for instance, explored educational, social, and political roles, stimulating academic discussions on curatorial work, experiential learning, social responsibility, and digital literacy beyond the pandemic.

Some Italian university museums designed service offerings and co-creation practices, adapting design areas and digital technologies with such events (Magliacani & Sorrentino, 2022). Similarly, the management of digital museum entities and art galleries proved beneficial in optimizing service usage, helping to offset the economic losses of the pandemic, and contributing to improving educational learning about diverse histories and cultures, issues that increased awareness and inclusivity (Wang & Hasoon, 2022). Additionally, NFTs and the metaverse demonstrated their presence in the context by disrupting the art market and cultural industry to raise operational funds (Yang, 2022). There was a need to examine the inherent pitfalls of the digital society, seeking direction for a Korean art museum in the evolving artistic ecosystem. The question seemed relevant: Is the metaverse a production hub that functions as artistic education and a virtual exhibition space?

Aware of the possibilities within the museum realm for learning, researchers analysed the strategies of educators—collaboration, networking, and feedback—to address the accessibility of content that would attract users within informal learning settings at science museums (Lee et al., 2023). Similarly, Kim et al. (2022) pointed out how responses by science museums to a pandemic could impact the accessibility of informal science education for the public. They investigated the case of the National Science Museum in Gwacheon, South Korea, using publicly accessible data from the museum's website and its YouTube channel. They noted the diversification of content offerings and the preparation of educational projects for deaf and blind visitors, who are often excluded from informal science learning opportunities. Moreover, post-pandemic, enhancing the visitor experience has become a central theme. For instance, consider the case of the Lanchester automotive engineering heritage, where virtual reality is seen as a medium allowing for three experimental approaches—gamified, narrated, and immersive—to better interpret artifacts (Alatrash et al., 2021).

3.3. Commitments to emotional well-being and education

In addition to changes in social, cultural, and economic habits, the pandemic had a significant impact on mental health; uncertainty, isolation, or job loss sometimes led to emotional exhaustion, anxiety, or depression. Various studies across different regions of the world—from Australia and Italy to Germany, Norway, and Canada—reported the emergence of depressive and anxious symptoms, dissatisfaction, somatic illnesses, and decreased mental well-being among adolescents (Lerario, 2022). These setbacks also exacerbated disparities among users. In this regard, inequalities in the programming of digital museums in low-income communities and racialized individuals were analysed, focusing on the specific case of the Explora Science Centre and Children's Museum in Albuquerque, New Mexico (Zollinger & DiCindio, 2021).

Different experiences were evaluated, such as virtual museum visits by seventh-grade students in Turkey, which contributed to academic and career development despite limitations in visual elements and social interaction (Elbay, 2022). Similarly, the study included two classes from a high school in Reggio Emilia, Italy (Manera, 2020), where the transition from more traditional forms of education to collaborative-focused models was analysed, reflecting on the use of digital technologies in school and museum education. A pilot study (Luck & Sayer, 2023) detailed the impact and relevance of online museum resources on the well-being of users during the pandemic. It also proposed expanding the research and supporting it with a more comprehensive agenda of social, economic, cultural, and environmental sustainability.

They highlighted proposals such as that of the University Museum of Navarra (Echarri-Iribarren, 2022) and its *Quidarte* (take care of oneself) programme, which advocated for cultural facilities that addressed people's well-being by providing care and reducing stress through the inclusion of concerts, dance performances, theatre, workshops, and interdisciplinary conferences. In the same vein, the online cultural experience called "Ways of Being" aimed to reduce anxiety and depression among young people at the Ashmolean Museum in Oxford (Sheriff et al., 2021).

Methods were also designed to attract the public to art and university collections (DiCindio & Rasmussen, 2021). Physical museum spaces and live encounters were essential in traditional museum education, but during times of confinement, they became inaccessible or had limited access. This collaboration project between two art museum education courses from different universities was developed during the pandemic to address this issue. The application of technological innovations is exemplified in groundbreaking proposals such as integrating mental health into the metaverse, in contrast to museums in the post-COVID-19 era (Kahambing, 2023), or projects like language learning during periods of physical and social isolation, supported by museums to aid in the education of international graduate students (Aranha, 2021).

4. Discussion and conclusions

The pandemic crisis brought about a significant shift in the trajectory of museums and necessitated innovation, collaboration, and strengthened resilience. These institutions implemented a series of measures to mitigate the inability for physical presence, emphasizing interaction through social networks, the application of technological tools, and the reformulation of museographic and museological proposals. Case studies, surveys, interviews with specialists, museum officials, and the public, as well as studies utilizing databases and various evaluations, have been discussed. Similarly, analyses have been conducted on different geographical environments, as well as specific museums and projects. These are institutions cited as examples of interventions, measures planning, and

diverse studies: the shift to digital platforms has been evaluated, along with modifications to physical operations, a reorientation towards the local audience, the collection of materials related to the pandemic crisis, and exhibitions dedicated to it and its impact on daily life (Raved & Yahel, 2022).

However, the critical approach is present in only some works (Mackay, 2021). The study of museums in Qatar (Al-Mannai, 2022), their management of challenges, and implemented initiatives—such as online workshops, virtual visits, mobile applications, and games—represent a paradigm. The essay concludes that, like globally, Qatari institutions were not prepared for this sudden transition to digital. Tan & Tan (2021) examine the management of various museums in Singapore during the most difficult months of the pandemic to exemplify their role as a public health resource. They are aware of the barriers presented by digital virtual platforms, such as access to technology among population groups, digital competence, and literacy. Common challenges they faced included user familiarity with electronic services, website usability, and copyright issues. The latter factor is also highly present in European museum contexts, where the need to digitize and share cultural heritage online could enhance public interest at the expense of authors' or creators' rights, amid concerns about potential infringements and liabilities (Klinowski & Szafaraowicz, 2023).

Delgado (2020) points out several drawbacks: minimal implementation of technological inclusion strategies, the need for new museum staff training, lack of collaboration between institutions, and insufficient market research and financial sustainability. Emergency measures, government aid, and fundraising campaigns proved crucial for the survival of some American museums. Indeed, investment in technology and the pursuit of sustainable models ensure the long-term resilience of these cultural spaces (Zolnowski, 2021).

The scientific production concerning museums and the COVID pandemic has evolved parallel to the crisis itself. In fact, as observed, studies and analyses have been consistently conducted from 2020 to the present. However, reflections on the incorporation of the digital world into the cataloguing, dissemination, and engagement of museum collection items date back to 2019 - the starting year of our bibliographic research. With more time elapsed, more precise assessments will be added, not only to understand how to improve exhibition approaches or complement physical visits with digital tools, but also to shape museums that are more closely connected to their communities. It should be noted that, despite the prevalence of QR codes during the pandemic, no articles have been found that precisely evaluate their presence in exhibitions during or after the health crisis, nor in the months following the toughest periods.

Aspirationally, museums are being planned as active agents of societies in the future. Museums are envisioned as community centres or with educational and social programs that promote diversity and social inclusion. Strategies will need to be evaluated to overcome revenue loss or government support, focusing on sustainable practices for the conservation and management of collections, as well as exploring new business models to ensure resilience in the face of future crises.

Conflict of Interests. The authors declare no conflict of interests.

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