


MUSEUM MODERNIZATION, CULTURAL PRESERVATION, AND SUSTAINABLE DEVELOPMENT IN THE SÃO PAULO PARAÍBA VALLEY

 <https://doi.org/10.56238/arev7n2-131>

Submitted on: 11/01/2025

Publication date: 11/02/2025

**Willian José Ferreira¹, Mauro Castilho Gonçalves², Katia Celina da Silva Richetto³,
Rachel Duarte Abdala⁴, Shayani Paula de Oliveira Domingues⁵ and Marcelo dos
Santos Targa⁶**

ABSTRACT

Museums preserve the cultural memory of humanity, leveraging historical reflections and the exaltation of diversity in inclusive and representative spaces. In this scenario, it is investigated how interactivity and museum modernization can contribute to the preservation and appreciation of cultural memory, promoting sustainable development in the Metropolitan Region of Vale do Paraíba and the North Coast of São Paulo (RMVPLN). From a bibliographic approach and direct observations, the use of interactive technologies, such as augmented reality, audio guides, and educational applications, in the strengthening of museums as cultural, social, and economic agents are analyzed. The results demonstrate that technological resources, such as augmented reality, audio guides, and educational applications, have the potential to transform museums into more dynamic and attractive spaces, connecting diverse audiences to regional traditions and promoting sustainable cultural tourism. However, modernization faces significant challenges, including insufficient financial resources, lack of integrated planning, and structural limitations. In addition, the lack of representative narratives, especially of Indigenous and quilombola

¹ Doctor in Space Geophysics
University of Taubaté (UNITAU)
Email: willian.jferreira@unitau.br
ORCID: <https://orcid.org/0000-0003-4636-868X>

² Doctor of Education
University of Taubaté (UNITAU)
E-mail: castilho@unitau.br
ORCID: <https://orcid.org/0000-0003-1316-0786>

³ Doctor in Materials Engineering
University of Taubaté (UNITAU)
Email: katia.csrichetto@unitau.br
ORCID: <https://orcid.org/0000-0002-7368-1973>

⁴ Doctor in History of Education
University of Taubaté (UNITAU)
E-mail: rachel.dabdala@unitau.br
ORCID: <https://orcid.org/0000-0002-6936-5329>

⁵ Master's student in Environmental Sciences
University of Taubaté (UNITAU)
E-mail: shayani.podomingues@unitau.br
ORCID: <https://orcid.org/0009-0008-2703-3888>

⁶ Doctor in Agronomy
University of Taubaté (UNITAU)
Email: mtarga@unitau.br
ORCID: <https://orcid.org/0000-0002-4140-3493>

communities, restricts the potential of museums to promote social inclusion and strengthen cultural identities in the RMVPLN. Given this panorama, the need for coordinated efforts between governments, educational institutions, and civil society to overcome these obstacles and enable museum modernization is highlighted. By integrating cultural preservation and contemporary demands for inclusion, equity, and sustainability, such initiatives can consolidate museums as agents of regional transformation, contributing to the integrated and sustainable development of the region.

Keywords: Cultural Heritage. Technological Resources. Equity. Sustainable development.

INTRODUCTION

Globally, museums have occupied a prominent place in the preservation of cultural memory, promoting critical reflection on history and valuing diversity (Witcomb, 2013). According to Padilha *et al.* (2014), over time, these institutions have evolved from simple guardians of objects and narrators of the past to become dynamic spaces for learning, intercultural dialogue, and citizenship building, responding to the demand for initiatives that promote a deeper understanding of the historical and social relevance of cultural heritage.

Defined by the International Council of Museums (ICOM, 2022) as permanent and non-profit institutions, museums are characterized as public and inclusive spaces, focused on reflection, knowledge sharing, and social integration (Vassiliadis; Belenioti, 2017; Dantas *et al.*, 2020). In addition, its transformative function encompasses educational and interactive activities, such as workshops, exhibitions, and debates, connecting the past to the present and contributing to a more inclusive and sustainable future (Günay, 2012; Erbay, 2019).

Although the traditional museological models of the twentieth century have been marked by limited interactions between the public and the collection, according to Costa (2022), recent transformations have prioritized participatory practices that intensify visitor engagement, stimulating more dynamic and thought-provoking experiences (Felgueiras, 2023). In this scenario, digital and interactive technologies have taken a leading role in expanding the possibilities of interpretation and experience of the collections, strengthening the public's connection with cultural heritage (Trunfio *et al.*, 2022; Omran *et al.*, 2023).

Despite the opportunities brought by museum modernization, according to Laurell *et al.* (2019), challenges such as budget limitations and the need for adequate planning for the implementation of innovations persist. However, according to Coban *et al.* (2022), initiatives that position these entities as dynamic learning centers have shown potential to attract diverse audiences, promote inclusive practices, and drive sustainable development on a regional scale.

In the Brazilian context, the Metropolitan Region of Vale do Paraíba and North Coast (RMVPLN), located in the state of São Paulo, is a relevant example of how museums can act in the preservation of cultural memory in historical contexts of great relevance. The region, also known as Vale do Paraíba Paulista, is composed of 39 municipalities and had significant participation in historical events, such as the Independence of Brazil and the abolitionist movements, in addition to influencing cultural currents, such as modernism and

regionalism (Fausto, 1994; Arruda, 2011). However, even though it has an expressive material heritage, issues such as the dispersion of historical materials make it difficult for the public and researchers to access these assets (Gonçalves; Oliveira, 2023).

The interactive cultural spaces in the RMVPLN have received attention for their contribution to the appreciation of cultural heritage and the stimulation of sustainable development. Initiatives of this nature expand historical understanding and boost the regional economy by strengthening production chains and promoting inclusive practices (Lupo, 2021). In addition, they dialogue with global goals, such as quality education (Sustainable Development Goal 4 – SDG 4), the construction of sustainable communities (SDG 11), and the strengthening of partnerships (SDG 17).

Through bibliometric techniques, this study seeks to analyze how interactivity and museum modernization can contribute to the preservation and appreciation of cultural memory, promoting sustainable development in the Metropolitan Region of Vale do Paraíba and North Coast (RMVPLN). Additionally, it examines the transition from museums to interactive cultural spaces and its impacts on the appreciation of cultural heritage, offering subsidies for reflections on the role of these institutions as agents of cultural, social, and economic transformation.

HISTORICAL AND CONCEPTUAL FOUNDATIONS OF MUSEUM PRESERVATION THE EVOLUTION AND CONTEMPORARY ROLE OF MUSEUMS

Over the centuries, museums have played a central role in the preservation and dissemination of the culture and history of societies, evolving from private collections of elites to public institutions accessible to the population (Abt, 2006). The creation of the Louvre Museum in 1793, during the French Revolution, for example, marked this transformation by converting a former royal residence into a public museum, symbolizing a democratic and inclusive movement in the museum field (Evrard; Krebbs, 2018). Another precursor illustration was the British Museum, founded in 1753, which cemented a systematic approach to the preservation and display of cultural and historical artifacts in the United Kingdom (Duttie, 2011).

In Brazil, the history of museums reflects the social and political transformations of the country, with the National Museum, founded in 1818, standing out as one of the first centers for research and preservation of Brazilian historical and cultural memory. According to the Brazilian Institute of Museums (IBRAM, 2019), Brazil is home to approximately 3,700

museums distributed throughout the national territory, expressing the country's rich cultural diversity and its relevance in promoting knowledge and reflection. These museums have the mission of preserving and valuing historical, cultural, and artistic heritage, promoting education, social engagement, and the construction of collective identities that connect past and present. In addition, they contribute to the democratization of access to culture and stimulate dialogues on contemporary issues, strengthening citizenship and promoting sustainable development.

Conceptualized by Molina and Da Luz (2022) as "places of memory", museums take on a singular dimension as spaces that transcend the mere preservation of objects, promoting a deep reflection on time, history, and memory. Such institutions, according to Gonçalves and Oliveira (2023), play an essential role as guardians of collective memory, dedicating themselves to the preservation of cultural identities in a scenario of constant transformations imposed by modernity. In addition, Massarani *et al.* (2023) highlight the importance of these spaces as agents of socialization, by creating opportunities for meaningful connections between communities and their cultural heritage, reinforcing identity bonds, and fostering collective belonging. Thus, museums are configured as bridges between the past and the present, promoting dialogues that enrich both the individual experience and the social fabric.

The evolution of museums, from exclusive private collections to accessible public spaces, illustrates a continuous expansion of their functions and meanings. Nora (2023) highlights that these institutions go far beyond the preservation of cultural heritage, acting as catalysts for education, reflection, and dialogue, by intertwining memories of the past with the challenges and perspectives of the present. In this way, through the adoption of innovative practices, such as interactivity, equity, and inclusion, museums assert themselves as dynamic agents of social, cultural, and economic transformation, articulating democratic values that strengthen community and identity ties.

CHALLENGES AND PERSPECTIVES FOR MUSEUM MANAGEMENT IN BRAZIL

In Brazil, museums face significant challenges related to representation, inclusion, and equity. Nascimento (2021) points out that many institutions still perpetuate exclusionary narratives, often ignoring or marginalizing historically disadvantaged groups, such as black, Indigenous, and people in vulnerable situations, including the illiterate. Although advances have been made, such as the recognition of local and community

memories, there remains an urgent need to promote a more equitable and diverse curatorship, that values and legitimizes the multiple voices that make up Brazilian society.

Duarte Cândido (2014) emphasizes that incorporating equitable practices is not limited to the diversification of collections, but also requires active engagement with communities, ensuring that their narratives are presented authentically and respectfully, reinforcing inclusion and the right to memory as fundamental pillars of social justice. According to Santos Garcia *et al.* (2022), it is essential to adopt policies and practices that leverage equity in all dimensions of its performance, from the selection and curation of collections to cultural mediation strategies and accessibility to physical and virtual spaces. This includes, for example, strengthening dialogues with marginalized communities, forming teams representative of social diversity, and implementing educational programs that consider different cultural and social contexts (Moraes Fonseca *et al.*, 2024).

With the advancement of digitalization, new challenges arise in the management of collections and access to preserved materials. Previously, Abreu (1998) introduced the concept of "archival syndrome", highlighting the need to address the exponential increase in archived records, as well as ethical issues related to privacy and documentary authenticity. In the past, Halbwachs and Díaz (1995) warned of the financial impacts of digitization on cultural institutions, demanding technological innovations and effective management strategies. Today, however, it is understood that digitization is not limited to the conversion of physical materials to digital formats, but implies a broad transformation in the processes of preservation and accessibility, requiring policies that ensure the integrity and long-term conservation of collections, while addressing the challenges of digital inclusion, allowing communities with limited access to technology to also enjoy these resources.

The use of interactive technologies has expanded the forms of audience engagement, although it requires careful planning to avoid superficial or decontextualized experiences. Trunfio *et al.* (2022) highlight that the implementation of these resources must be aligned with the demands of communities, promoting social inclusion and ensuring access in an equitable and democratized manner. Such an approach strengthens visitors' connection to cultural heritage while expanding opportunities for meaningful learning and critical engagement.

In the Brazilian scenario, Interactive Museums (MIS) have stood out as examples of this museological innovation. According to Mendonça (2012), these spaces deal not only

with material collections but also with immaterial manifestations, being pioneers in practices that combine interactivity and inclusion. Data from the Brazilian Institute of Museums (IBRAM, 2019) indicate the existence of approximately 750 interactive museums in Brazil, reinforcing their relevance as spaces for social and cultural transformation.

Emblematic examples include the Museum of Image and Sound (MIS SP), in São Paulo, and the Museum of Tomorrow (MdA RJ), in Rio de Janeiro. MIS SP, which opened in 1970, is recognized for its innovative approach, which explores new technological media and offers diversified programs, such as interactive exhibitions and cultural events. MdA RJ, in turn, combines science, art, and technology to address sustainability issues, promoting reflections on the challenges and opportunities of the future (Tolmasquim *et al.*, 2021). Both show how interactivity and the use of technologies can enrich the experience of visitors and foster a critical dialogue on contemporary issues.

In this context, inclusion emerges as an indispensable pillar in interactive museums. Desvallées and Mairesse (2013) point out that accessible architectural projects, with ramps, elevators, and adequate signage, are essential to ensure that people with different abilities can fully enjoy these spaces. In this way, such actions strengthen the function of museums as meeting places, promoting equity in access to culture and learning, while expanding their social and educational impact.

Through the convergence between inclusion, equity, interactivity, and sustainability, museums in Brazil have the potential to overcome historical challenges and act as transformative agents. The examples of MIS SP and MdA RJ illustrate how these institutions can have a significant impact, not only in preserving cultural heritage but in strengthening democratic values and stimulating regional development.

MUSEUMS AND SUSTAINABILITY: CONTRIBUTIONS ALIGNED WITH THE SDGS

The connection between museums and the Sustainable Development Goals (SDGs) underscores their transformative role in multiple social, cultural, and economic dimensions. In the context of SDG 4 (quality education), museums stand out as spaces for lifelong learning, promoting interactive experiences that stimulate the development of critical, cultural, and social skills. In addition to expanding access to knowledge for diverse audiences, including historically marginalized communities, these institutions offer exhibitions, workshops, and pedagogical programs that enrich formal learning and promote

engagement with global issues, such as environmental preservation, human rights, and social justice.

Within the scope of SDG 11 (sustainable cities and communities), museums play a representative role in valuing cultural and natural heritage, reinforcing the sense of belonging and community identity. These spaces foster social cohesion, preserve local traditions, and promote sustainable cultural tourism, while accessibility and inclusion initiatives expand the reach of cultural experiences, ensuring the full participation of a diverse audience and generating economic and social benefits for the regions where they are located.

Other SDGs also find an echo in museum practices. SDG 5 (gender equality) is contemplated in initiatives that promote female representation in exhibitions and cultural narratives, highlighting the historical and contemporary contributions of women in different areas. SDG 10 (reduction of inequalities) is evidenced by efforts that seek to include voices and stories of marginalized groups, such as indigenous people, blacks, and peripheral populations, in educational collections and programs. Such an approach not only expands diversity in cultural narratives but also promotes critical reflections on structural inequalities.

The relevance of SDG 13 (action against global climate change) is highlighted when museums take an active role in environmental education and awareness of climate issues. According to Ferreira *et al.* (2023a), through thematic exhibitions, educational events, and initiatives that integrate science and art, these institutions encourage debate on sustainability and encourage the adoption of environmentally responsible practices. In addition, by incorporating sustainable technologies into their infrastructure and operations, museums reinforce their commitment to mitigating environmental impacts.

In the specific scope of the Metropolitan Region of Vale do Paraíba and North Coast (RMVPLN), initiatives that integrate interactivity, inclusion, and sustainability have been consolidated as examples of the positive impact that museums can generate in regional development. By strengthening cultural identities, promoting sustainable practices, and fostering cultural tourism, these institutions take an active role in building a more equitable, inclusive, and environmentally conscious future. Projects that involve partnerships between museums, communities, and educational institutions have the potential to expand the reach of these actions, contributing to the formation of critical citizens engaged in the preservation of cultural and environmental heritage.

According to Miguel *et al.* (2023), the integration of museums into the SDGs reflects their ability to act as transformative agents in an ever-changing global society. Thus, by articulating practices that promote inclusion, sustainability, and educational engagement, these spaces reaffirm their relevance in building a fairer and more balanced world, where cultural heritage is preserved as a strategic resource for the well-being of present and future generations.

MATERIALS AND METHODS

CHARACTERIZATION OF THE STUDY AREA: THE METROPOLITAN REGION OF VALE DO PARAÍBA AND NORTH COAST

Located in southeastern Brazil, in the eastern cone of São Paulo (Figure 1), the Metropolitan Region of Vale do Paraíba and North Coast (RMVPLN) comprises 39 municipalities distributed between the approximate coordinates of 22°50' to 23°40' south latitude and 44°10' to 46°30' west longitude (Ferreira *et al.*, 2013).

Figure 1. Geographical location of the Metropolitan Region of Vale do Paraíba and North Coast (RMVPLN).



● Localização geográfica da RMVPLN de São Paulo

Source. Prepared by the authors (2025).

Bordered by the Serra da Mantiqueira to the north and the Serra do Mar to the south, the RMVPLN occupies a strategic corridor that connects some of the main economic areas of the country, standing out for its historical and contemporary relevance (Gomes; Andrade, 2020). The geographical configuration of the region favors economic, social, and cultural integration, articulating urban, rural, and coastal areas dynamically.

After the decline of this economic cycle, from the 1970s onwards, the region was impacted by the industrial expansion of the Metropolitan Region of São Paulo (RMSP), which stimulated the relocation of industries to cities such as São José dos Campos and Taubaté (Ferreira *et al.*, 2013; Gomes, 2003). Currently, the economy of the RMVPLN is diversified, concentrating high-tech industries along the axis of the Presidente Dutra Highway and port and oil activities on the North Coast.

In addition to its industrial relevance, the RMVPLN stands out in tourism, with attractions such as natural landscapes, extensive coastlines, and historic cities (Oliveira *et al.*, 2020). Regions such as the Mantiqueira, Bocaina, and Mar Mountains, as well as historic farms with unique architecture, make up a heritage of great potential for preservation and cultural use (Maria, 2016). These elements attract visitors interested in learning about local culture and history, as well as contributing to environmental awareness and sustainable practices.

The construction of the historical narrative of the RMVPLN, however, suffered from the denial of the past in previous periods. The modernist thinking of the 1920s and 1940s promoted the distancing of agrarian traditions, prioritizing a vision of urban and industrial progress (Lencioni, 2005; Abreu, 1998). Works such as *Dead Cities*, by Monteiro Lobato, consolidated this perspective, describing the cities of the Valley as decadent and disconnected from modern transformations.

Today, there is a movement to rescue regional narratives, motivated by the recognition of the historical value in the construction of regional identity. Rodrigues and Evangelista (2024) point out that tourism has played an important role in this process, by attracting visitors and strengthening the communities belonging to their histories. From this perspective, the appreciation of historical heritage fosters economic development through investments and job creation aimed at cultural preservation.

The safeguarding of the collective memories of the RMVPLN, both through documentary records and cultural manifestations, is essential to ensure that future generations understand and identify with regional history. In addition to preserving the cultural legacy, these initiatives strengthen the connection of communities with their territory and promote development practices aligned with sustainability.

METHODOLOGICAL APPROACH

The research, of a bibliographic nature, followed a basic approach focusing on the analysis of literature and preexisting documents, according to the guidelines of Prodanov and Freitas (2013). The study focused on the transversality of the theme, exploring concepts and interests that contribute to the theoretical advancement related to the interactive preservation of cultural memory. The procedures of Casula *et al.* (2021) guided the selection of data, enabling the fragmentation and systematic evaluation of information.

The review began with the formulation of the following research question: how can museums and interactive cultural spaces contribute to an inclusive, equitable, and quality visitor experience? The search was carried out on the Capes Journal Portal (PPC) and Google Scholar (GS), covering articles published in the last 10 years (2014-2023) in peer-reviewed journals. The Boolean operator "and" was used to combine the terms "museums" and "interactivity" present in titles and abstracts of scientific publications. The time constraint sought to ensure the contemporaneity of the data and their relevance to the field of study. As an additional criterion, the term "equity" was included.

The selection focused on the evaluation of the methodological quality of the articles, to ensure that the results were analyzed consistently and aligned with the research question. Studies that did not contain at least one of the defined descriptors, as well as monographs, dissertations, theses, and editorials, were excluded, prioritizing publications that guaranteed greater quality and relevance to the topic investigated.

To organize the set of texts, a detailed analysis of the selected publications was carried out, resulting in the elaboration of individual expanded abstracts. From these summaries, a word cloud was created using a natural language processing (NLP) algorithm developed by Ferreira *et al.* (2023b) in Google Colab, implemented in Python. The algorithm integrated specific libraries, including 're' for regular expressions, 'nltk' (Natural Language Toolkit) for linguistic processing and analysis, 'unidecode' for normalization of special characters, and 'matplotlib' and 'WordCloud' for visualization of the results.

The pre-processing of the text involved a series of essential steps to ensure the quality of the analysis, including tokenization, which consists of dividing the text into words or units of meaning; the removal of stopwords, which eliminates terms of low relevance, such as articles and prepositions; lemmatization, which reduces words to their base form,

facilitating linguistic standardization; and the normalization of accents, ensuring the uniformity of the text for computational analysis.

Based on the frequency of the terms, a word cloud was generated using the WordCloud tool, while the Matplotlib library was employed to create detailed graphical representations. The resulting visual synthesis clearly highlighted the most recurrent terms, allowing a deeper interpretation of the predominant concepts in the analyzed sources and offering a perspective to understand the central ideas present in the textual corpus.

Subsequently, a Discursive Textual Analysis (DTA) was carried out, based on the methodology of Medeiros and Amorim (2017), with the objective of evaluating how the discourses present in the selected texts contribute to understanding how the incorporation of elements of interactivity in museums and cultural spaces can promote equity and sustainable development in their practices.

Between July and August 2023, the analysis was enriched by visits and direct observations carried out in four museums located in the RMVPLN. Adopting the visitor-observer perspective, the visits sought to record aspects related to interactivity in these spaces. In this way, the ATD was complemented by reflections that show how the interactivity and modernization of museums can act as agents of transformation in the cultural, economic and environmental spheres of the RMVPLN.

RESULTS

BIBLIOMETRIC ANALYSIS AND KEYWORDS IN THE CONTEXT OF CULTURAL PRESERVATION

After the association of all key descriptors in the databases, a total of 69 publications were identified in the PPC and 1090 in the GS. By applying the inclusion and exclusion criteria, 69 articles were selected. Within this group, 15 were excluded due to the presence of duplicates, while 37 were eliminated because they did not directly address the objectives of this research. Thus, in accordance with the procedures outlined in the 'Methodological Approach' section, Chart 1 presents the 17 articles that were defined as guiding elements for the research question of this investigation. The table shows the publications listed in chronological order, their researchers, and the central focus on these researches.

From the expanded abstracts derived from the articles listed in Chart 1, and using NLP techniques, a word cloud representative of the global corpus of the research was obtained (Figure 1). According to the results obtained following the methodological

procedure outlined, it was observed that the words that most appear in the corpus are: access, inclusion, school, environment, knowledge and experience.

Table 1. Articles selected from the initial search, organized chronologically, with indication of the researchers and the central focus of the research.

n	Year of Publication	Researcher(s)	Main Focus
1	2014	Ferraro and Giglio	Science Museums as educational platforms and interdisciplinary interactions
2	2014	Duarte Cândido	Analysis of musical iconography in museum contexts: an interdisciplinary dialogue
3	2017	Lamim-Guedes	Promotion of scientific and environmental culture through educational spaces
4	2018	Seiffert-Santos e Cunha	Approach to non-formal education through interaction in museums in the North Region
5	2018	Gomes and Marins	Teaching action in the collaborative integration between schools and museums
6	2019	Lamy <i>et al.</i>	The Fiocruz Science Park as an interactive environment for science education
7	2019	Araújo <i>et al.</i>	The interactivity of Information and Communication Technologies in education
8	2020	Pimentel <i>et al.</i>	Promotion of educational activities through interactivity in museums
9	2021	Rocha <i>et al.</i>	Exploring children's rights in scientific contexts through Interactive Museum Experiences
10	2021	Padua <i>et al.</i>	Promoting social innovation in museums through interactive and participatory strategies
11	2021	Rocha and Franco	Learning opportunities in virtual exhibitions at the Football Museum
12	2022	Massarani <i>et al.</i>	Engagement and participation of adolescents through the investigation of experiences learning in interactive museums
13	2022	Faria and Pascotto	Analysis of public characterization and perception assessment at the Museum of Natural History and Archaeology (MuHNA)
14	2023	Henrique Júnior e Pereira	Promotion of culture and collaborative learning in Science Centers
15	2023	Bittencourt <i>et al.</i>	Experience implementing accessibility in 3D virtual museums
16	2023	Gonçalves <i>et al.</i>	Critical analysis of cultural accessibility, highlighting the importance of inclusion and participation in museum spaces
17	2023	Massarani <i>et al.</i>	Study of the dynamics of family interactions in exposure to water, emphasizing engagement and joint learning

Source. Prepared by the authors (2025).

As shown in Figure 2, the interactive preservation of society's cultural memory emerges as a multifaceted theme that demands an open and inclusive approach to encompass different perspectives, experiences, and narratives.

Continuous learning is an indispensable element in this process, because, in addition to preserving the collective memory of society, it allows new generations to reconnect with their past, understand and strengthen their cultural identity. The articulation of cultural heritage with education positions the "teacher" as a key figure in guiding students in the exploration and assimilation of this legacy. "Teaching", in this sense, enables critical reflection and interactive dialogue on cultural issues, encouraging communities to engage in a meaningful way with their history and identity.

According to Figure 2, inclusion, continuous learning and the connection between cultural heritage and education play essential roles in preserving culture and strengthening

the sustainable development of communities. Education offers new generations the opportunity to reconnect with the past, understand traditions and cultural values, and consolidate their identity. When individuals become more aware and proud of their cultural heritage, they tend to adopt practices that favor the conservation and protection of historical sites and monuments, as well as promote sustainable initiatives that respect and maintain the local culture. The interplay between education, cultural heritage, and sustainable development lays a foundation for the harmonious progress of communities, treating cultural preservation not only as a responsibility, but as a valuable resource for collective growth and well-being.

MUSEUM MODERNIZATION AND INTERACTIVITY: CHALLENGES AND CONNECTIONS WITH SUSTAINABLE DEVELOPMENT IN THE RMVPLN

In recent years, interdisciplinary discussions on the tangible and intangible historical heritage of the RMVPLN have reinforced the importance of repositioning the region's relationship with its cultural memory. As Massarani *et al.* (2023), museums play a leading role in the preservation and dissemination of collective memory, connecting local communities to their past and promoting critical reflections on contemporary challenges. In the RMVPLN, these discussions foster regional narratives, contributing to a sense of belonging and an inclusive dialogue about local history, essential to the appreciation of different historical perspectives.

Among the cultural spaces highlighted in the RMVPLN, institutions such as the Museum of Anthropology of the Paraíba Valley (Figure 3a), the Brazilian Aerospace Memorial (Figure 3b), the Museum of Natural History (Figure 3c) and the Mazzaropi Museum (Figure 3d) illustrate the historical and cultural diversity of the region. The Museum of Anthropology, in Jacareí, preserves a rich collection of sacred and baroque art, connecting the public to the religious and architectural legacy of historical periods. The Brazilian Aerospace Memorial, in São José dos Campos, reflects the importance of the aerospace industry for the region's economic transition, consolidating itself as a hub of high technology and innovation (Lamy *et al.*, 2019). While these institutions play key roles in historic preservation, the absence of contemporary elements of interactivity limits their potential impact on visitor engagement and experience.

During the visits, it was found that most of the museums analyzed lack resources such as audio guides, interactive panels and digital maps, which are essential to promote

an immersive and participatory experience. Only the Mazzaropi Museum, in Taubaté, presents an interactive exhibition that explores the backstage of the filmmaker's productions, but in a restricted way and without a broader connection with innovative practices of interactivity. Other spaces, such as the Casa de Frei Galvão Museum, in Guaratinguetá, and the Boa Vista Palace, in Campos do Jordão, preserve historical collections of great relevance, but follow traditional exhibition models that prioritize passive observation and offer little in terms of active engagement.

As mentioned by Ahmed *et al.* (2020), the introduction of interactive technologies presents a strategic opportunity to transform RMVPLN museums into more dynamic and attractive spaces. Tools such as augmented reality, personalized audio guides, and educational apps can play a central role in connecting generations and regional traditions, promoting a deeper understanding of cultural heritage. These technological innovations, in addition to expanding public engagement, have the potential to foster sustainable cultural tourism, positively impacting sectors such as commerce, gastronomy, and accommodation, especially in municipalities with less economic dynamism (Trunfio *et al.*, 2022). However, modernization requires more than the adoption of technological tools.

Figure 3. Museum spaces in the RMVPLN: Museum of Anthropology of the Paraíba Valley (3rd); Brazilian Aerospace Memorial (3b); Natural History Museum (3c); Mazzaropi Museum (3d).



Source. Prepared by the authors (2025).

To this end, Massarani *et al.* (2022) emphasize that museological transformation requires a conceptual review, repositioning visitors as active participants in the process of cultural interpretation and preservation. In the RMVPLN, the need for inclusive and representative practices is especially urgent, given the underrepresentation of indigenous and quilombola narratives. The absence of these perspectives compromises the diversity of the collections and the connection between visitors and regional cultural identity (Gonçalves; Oliveira, 2023). Thus, modernization planning must ensure that technologies complement and enrich historical narratives, avoiding decontextualization or superficialities.

However, modernization faces significant challenges, such as the lack of financial resources, the infrastructure deficit, and the absence of standardization in the digitization of collections (Ahmed *et al.*, 2020). Although the Mazzaropi Museum has already begun digitizing part of its audiovisual collection, these initiatives remain punctual and limited. Overcoming these barriers requires strategic partnerships between governments, educational institutions, and the private sector, capable of ensuring the necessary investments for team training, equipment modernization, and the implementation of inclusive communication strategies.

To consolidate the museums of the RMVPLN as agents of cultural, economic and social transformation, it is essential that modernization is accompanied by a broad and strategic approach. In addition to technologies, valuing marginalized narratives and strengthening the connection with local communities are indispensable. According to Almeida Moraes *et al.* (2024), such initiatives allow museums to play a critical role in promoting sustainable cultural tourism and strengthening regional identity. However, without a coordinated effort, as emphasized by Maria (2016), these institutions will remain short of their transformative potential, perpetuating traditional models that no longer meet contemporary demands.

Despite the limitations of the present study – such as the analysis restricted to a few museums and the dependence on secondary data and specific visits – the results indicate that technologies such as augmented reality, audio guides, and interactive exhibitions are viable ways to modernize the museums of the RMVPLN. Moreover, these tools can solidify the position of museums as agents of cultural, economic, and environmental transformation.

Future research could deepen the analysis of the economic and social impacts of the introduction of interactive technologies in regional museums, with special attention to the inclusion of marginalized communities. Comparative studies between museums in the RMVPLN and other regions of Brazil would be valuable to identify good practices and replicable models. In addition, investigations on the perceptions of visitors and local communities regarding museum modernization and cultural representativeness could guide policies and actions that promote sustainable development in the region.

CONCLUSION

This research aimed to analyze how interactivity and museum modernization can contribute to the preservation and appreciation of cultural memory, promoting sustainable development in the Metropolitan Region of Vale do Paraíba and North Coast (RMVPLN). The results demonstrated that tools such as augmented reality, personalized audio guides, and educational apps can make museums more attractive and accessible, connecting different audiences to regional traditions and histories. These technologies have the potential to boost sustainable cultural tourism and generate economic benefits in sectors such as commerce, gastronomy and accommodation, especially in municipalities with less economic dynamism.

The central contribution of the study lies in the relationship between technological modernization and social inclusion in the museological field, reinforcing the role of museums as promoters of cultural, social and economic transformation. The adoption of interactive practices and more inclusive narratives, especially those that integrate stories of indigenous and quilombola communities, can amplify the impact of these institutions, strengthening the connection of communities with their cultural heritage and stimulating regional development.

In this context, the survey highlights the need for coordinated efforts between governments, educational institutions, and civil society to overcome challenges related to lack of resources, infrastructure, and planning. Initiatives that integrate cultural preservation, inclusion and sustainability are fundamental to consolidate museums as agents of regional transformation.

Future studies can deepen the analysis of the economic, social, and cultural impacts of museum modernization, with a focus on the inclusion of marginalized communities. Comparisons between museums in the RMVPLN and other regions of Brazil can offer

references for replicable modernization models. In addition, qualitative investigations on the perception of visitors, managers and communities can guide public policies and initiatives aimed at a more equitable and sustainable regional development.

THANKS

This work was supported by the Coordination for the Improvement of Higher Education Personnel (CAPES) – Financing Code 001. The authors express their gratitude to the Graduate Program in Environmental Sciences (PPGCA), the Graduate Program in Ecodevelopment and Environmental Management (PPGEDGA), the Graduate Program in Regional Management and Development (PPGGDR), the Academic Master's Degree in Human Development (MADH), the Professional Master's Degree in Education (MPE) of the University of Taubaté and the Institute for Environmental Research in Watersheds (IPABHi) for the technical and institutional support provided to the development of this research.

REFERENCES

1. Abreu, M. A. (1998). Sobre a memória das cidades. *Journal of the Faculty of Letters*, 14, 77–97.
<https://mauricioabreu.com.br/files/artigos/Sobre%20a%20memoria%20das%20cidade%20s.pdf>
2. Abt, J. (2006). The origins of the public museum. In S. Macdonald (Ed.), *A companion to museum studies* (pp. 115–134). <https://doi.org/10.1002/9780470996836>
3. Ahmed, Z. A., Qaed, F., & Almurbati, N. (2020). Enhancing museums' sustainability through digitalization. In *2020 Second International Sustainability and Resilience Conference: Technology and Innovation in Building Designs* (pp. 1–4). IEEE. <https://doi.org/10.1109/IEEECONF51154.2020.9319977>
4. Almeida Moraes, R., Taunay, M. P. V., & Pereira, E. W. (2024). The production of the source guide of the Museum of Education of the Federal District: Movement and challenge. *Aracê Magazine*, 6(4), 18524–18534. <https://doi.org/10.56238/arev6n4-438>
5. Araújo, C. W. C., Ribeiro, M. A. P., Batista, L. S. A., & Sobral, Y. R. A. (2019). A look at the trajectory of the Ricardo Ferreira Science Museum. *Electronic Journal Debates in Scientific and Technological Education*, 9(1).
6. Arruda, M. A. do N. (2011). Modernism and regionalism in Brazil: Between innovation and tradition. *Tempo Social*, 23, 191–212. <https://doi.org/10.1590/S0103-20702011000200008>
7. Bittencourt, S., Amaral, F., & de Oliveira Heidrich, R. (2023). Exploring accessibility tools in virtual museums and their applications in teaching during the pandemic: A case study. *Contribuciones a las Ciencias Sociales*, 16(8), 12287–12307.
8. Casula, M., Rangarajan, N., & Shields, P. (2021). The potential of working hypotheses for deductive exploratory research. *Quality & Quantity*, 55(5), 1703–1725. <https://doi.org/10.1007/s11135-020-01072-9>
9. Coban, M., Bolat, Y. I., & Goksu, I. (2022). The potential of immersive virtual reality to enhance learning: A meta-analysis. *Educational Research Review*, 36, 100452. <https://doi.org/10.1016/j.edurev.2022.100452>
10. Costa, C. H. (2022). The new interactive museums of Salvador. *Concinnitas Magazine*, 23(44), 242–252. <https://doi.org/10.12957/concinnitas.2022.62825>
11. Dantas, L. F. S., de Sá Alves, T. R., & Deccache-Maia, E. (2020). The importance of science centers and museums: The contribution of their activities. *International Journal Education and Teaching*, 3(2), 1–18. <https://doi.org/10.31692/2595-2498.v3i2.129>
12. Desvallées, A., & Mairesse, F. (Eds.). (2013). *Key concepts of museology*. São Paulo: Brazilian Committee of the International Council of Museums, Pinacoteca do Estado de São Paulo.

13. Duarte Cândido, M. M. (2014). Archaeology, museum and perspectives: The museological diagnosis of the Ângelo Rosa de Moura de Porangatu museum. *Cadernos do LEPAARQ – Textos de Antropologia, Arqueologia e Patrimônio*, 11(21), 3166. <https://doi.org/10.15210/lepaarq.v11i21.3166>
14. Evrard, Y., & Krebs, A. (2018). The authenticity of the museum experience in the digital age: The case of the Louvre. *Journal of Cultural Economics*, 42(3), 353–363. <https://doi.org/10.1007/s10824-017-9309-x>
15. Faria, F. B., & Pascotto, M. C. (2022). Visiting public of the Araguaia Museum of Natural History. *Multiple Perspectives in Information Science*, 12.
16. Felgueiras, M. L. (2023). The Museum of the Primary School in Porto: Historical and cultural guidelines. *Educação em Revista*, 16(31). <https://periodicos.ufmg.br/index.php/edrevista/article/view/42755>
17. Ferraro, J. L. S., & Giglio, R. (2014). The museum as a space of transversality. *Education in Writing*, 5(2), 333–345. <https://doi.org/10.15448/2179-8435.2014.2.17802>
18. Ferreira, W. J., Batista, G. T., Targa, M. dos S., Castro, M. C., & Devede, A. C. P. (2013). Physical properties of soil cultivated with *Jatropha curcas* and associated green vegetation covers. *Environment and Water - An Interdisciplinary Journal of Applied Science*, 8(4), 60–70. <https://doi.org/10.4136/1980-993X>
19. Ferreira, W. J., da Silva Richetto, K. C., & Chagas, E. V. (2023a). Environmental education: A sustainable path to combat climate change. *Biosciences Journal*, 29(special). <https://periodicos.unitau.br/biociencias/article/view/3726>
20. Ferreira, W. J., da Silva Richetto, K. C., da Veiga, S. A., de Moura Ribeiro, M. T., & Gouvea, E. J. C. (2023b). Math phobia and maths anxiety: Multidisciplinary approaches for a more inclusive and equitable education in Brazil. *Concilium*, 23(17), 663–677. <https://doi.org/10.53660/CLM-2205-23Q30>
21. Gomes, C., & Andrade, D. J. (2020). Política e planejamento no Vale do Paraíba e Litoral Norte: A integração regional em questão. *Ambiente & Sociedade*, 23, e0129. <https://doi.org/10.1590/1809-4422asoc20190129vu2020L2DE>
22. Gonçalves, M. C., & Oliveira, D. R. (2023). From the glorious past to the abstract present: A historical and environmental analysis of the Paraíba do Sul River (São Paulo–Brazil). *UEG History Journal*, 12(2), e222308. <https://doi.org/10.31668/revistaueg.v12i2.13884>
23. Günay, B. (2012). Museum concept from past to present and importance of museums as centers of art education. *Procedia - Social and Behavioral Sciences*, 55, 1250–1258.
24. Halbwachs, M., & Díaz, A. L. (1995). Memoria colectiva y histórico. *Reis*, (69), 209–219.
25. Henrique Júnior, S. D. S., & Pereira, G. R. (2024). Mediation in a science museum in Belford Roxo/RJ as a form of social inclusion. *Teias Magazine*, 25(76), 334–347.

26. Lamim-Guedes, V. (2017). Socio-environmental theme in science museums: Environmental education and scientific education. *Environment & Education: Journal of Environmental Education*, 22(1), 77–95. <https://doi.org/10.14295/ambeduc.v22i1.6103>
27. Lamy, G. S., Alcoforado, L. F., Longo, O. C., & de Castro, E. B. P. (2019). Inclusive design in science centers and museums: A study on the campus of Fiocruz, RJ, Brazil. *Interiencia*, 44(11), 629–636. <https://www.redalyc.org/journal/339/33962174004/33962174004.pdf>
28. Laurell, C., Sandström, C., Berthold, A., & Larsson, D. (2019). Exploring barriers to adoption of virtual reality through social media analytics and machine learning. *Journal of Business Research*, 100, 469–474. <https://doi.org/10.1016/j.jbusres.2019.01.017>
29. Massarani, L., Rowe, S., Scalfi, G., Gonçalves, W., da Silva, C. M., Coelho, P., & Rocha, J. N. (2022). The role of emotions in the visit of adolescents to the Marine Aquarium of Rio de Janeiro. *Revista Iberoamericana de Ciencia, Tecnología y Sociedad-CTS*, 17(49), 39–67.
30. Massarani, L., Scalfi, G., Gonçalves, W., de Araújo, J. M., Ribeiro, A., & Barros, J. (2023). Looking at the objects in the National Historical Museum: An analysis of family conversations and interactions. *ACTIO: Teaching in Sciences*, 8(3), 1–25. <https://doi.org/10.3895/actio.v8n3.16412>
31. Medeiros, E. A. de, & Amorim, G. C. C. (2017). Discursive textual analysis: Analytical device of qualitative data for research in education. *Laplace em Revista*, 3(3), 247–260. <https://doi.org/10.24115/S2446-6220201733385p.247-260> [Accessed on: inserir data]
32. Miguel, O. L., Créixams, M. M., & Ribugent, G. C. (2023). Museums i ODS = Museums and SDGs. *Mnemòsine: Revista Catalana de Museologia*, 13, 6. <https://dialnet.unirioja.es/servlet/articulo?codigo=8964280>
33. Molina, A. H., & da Luz, J. A. R. (2022). Museums and places of memory. *Paço and Littera*.
34. Moraes Fonseca, A., de Paula, V. B. M., da Silva Galeano, M., Ferreira, W. J., & da Silva Richetto, K. C. (2024). Exploring collaborative games for equity in mathematics education. *Cuadernos de Educación y Desarrollo*, 16(9), e5427. <https://doi.org/10.55905/cuadv16n9-011>
35. Nora, P. (2023). *Les lieux de mémoire*. Gallimard.
36. Oliveira, G. C. de, Anazawa, T. M., & Monteiro, A. M. V. (2020). Spatial microsimulation combined with skater regionalization methods: A study for the Paraíba Valley and North Coast Metropolitan Region Subregion 4 in the São Paulo State. *Revista Brasileira de Cartografia*, 72(4). <https://doi.org/10.14393/revbrascartogr>

37. Omran, W., Ramos, R. F., & Casais, B. (2023). Virtual reality and augmented reality applications and their effect on tourist engagement: A hybrid review. *Journal of Hospitality and Tourism Technology*, 1(1), 1–31. <https://doi.org/10.1108/JHTT-11-2022-0299>
38. Padilha, R. C., Café, L., & Silva, E. L. (2014). The role of museological institutions in the information/knowledge society. *Perspectives in Information Science*, 19, 68–82. <https://doi.org/10.1590/1981-5344/1889>
39. Pádua, M. C., Jorente, M. J. V., & Semedo, A. (2019). Information design and communication actions on museum websites. In *Annals of the 9th CIDI-International Congress of Information Design* (2019 edition).
40. Pimentel, J. (2020). *The colonial collection of the Cinemateca*. Cinemateca Editions.
41. Prodanov, C. C., & de Freitas, E. C. (2013). *Methodology of scientific work: Methods and techniques of research and academic work*. Editora Feevale.
42. Rocha, C. G., & Franco, A. (2021). The virtualization of the football museum as a learning space: Dialogues with cyberculture and culture of convergence. *Plurais-Multidisciplinary Journal*, 6(2), 161–178.
43. Rocha, J. N., Alvaro, M., Massarani, L., & de Abreu, W. V. (2021). Accessibility in science museums: The perspective of Brazilian mediators. *Scientific-Human and Social Interfaces*, 9(1), 103–120.
44. Rodrigues, R. C. F., & Evangelista, R. (2024). Memories and heritage education at the Casa Hansen Bahia Museum. *Aracê*, 6(4), 16742–16751. <https://doi.org/10.56238/arev6n4-332>
45. Santos Garcia, M. I., Cabral, R. G., & da Silva, B. R. (2022). “Where is the museum?” Reflections on the impact of the pandemic on cultural spaces and deaf museum educators. *Lusófona Journal of Cultural Studies*, 9(1), 105–125. <https://doi.org/10.21814/rlec.3679> [Accessed on: inserir data]
46. Seiffert-Santos, S. C., & Cunha, M. (2018). Approximation of the theory of discursive genre and the communicational perspective of museums: Chronotope of museum generations. In *6th National Symposium on Education; 27th Academic Week of Pedagogy; 1st Graduate Exhibition*, Cascavel.
47. Tolmasquim, A., Bonela, D., & Cotia, R. (2021). Pandemic and vision of the future: The perception of the public of the Museum of Tomorrow about the future from the pandemic of the new coronavirus. *Ciência e Cultura*, 73(1), 4–8. <https://doi.org/10.21800/2317-66602021000100002>
48. Trunfio, M., Della Lucia, M., Campana, S., & Magnelli, A. (2022). Innovating the cultural heritage museum service model through virtual reality and augmented reality: The effects on the overall visitor experience and satisfaction. *Journal of Heritage Tourism*, 17(1), 1–19. <https://doi.org/10.1080/1743873X.2020.1850742>

49. Vassiliadis, C., & Belenioti, Z. C. (2017). Museums & cultural heritage via social media: An integrated literature review. *Tourismos*, 12(3), 97–132. <https://doi.org/10.26215/tourismos.v12i3.533>
50. Witcomb, A. (2013). Understanding the role of affect in producing a critical pedagogy for history museums. *Museum Management and Curatorship*, 28(3), 255–271. <https://doi.org/10.1080/09647775.2013.807998>