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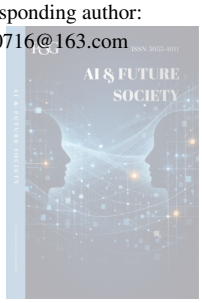
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Beyond the Algorithm: How AI is Reshaping Museums, from Preservation to Participation

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Abstract

This paper provides a comprehensive systematic review of the current state of artificial intelligence (AI) applications in museums, the challenges encountered, and potential future directions. The review synthesizes literature demonstrating how AI technologies—encompassing machine learning, natural language processing, computer vision, and generative models—are transforming key museum functions. These include conservation and restoration, exhibition and narrative design, education and accessibility, and the development of smart museum infrastructures for enhanced visitor experiences. Findings indicate that AI offers significant potential to improve operational efficiency, democratize access to cultural heritage, and foster participatory, co-creative engagement between institutions and audiences. However, the integration of AI also raises critical ethical and practical concerns regarding authenticity, curatorial authority, data bias, intellectual property, privacy, and equitable access. The paper concludes that the future trajectory of AI in museums will depend less on technological sophistication and more on the development of robust ethical frameworks, interdisciplinary collaboration, and thoughtful institutional choices that align with the core mission of museums as custodians of culture and public educators.

Keywords: Artificial Intelligence; Museums; Cultural Heritage Conservation; Exhibition Design; Cultural Governance

1. Introduction

Museums have historically served as custodians of cultural heritage, repositories of knowledge, and spaces for collective learning. For centuries, their mission has remained consistent: to preserve artifacts, interpret cultural narratives, and provide the public with access to the tangible and intangible heritage of humanity. Yet in the twenty-first century, museums are facing unprecedented pressures brought about by rapid digitization, globalization, and shifts in visitor expectations. Increasingly, museums must compete not only with traditional cultural institutions but also with the broader digital ecosystem in which audiences consume information, entertainment, and education. Against this backdrop, technological innovation has become central to reimagining the role of museums in contemporary society. Among the emerging technologies, Artificial Intelligence (AI) is one of the most transformative forces.

AI encompasses a wide array of computational techniques, including machine learning, natural language processing, computer vision, and, more recently, generative models such as large language models and generative adversarial networks. In the museum sector, AI has found applications across collection management, conservation science, exhibition design, education, and audience engagement. From automating the cataloguing of artifacts to creating personalized visitor experiences, AI promises to enhance both the efficiency and the inclusivity of museums. However, this technological promise is coupled with serious concerns about ethics, authenticity, and accessibility. Scholars have raised important questions: Can AI truly support the preservation of cultural heritage without distorting its meaning? What does it mean for an AI-generated artwork to be exhibited alongside human-created artifacts? And how can museums ensure that the deployment of AI aligns with their mission of inclusivity, rather than reinforcing existing inequalities?

The growing academic interest in these questions reflects the broader digitization of cultural heritage studies. Research has shown that AI can facilitate conservation by predicting environmental risks to artifacts [1], support accessibility by creating tools for disabled audiences [6], and enable interactive storytelling through chatbots and generative

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AI [2, 3]. Bibliometric analyses confirm that publications on AI and museums have increased dramatically since the mid-2010s [13, 17]. Importantly, this literature also highlights the uneven adoption of AI technologies across regions. While institutions in Europe and North America have often been early adopters, Chinese and Middle Eastern museums have increasingly leveraged AI for both cultural dissemination and smart museum infrastructure [10, 16].

Beyond technical applications, AI compels museums to reconsider their philosophical foundations. Traditional curatorial practice has emphasized the authority of experts to interpret objects and create coherent narratives. AI, however, opens the possibility of co-creation, where visitors, algorithms, and curators collectively shape meaning. This shift is evident in projects where generative AI produces alternative exhibition narratives, encouraging audiences to engage not just as passive recipients but as active participants. Such approaches align with broader moves toward participatory and dialogic models of museology, yet they also raise ethical dilemmas about authorship and authenticity. Kikilashvili [8], for instance, highlights the legal ambiguities surrounding AI-generated artworks in the context of EU exhibition law, illustrating the broader governance challenges museums must navigate.

The significance of AI for museums extends beyond immediate practical applications. It symbolizes a broader transformation in how culture is produced, preserved, and consumed in the digital age. AI technologies offer museums the potential to democratize access to heritage by transcending linguistic and physical barriers. They also provide tools for predictive modeling, which can safeguard collections against climate change and other environmental threats. Yet, these same technologies risk amplifying cultural bias, commercializing heritage, and undermining the authenticity of museum narratives. For this reason, it is crucial that scholars, curators, policymakers, and technologists engage in critical dialogue about the responsible integration of AI in museum practice.

This review seeks to provide a comprehensive synthesis of the current state of research on AI in museums, focusing on four key domains: (1) conservation and restoration, (2) exhibition and narrative design, (3) education and accessibility, and (4) visitor experience and smart museum infrastructures. The review also critically examines the challenges and ethical concerns raised by AI adoption, particularly with respect to authenticity, inclusivity, and governance. Finally, the paper outlines future directions, emphasizing the need for interdisciplinary collaboration and international ethical frameworks.

By situating AI within the evolving landscape of museum studies, this paper contributes to a growing body of literature that views technology not merely as a tool but as a collaborator in cultural interpretation. The integration of AI into museums is not an inevitable or uniform process; rather, it reflects a complex negotiation between technological innovation and cultural responsibility. The central argument advanced here is that the future of AI in museums will depend less on the sophistication of the technologies themselves and more on the institutional choices made about how these tools are deployed. In this way, museums serve as testbeds for broader societal debates about the role of AI in shaping human knowledge, memory, and identity.

2. Literature Review

The academic literature on artificial intelligence (AI) in museums has expanded substantially over the past two decades, reflecting both the acceleration of technological innovation and the evolving priorities of cultural institutions. While early scholarship on digital heritage was primarily concerned with digitization and online access, more recent work has emphasized the transformative role of AI in shaping conservation practices, exhibition design, visitor engagement, and museum education. This section reviews the major themes and trends in the literature, paying particular attention to chronological developments, methodological diversity, and regional differences.

2.1. Early Work: Digitization and the Foundations of Digital Heritage

The roots of AI in museums lie in earlier projects of digitization and digital heritage studies. From the late 1990s to the early 2010s, museums focused heavily on building digital catalogues and making collections accessible online. During this period, computational methods were primarily seen as tools for improving efficiency in documentation and cataloguing rather than as partners in interpretation. Research largely centered on metadata standards, digital archives, and database interoperability. Although these efforts predated the current wave of AI applications, they laid the groundwork by creating structured datasets upon which machine learning algorithms could later operate.

2.2. The Rise of AI Applications in the 2010s

The mid-2010s marked the beginning of substantive discussions about AI in the cultural heritage sector. As machine learning and computer vision matured, scholars began exploring applications beyond digitization. For example, Gaia, Boiano, and Borda [3] examined the potential of AI-powered chatbots to create interactive museum experiences. Their work emphasized the dialogic possibilities of AI, enabling museums to shift from one-way information dissemination to interactive visitor engagement. Similarly, Ismail [7] provided an early conceptual vision of how AI and emerging technologies could transform museum operations, calling attention to both conservation and educational potentials.

These contributions signaled a shift from viewing AI as an operational tool to recognizing its interpretive and experiential dimensions. At the same time, scholars also began to raise concerns about the implications of AI adoption, particularly with respect to authenticity and curatorial authority.

2.3. The 2020s: Generative AI and Expanding Horizons

In the 2020s, the literature expanded rapidly as AI technologies became more sophisticated and accessible. A key theme is the use of generative AI to co-create cultural narratives and exhibition experiences. Fu et al. [2] demonstrated how generative AI could be employed to design artifacts and enhance storytelling in museum exhibitions, framing AI as a creative partner rather than merely a tool. Furthermore, scholars explored how visitors themselves could collaborate with generative AI to reconstruct cultural heritage narratives, thus positioning museums as spaces of participatory co-creation.

Another major area of focus is exhibition design and immersive experiences. Xu [15] investigated the role of AI in exhibition planning, emphasizing how algorithms can analyze visitor data to create tailored, audience-centered designs. Ribeiro and Santos [11] discussed how the integration of AI with VR, AR, and gamification could produce immersive, multisensory experiences, redefining the very concept of museum exhibits. These studies highlight the increasing convergence of AI with other digital technologies in shaping the museum experience.

In terms of conservation, scholars have underscored AI's capacity to monitor and preserve fragile artifacts. Wang and Fan [14] demonstrated AI-driven methods for conservation and restoration, while Shen and Zhu [12] analyzed AI's role in safeguarding cultural heritage through

predictive modeling and digital archiving. Bile et al. [1] developed neural networks for predicting short-term environmental fluctuations in museums, thereby illustrating the practical benefits of AI for preventative conservation. These studies represent a growing body of literature that integrates AI with conservation science.

2.4. Accessibility and Inclusivity

A growing body of research highlights AI's potential for improving accessibility and inclusivity in museums. Islek et al. [6] examined how AI could support accessible museum experiences for people with disabilities, underscoring its role in promoting cultural participation for marginalized groups. Ilhan and Aslan [5] considered AI's contribution to museum education, particularly its capacity to enable adaptive learning. Yang and Cui [16] explored AI's role in multimodal translation, illustrating how AI can help museums reach global audiences by bridging linguistic barriers. Together, these works reveal that AI is not only a technological innovation but also a catalyst for rethinking the social mission of museums.

2.5. Ethical Concerns and Governance

While the literature largely celebrates the benefits of AI, scholars have also raised important concerns. Kikilashvili [8] investigated the legal and ethical status of AI-generated artworks in the EU, questioning whether such creations can be recognized as authentic works of art. Siri [13] warned against overemphasizing the technological spectacle of AI at the expense of meaningful cultural engagement, while Ghaith and Hutson [4] highlighted the importance of ethical frameworks for inclusive conservation. These studies underscore the need for critical reflection and governance mechanisms to ensure that AI enhances rather than undermines the mission of museums.

2.6. Bibliometric and Systematic Reviews

In addition to case studies, scholars have employed bibliometric and systematic review methods to analyze trends in AI and museums. Siri [13] conducted a bibliometric analysis of AI in museums using Scopus data, revealing a sharp increase in publications after 2015 and identifying clusters of research focused on education, accessibility, and exhibition design. Yu et al. [17] carried out a systematic review of AI curation in museums, showing how the discourse has shifted from conceptual frameworks to practical implementations. These meta-level analyses provide a useful overview of the field and highlight areas where further research is needed, such as long-term impact assessments and cross-cultural comparisons.

2.7. Regional Variations

Finally, the literature reflects notable regional variations in the adoption and study of AI in museums. European and North American institutions have often been early adopters, with substantial investments in immersive technologies and data-driven visitor analytics. In contrast, Chinese museums have emphasized AI's role in cultural dissemination and smart infrastructure [10, 16]. Meanwhile, scholars in Eastern Europe have explored AI's contribution to heritage preservation under conditions of resource constraints [9]. These variations highlight the importance of context in shaping both the opportunities and challenges of AI adoption in the museum sector.

2.8. Summary

Overall, the literature reveals a dynamic and rapidly evolving field. Early work emphasized digitization, the 2010s marked the rise of interactive AI applications, and the 2020s have been defined by generative AI and interdisciplinary collaborations. At the same time, scholars have raised critical concerns about ethics, governance, and inclusivity. Bibliometric analyses demonstrate the exponential growth of the field, while regional studies underscore the unevenness of adoption across global contexts. Collectively, this literature provides a rich foundation for analyzing the applications, challenges, and future directions of AI in museums, which will be explored in the subsequent sections of this review.

3. Applications

3.1. Conservation and Restoration

Conservation is one of the most critical responsibilities of museums, ensuring that cultural artifacts are preserved for future generations. Artificial intelligence has increasingly been recognized as a transformative tool in this domain. By leveraging computer vision, predictive analytics, and neural networks, AI can assist conservators in identifying risks, preventing damage, and even restoring objects with unprecedented precision.

One of the most prominent applications involves the use of AI for environmental monitoring. Museums house artifacts that are highly sensitive to fluctuations in temperature, humidity, and light. Bile et al. [1] developed a model based on artificial neural networks that predicts short-term temperature evolution in museum environments, enabling staff to take proactive measures to safeguard collections. This predictive capacity is particularly valuable in the context of climate change, where extreme weather events and environmental instability pose new risks to heritage institutions.

In addition to environmental monitoring, AI supports digital restoration and archiving. Shen and Zhu [12] examined how AI technologies could digitize fragile artifacts and generate predictive models for their preservation, providing virtual surrogates in case of deterioration or loss. Wang and Fan [14] advanced this work by demonstrating how machine learning algorithms could assist in the detection of micro-damages and support restoration decisions. These approaches allow conservators to intervene more effectively and allocate resources to the most at-risk items.

AI also plays a role in heritage authentication and forgery detection. By analyzing patterns at the microscopic level, AI can identify subtle discrepancies that human experts might miss. This not only enhances conservation practices but also supports the integrity of museum collections. Kotsiubivska, Tymoshenko, and Vasylevsky [9] have argued that such technologies are particularly valuable in regions where resources for conservation are limited, as AI can reduce costs while improving accuracy.

Together, these studies illustrate that AI is reshaping conservation from a reactive practice into a proactive, predictive discipline. Rather than responding to damage after it occurs, museums can now anticipate and prevent risks, thereby extending the lifespan of cultural artifacts.

3.2. Exhibition and Narrative Design

Exhibition design has traditionally relied on curatorial expertise to construct narratives around objects. With the advent of AI, this process has become increasingly dynamic and participatory. AI tools

allow curators to analyze visitor preferences, generate new interpretive frameworks, and even co-create exhibits with audiences.

A seminal contribution to this domain is Gaia, Boiano, and Borda's [3] study of AI-powered chatbots, which demonstrated how conversational agents could engage visitors in interactive dialogues. Rather than presenting static information panels, chatbots create personalized pathways through exhibitions, adapting content based on visitor questions. This innovation reflects a broader trend toward dialogic museology, where interpretation is co-constructed between institutions and audiences.

Generative AI has further expanded these possibilities. Fu et al. [2] explored how generative AI could co-create artifacts and exhibition content, demonstrating that such collaborations can foster deeper emotional engagement. Scholars extended this work by examining how visitors could use AI to reconstruct cultural narratives, effectively transforming audiences from passive consumers into active co-authors. Xu [15] also emphasized AI's role in analyzing audience data to optimize exhibition design, ensuring that displays are tailored to diverse visitor needs.

The integration of AI with immersive technologies such as virtual reality (VR) and augmented reality (AR) further enriches exhibition design. Ribeiro and Santos [11] proposed AI-driven immersive systems that adapt in real time to user interactions, combining VR, AR, and gamification. Such approaches create multisensory environments that allow visitors to "step into" cultural heritage contexts, whether walking through ancient cities or participating in reconstructed rituals.

These studies highlight a fundamental shift: exhibitions are no longer fixed narratives determined solely by curators but dynamic, adaptive experiences shaped by the interplay of curators, visitors, and AI systems. While this enhances engagement, it also raises questions about curatorial authority and the authenticity of AI-generated narratives, which will be discussed later in this review.

3.3. Education and Accessibility

Education has always been a central mission of museums, and AI significantly expands their pedagogical toolkit. AI enables adaptive learning, supports multimodal communication, and promotes inclusivity by making museums more accessible to diverse audiences.

Ilhan and Aslan [5] highlighted the potential of AI in museum education, particularly in designing adaptive learning experiences that respond to individual visitor needs. Such systems allow museums to move beyond one-size-fits-all programming toward personalized educational pathways. Similarly, Islek et al. [6] examined how AI can create accessible experiences for visitors with disabilities, including real-time translation, text-to-speech services, and tactile feedback systems. These innovations align with the growing emphasis on equity and inclusion in cultural institutions.

AI also plays a crucial role in multilingual translation and global outreach. Yang and Cui [16] investigated how AI-driven multimodal mediation could translate Chinese museum culture for international audiences, thereby bridging linguistic barriers. Their findings underscore the importance of AI for expanding the reach of museums, especially in an increasingly globalized and interconnected world.

In addition, AI contributes to interactive educational programming. Ghaith and Hutson [4] argued that AI could facilitate inclusive heritage conservation practices, which are often integrated into museum education. By embedding AI into conservation exhibits, museums can educate the public about both technological innovations and heritage preservation.

Collectively, these studies demonstrate that AI not only enhances the educational mission of museums but also redefines accessibility. By tailoring content to individual needs and breaking down barriers of language and ability, AI helps museums fulfill their role as public institutions that serve diverse communities.

3.4. Visitor Experience and Smart Museums

Beyond conservation, exhibition, and education, AI is transforming the overall visitor experience through the concept of the "smart museum." Smart museums integrate AI with Internet of Things (IoT) technologies, big data analytics, and responsive architecture to create adaptive environments.

Ribeiro and Santos [11] demonstrated how AI could enhance immersive visitor experiences by combining real-time behavioral data with adaptive VR and AR content. This allows exhibitions to evolve dynamically, offering different experiences based on individual visitor engagement. Li [10] further explored the role of AI in smart museum infrastructure, examining how AI-enabled buildings can optimize energy use, monitor visitor flow, and enhance safety. These applications demonstrate AI's potential to make museums not only more engaging but also more sustainable.

Visitor analytics represent another important dimension of smart museums. By analyzing movement patterns, dwell times, and visitor interactions, AI provides valuable insights for curators and administrators. These data-driven insights can inform exhibition planning, improve crowd management, and enhance the overall quality of visitor services.

Importantly, the smart museum model also has implications for inclusivity and participation. Adaptive systems ensure that exhibitions remain accessible and engaging across diverse audiences, offering personalized pathways and real-time adjustments. However, the reliance on surveillance and data collection also raises ethical questions about privacy and consent, which require careful consideration.

3.5. Summary of Applications

The literature illustrates that AI applications in museums span a wide range of domains: conservation, exhibition, education, and visitor experience. Collectively, these innovations demonstrate AI's potential to transform museums into more efficient, inclusive, and engaging institutions. At the same time, they reveal the challenges of balancing technological innovation with ethical responsibility and cultural authenticity.

4. Challenges and Ethical Issues

The integration of artificial intelligence (AI) into museums is accompanied by significant challenges that go beyond technical limitations. While AI promises to enhance conservation, enrich exhibitions, and democratize access, it also raises pressing questions about authenticity, ethics, inclusivity, and governance. This section reviews the major debates in the literature surrounding these challenges.

4.1. Authenticity and Curatorial Authority

One of the most frequently cited concerns in the literature is the question of authenticity. Museums traditionally position themselves as trusted custodians of cultural artifacts, where authenticity underpins institutional authority. AI complicates this relationship by introducing algorithmically generated outputs into the museum space. Kiki-

lashvili [8] argued that AI-generated artworks challenge established legal and philosophical definitions of authorship in the European Union, raising questions about whether they can be considered authentic museum artifacts. Similarly, generative AI systems that create narratives or visual representations risk blurring the boundaries between human creativity and algorithmic simulation.

For curators, this raises the issue of interpretive authority. Traditionally, curators construct narratives that frame how visitors understand objects. AI-driven personalization and co-creation tools shift part of this interpretive power to algorithms and audiences, which can destabilize the traditional authority of curators. While some scholars view this as a democratizing process, others warn that it risks fragmenting the coherence of exhibitions and eroding trust in museums.

4.2. Intellectual Property and Copyright

Closely related to authenticity are questions of copyright and intellectual property. AI systems are trained on vast datasets that often include copyrighted materials. The use of these datasets to generate new outputs has sparked global debates about ownership and fair use. For museums, which rely on intellectual property protections to regulate the reproduction of collections, the rise of AI-generated content creates legal uncertainty. Kikilashvili [8] emphasized that current EU law does not provide adequate guidance for AI-generated works, creating a gap that could undermine both artists' rights and museums' curatorial practices.

These uncertainties are especially acute in collaborative projects where generative AI is used to produce exhibition content. When AI co-creates artifacts with curators or visitors, the question arises: who owns the resulting work? The lack of clear legal frameworks poses risks for museums that seek to adopt AI but also remain compliant with copyright regulations.

4.3. Data Bias and Inclusivity

AI systems are only as objective as the data on which they are trained. If training datasets are biased or incomplete, the resulting outputs can perpetuate or even exacerbate existing inequalities. Siri [13] warned against the overemphasis on AI's technological spectacle, which may mask the ways in which algorithms reproduce cultural biases. For instance, if datasets overrepresent Western cultural artifacts, AI systems may prioritize Western narratives at the expense of non-Western perspectives, thereby reinforcing global cultural hierarchies.

Inclusivity is particularly relevant in accessibility initiatives. While AI tools can enhance access for people with disabilities, they may also inadvertently exclude groups if not carefully designed. For example, voice recognition systems often struggle with non-standard accents, and image recognition algorithms may fail to represent non-Western objects accurately. These limitations underscore the need for diverse and representative training datasets as well as inclusive design practices.

4.4. Privacy and Surveillance

Another major concern is privacy. The rise of smart museums, which rely on sensors, cameras, and AI-driven visitor analytics, has increased the collection of personal data. While these tools enable museums to optimize visitor experiences and crowd management, they also raise ethical questions about consent and surveillance. Visitors may not always be aware that their behaviors are being tracked and analyzed, which could undermine trust between institutions and the public.

Moreover, data security is an ongoing challenge. Museums, like other institutions, are vulnerable to cyberattacks that could compromise sensitive visitor data. The implementation of AI systems thus necessitates robust data protection frameworks that balance innovation with privacy rights.

4.5. Technological Dependence and Resource Inequalities

The adoption of AI also risks deepening inequalities between institutions. Wealthy museums with substantial resources can afford to invest in cutting-edge AI systems, while smaller institutions may struggle to keep pace. This digital divide could exacerbate existing inequalities in the cultural sector, concentrating innovation in a few well-funded institutions while leaving others behind.

Furthermore, an overreliance on AI can lead to technological determinism, where institutions prioritize technological solutions over human judgment and curatorial expertise. Siri [13] warned that museums risk becoming sites of technological spectacle rather than spaces of meaningful cultural engagement. If AI is deployed uncritically, museums may inadvertently shift their mission from education and heritage preservation toward entertainment-driven experiences.

4.6. Governance and Ethical Frameworks

Scholars widely agree that robust governance mechanisms are needed to regulate AI adoption in museums. Ghaith and Hutson [4] emphasized the importance of developing ethical frameworks that ensure inclusive and equitable applications of AI in cultural heritage conservation. International organizations such as UNESCO have begun advocating for ethical AI guidelines, but these frameworks remain in early stages and often lack enforceability.

A key challenge lies in balancing global standards with local contexts. While universal ethical principles are necessary, they must also be adaptable to the diverse cultural, legal, and institutional settings in which museums operate. Collaborative governance, involving curators, technologists, policymakers, and communities, is therefore essential to ensure that AI aligns with the mission of museums rather than undermining it.

4.7. Summary

In sum, the challenges of AI adoption in museums encompass authenticity, copyright, inclusivity, privacy, inequality, and governance. These issues highlight that AI is not merely a technical innovation but a social and cultural phenomenon with far-reaching implications. Addressing these challenges requires critical reflection, ethical frameworks, and collaborative governance. Without such measures, the transformative potential of AI could be undermined by ethical dilemmas and public mistrust.

5. Future Directions and Conclusion

The future of AI in museums is poised to be transformative, but its trajectory will depend on institutional choices, governance frameworks, and societal values. Rather than a linear adoption of new technologies, the integration of AI should be understood as a negotiation between innovation and responsibility.

5.1. Toward Participatory and Co-Creative Museums

One of the most promising directions lies in the development of participatory models of museology. Recent participatory experiments have shown that museums may increasingly position visitors as co-creators of meaning rather than passive recipients. Generative AI can support this by allowing audiences to engage in personalized storytelling, contribute interpretations, and shape exhibit narratives. Such practices align with broader movements in cultural studies toward democratization and shared authority.

5.2. AI for Global Accessibility and Cultural Exchange

Another future pathway is the use of AI to facilitate cross-cultural communication. Yang and Cui [16] demonstrated how multimodal AI can enhance the international dissemination of museum culture, especially in non-Western contexts. By integrating text, image, and audio, AI systems may bridge linguistic and cultural divides, enabling museums to serve as hubs of global exchange. Future developments may see AI functioning as cultural translators, not just linguistic ones, ensuring that heritage narratives resonate across diverse audiences.

5.3. Integration with Immersive and Emerging Technologies

AI is also likely to converge with immersive technologies such as virtual reality (VR) and augmented reality (AR). Ribeiro and Santos [11] have already shown how AI-driven gamification can enhance exhibitions. Future applications may involve AI-curated VR tours that adapt dynamically to visitor preferences, or AR overlays that provide real-time interpretive content tailored to a visitor's interests. Such integrations point toward hybrid museum environments that blur the boundaries between physical and digital space.

5.4. Ethical AI Frameworks for Museums

As AI adoption grows, the development of ethical frameworks will become increasingly urgent. Kikilashvili [8] has raised critical questions about copyright, while Ghaith and Hutson [4] emphasize governance needs. Future scholarship must address these concerns by proposing actionable frameworks that balance innovation with responsibility. Such frameworks should include principles of transparency, accountability, inclusivity, and cultural sensitivity. International cooperation may be necessary to establish shared guidelines, particularly as museums operate across global cultural and legal contexts.

5.5. Sustaining Human Expertise in the Age of AI

A recurring theme across the literature is the irreplaceable role of human expertise. Ismail [7] has argued that AI should be seen as a collaborator rather than a substitute. Looking forward, museums must prioritize hybrid models where AI supports but does not supplant curators, educators, and conservators. Professional training programs will be essential to equip museum staff with the skills to critically assess and responsibly integrate AI tools.

5.6. Conclusion

The integration of AI into museums represents both opportunity and challenge. On the one hand, AI offers tools for predictive conservation, adaptive exhibitions, inclusive accessibility, and participatory storytelling. On the other hand, it raises complex issues of authenticity, bias, copyright, and governance. The future of AI in museums will thus hinge less on the sophistication of the technology itself than on the choices museums make about its adoption.

Museums are not merely sites of display; they are custodians of memory, interpreters of culture, and educators of society. AI can support these missions if implemented thoughtfully, but it must be guided by ethical responsibility, inclusivity, and respect for human expertise. The central task ahead is to ensure that AI serves as a bridge between past and future, enhancing rather than eroding the core values of the museum institution.

Author Contribution

Zihan Yu: Conceptualization, Writing-Original Draft. The author has read and agreed to the published version of the manuscript.

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Competing Interest Declaration

The author declares that, to their knowledge, they have no financial, personal, or professional relationships that could be construed as a potential competing interest regarding the work described in this manuscript.

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