
| RESEARCH ARTICLE

Artificial Intelligence and Cultural Heritage: A Review of Opportunities, Risks, and Ethical Challenges

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| ABSTRACT

Artificial intelligence (AI) is increasingly transforming the documentation, preservation, interpretation, and public engagement of cultural heritage. This review examines the opportunities, risks, and ethical challenges associated with the application of AI in cultural heritage management and research. Drawing on interdisciplinary literature spanning heritage studies, computer science, digital humanities, museum studies, and information ethics, the review synthesizes evidence on the use of machine learning, computer vision, natural language processing, generative AI, and three-dimensional technologies in heritage contexts. The findings indicate that AI can enhance the digitization and classification of cultural collections, reconstruct damaged or lost heritage assets, support archaeological analysis, improve multilingual access to heritage resources, and create more interactive experiences for museums and heritage sites. AI also offers opportunities for predictive conservation through automated monitoring of environmental conditions, material deterioration, and structural changes. However, these benefits are accompanied by significant risks, including algorithmic bias, inaccurate reconstruction, cultural misrepresentation, intellectual-property disputes, data privacy concerns, technological dependency, and the marginalization of communities whose cultural knowledge is incorporated into AI systems without meaningful participation or consent. Generative AI presents additional challenges because synthetic representations may blur distinctions between historically documented evidence and machine-generated interpretations. The review therefore emphasizes the importance of human oversight, transparent documentation of AI-generated outputs, culturally sensitive data governance, community participation, provenance tracking, and equitable access to digital heritage technologies. Overall, AI should be understood not simply as a technological tool but as a socio-cultural intervention whose deployment requires collaboration among technologists, heritage professionals, researchers, governments, and source communities. Responsible and inclusive AI governance can enable technological innovation while protecting the authenticity, diversity, ownership, and cultural significance of heritage resources.

| KEYWORDS

Artificial intelligence; Cultural heritage; Digital preservation; Generative AI; Heritage ethics.

| ARTICLE INFORMATION

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1. Introduction

Cultural heritage represents the tangible and intangible expressions through which societies preserve, interpret, and transmit their histories, identities, knowledge, beliefs, and creative practices across generations. Tangible heritage includes archaeological sites, historic buildings, monuments, museum collections, manuscripts, artworks, and cultural landscapes, while intangible heritage encompasses languages, oral traditions, rituals, music, performing

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arts, traditional knowledge, craftsmanship, and social practices (Islam, 2026). The preservation of these resources has become increasingly complex because cultural heritage is exposed to natural deterioration, urban development, armed conflict, climate change, illicit trafficking, mass tourism, and the gradual loss of traditional knowledge. At the same time, rapid developments in digital technologies have created new possibilities for documenting, managing, interpreting, and sharing heritage resources (Tiribelli, 2024). Among these technologies, artificial intelligence (AI) has emerged as an increasingly important tool with potential applications across the cultural heritage lifecycle, from documentation and conservation to interpretation, education, and public engagement.

Artificial intelligence refers broadly to computational systems capable of performing tasks that traditionally require aspects of human intelligence, including pattern recognition, classification, prediction, language processing, image analysis, and decision support. Recent advances in machine learning, deep learning, computer vision, natural language processing, generative AI, and multimodal systems have expanded the range of applications available to cultural heritage institutions (Pansoni, 2023). AI can assist in identifying objects within large digital collections, recognizing architectural or archaeological features, transcribing historical documents, translating heritage materials, reconstructing damaged or incomplete objects, and improving access to digitized collections. Computer vision, for example, can be used to analyze photographs, paintings, manuscripts, archaeological artefacts, and architectural structures, while natural language processing can support the organization and retrieval of textual collections (Ghaith, 2024). These capabilities are particularly significant as museums, archives, libraries, archaeological organizations, and heritage agencies generate increasingly large quantities of digital data.

One of the most important opportunities presented by AI is the enhancement of cultural heritage documentation and preservation. Traditional documentation processes can be time-consuming and dependent on specialist expertise, particularly when institutions manage extensive collections or geographically dispersed heritage sites. AI-assisted image recognition and classification can help heritage professionals organize collections and identify patterns that may otherwise be difficult to detect manually. Machine-learning techniques can also support the monitoring of buildings, monuments, archaeological sites, and cultural landscapes by detecting changes in images or other forms of sensor data (Islam, 2026). Such applications may contribute to early identification of deterioration and facilitate more targeted conservation interventions. In archaeological research, AI can assist with the interpretation of remote-sensing imagery and the identification of potential archaeological features, thereby expanding researchers' capacity to investigate large or difficult-to-access areas.

AI also offers significant opportunities for the restoration and reconstruction of damaged cultural heritage. Digital technologies can combine historical photographs, archival records, three-dimensional scans, drawings, and other evidence to generate representations of objects, buildings, or sites that have been damaged or lost. Such reconstructions can support scholarly research, museum interpretation, education, and virtual access. Importantly, however, digitally reconstructed heritage must be distinguished from historically verified evidence (Wang, 2025). AI-generated reconstructions may contain assumptions or fabricated elements when source material is incomplete. Consequently, the value of AI in reconstruction depends not only on technological sophistication but also on transparent documentation of evidence, uncertainty, methodology, and human interpretation.

Another major opportunity concerns access, interpretation, and public engagement. Digital heritage collections can be difficult for non-specialist audiences to navigate because of technical terminology, large volumes of information, language barriers, and limited accessibility. AI-powered search systems, recommendation tools, conversational interfaces, automated translation, speech recognition, and personalized educational applications can make collections more accessible to diverse audiences (Fu, 2025). Generative AI may further enable museums and heritage organizations to develop interactive narratives, educational resources, multilingual descriptions, and virtual experiences. These applications can potentially broaden participation in cultural heritage by connecting collections with audiences who may be geographically distant from physical institutions or excluded by conventional modes of interpretation.

Despite these opportunities, the integration of AI into cultural heritage raises substantial ethical, epistemological, legal, and social concerns. Cultural heritage is not simply a collection of objects or datasets; it is closely connected to community identity, memory, cultural rights, and relationships between present and past generations. AI systems trained on digitized heritage materials may reproduce assumptions embedded in historical records or institutional catalogues (Shaikhon, 2025). Where datasets are incomplete or disproportionately represent particular cultures, regions, languages, or social groups, AI-generated outputs may reinforce existing inequalities. The apparent objectivity of algorithmic systems can therefore obscure the human decisions involved in selecting data, defining categories, designing models, and interpreting results.

The issue of cultural representation is particularly important when AI is used to generate or interpret heritage narratives. Generative systems can produce convincing descriptions, images, reconstructions, or historical explanations even when the underlying evidence is uncertain. This creates risks of historical inaccuracies, fabricated information, cultural stereotyping, and the unintentional alteration of collective memory (Pisoni, 2021). In heritage contexts, an inaccurate AI-generated interpretation may have consequences beyond ordinary misinformation because it can influence how communities understand their histories and how external audiences perceive their cultural identities. Human oversight, source verification, provenance documentation, and clear communication of uncertainty are therefore essential when AI-generated content is used for heritage interpretation.

Questions of ownership, intellectual property, consent, and cultural sovereignty further complicate AI adoption. Digitized cultural materials may include works whose copyright status varies, traditional knowledge that is collectively held, sacred materials that communities do not wish to make publicly accessible, or objects acquired under historically unequal circumstances. The availability of a cultural object or archival record in digital form does not necessarily mean that unrestricted AI processing, reproduction, or commercial use is ethically appropriate. Indigenous communities and other source communities may have specific expectations concerning access, attribution, representation, and control over cultural knowledge (Islam, 2023). AI-related heritage initiatives consequently require attention to community participation, rights, provenance, and culturally appropriate governance rather than relying exclusively on technical or institutional considerations.

Data privacy and security are additional concerns, particularly when AI systems process personal information contained within archival collections, oral histories, photographs, genealogical records, or contemporary community datasets. Digitization and AI can increase the discoverability and accessibility of information that was previously difficult to locate. While greater accessibility can support research and public engagement, it can also expose sensitive information or enable unintended forms of surveillance and profiling (Zamchalova, 2023). Heritage institutions therefore face the challenge of balancing openness and accessibility with privacy, cultural sensitivity, data protection, and responsible stewardship.

There are also practical challenges associated with technological inequality and institutional capacity. Large cultural institutions may have access to specialized staff, computing infrastructure, digitization facilities, and financial resources, whereas smaller museums, archives, libraries, and community organizations may face significant barriers to AI adoption. Differences in digital infrastructure and technical expertise could therefore create a new form of heritage inequality in which well-resourced institutions are better positioned to digitize, analyze, and promote their collections (Laohaviraphap, 2024). Language representation is another concern because AI technologies tend to perform unevenly across languages, particularly for low-resource languages and dialects. This is especially relevant to intangible cultural heritage, where oral traditions and local languages may have limited digitized training data.

The responsible use of AI in cultural heritage therefore requires a multidisciplinary approach that brings together heritage professionals, historians, archaeologists, conservators, archivists, librarians, computer scientists, legal scholars, ethicists, and source communities. Rather than treating AI as a replacement for human expertise, emerging approaches increasingly emphasize human oversight, explainability, provenance, participatory governance, and accountability. The involvement of communities is particularly important because decisions concerning the digitization, interpretation, and circulation of cultural heritage can affect how cultural identities and historical

narratives are represented (Floridi, 2023). Ethical AI in heritage should consequently consider not only whether a system can perform a particular task, but also whether its use respects cultural values, historical evidence, community rights, and principles of responsible stewardship.

Against this background, a systematic examination of the relationship between artificial intelligence and cultural heritage is necessary. Existing applications demonstrate considerable potential for improving documentation, conservation, research, accessibility, education, and engagement, but technological benefits cannot be separated from questions of accuracy, bias, ownership, privacy, cultural sovereignty, authenticity, and unequal access. This review therefore examines the opportunities, risks, and ethical challenges associated with the application of AI to cultural heritage (Raso, 2018). By bringing together evidence across technological and heritage domains, the review seeks to clarify how AI is transforming heritage practices, identify major areas of concern, and highlight principles and governance approaches that can support responsible, inclusive, and evidence-based adoption of AI in cultural heritage.

2. Methodology

2.1 Research Design

This study employed a structured narrative review design to examine the opportunities, risks, and ethical challenges associated with the application of artificial intelligence (AI) in cultural heritage. A review approach was considered appropriate because AI applications in cultural heritage span multiple disciplines, including archaeology, museum studies, archival science, conservation, digital humanities, computer science, anthropology, and information science. The review synthesized existing scholarly evidence to identify major applications of AI, assess their potential contributions to cultural heritage preservation and interpretation, and critically examine concerns related to authenticity, bias, cultural ownership, privacy, intellectual property, representation, and technological dependence.

2.2 Search Strategy

A comprehensive literature search was undertaken using major academic databases and scholarly information sources, including Scopus, Web of Science, ScienceDirect, SpringerLink, Taylor & Francis Online, Wiley Online Library, IEEE Xplore, and Google Scholar. Searches focused on literature published in English and incorporated combinations of keywords and Boolean operators. The principal search terms included "artificial intelligence," "machine learning," "deep learning," "cultural heritage," "digital heritage," "heritage preservation," "archaeology," "museum," "archives," "heritage conservation," "computer vision," "natural language processing," "generative AI," "ethics," "bias," "authenticity," "intellectual property," and "cultural ownership." Search strings were adapted to the requirements of individual databases to maximize the retrieval of relevant literature.

2.3 Eligibility Criteria

Studies were considered eligible when they directly examined the application, implications, or governance of AI within cultural heritage contexts. The review included peer-reviewed journal articles, conference papers, scholarly book chapters, and authoritative institutional publications that provided substantive evidence concerning AI-enabled heritage documentation, preservation, conservation, interpretation, classification, reconstruction, management, or public engagement. Literature addressing ethical and societal implications of AI in heritage was also included where it contributed to understanding issues such as algorithmic bias, cultural representation, data ownership, privacy, intellectual property, authenticity, or community participation. Studies were excluded when they focused exclusively on AI applications unrelated to cultural heritage, contained insufficient discussion of the subject, or were inaccessible in full text. Duplicate records and publications with substantially overlapping content were removed during the screening process.

2.4 Literature Screening and Selection

The retrieved literature was screened in successive stages. Initially, titles and abstracts were examined to determine their apparent relevance to the research objectives. Potentially relevant publications were subsequently assessed through full-text examination. During this process, particular attention was given to whether a publication provided evidence about AI technologies used in cultural heritage or critically addressed the opportunities, risks, and ethical

implications associated with their use. Studies that did not satisfy the established eligibility criteria were excluded. The remaining literature constituted the evidence base for the thematic synthesis.

2.5 Data Extraction

Relevant information was systematically extracted from the selected literature. The extracted information included publication characteristics, cultural heritage domain, AI technology or computational method examined, principal application, reported benefits, identified limitations, ethical concerns, and implications for heritage professionals and communities. Attention was also given to the geographical and institutional contexts in which AI applications were reported because cultural heritage practices and ethical expectations can differ considerably across societies and heritage institutions. The extracted information was organized thematically to facilitate comparison across different applications and perspectives.

2.6 Thematic Analysis

The reviewed literature was analyzed using thematic synthesis. Findings were initially grouped according to the principal applications of AI in cultural heritage, including automated documentation and digitization, image and object recognition, archaeological discovery and classification, restoration and conservation, digital reconstruction, museum interpretation, heritage information management, and public engagement. A second analytical dimension focused on the opportunities created by these applications, particularly improved efficiency, large-scale data processing, preservation of vulnerable heritage resources, enhanced accessibility, and new approaches to interpretation. A third dimension examined risks and ethical challenges, including algorithmic bias, inaccurate reconstruction, loss of authenticity, data and intellectual property concerns, cultural appropriation, privacy, unequal technological access, limited community participation, and overreliance on automated systems.

2.7 Critical Synthesis of Evidence

Rather than treating all reported AI applications as inherently beneficial, the review critically compared the evidence concerning their benefits and limitations. Particular emphasis was placed on the relationship between technological performance and cultural validity. For example, an AI system may demonstrate high accuracy in recognizing objects or reconstructing damaged materials while still producing culturally inappropriate interpretations when the underlying datasets are incomplete or biased. The synthesis therefore considered both technical and socio-cultural dimensions of AI adoption. Where studies reported conflicting findings, differences were examined in relation to technological approaches, datasets, institutional contexts, cultural settings, and research objectives.

2.8 Ethical Considerations

Because the study was based exclusively on previously published and publicly available literature, it did not involve direct participation of human subjects and therefore did not require primary-data collection from individuals or communities. Nevertheless, ethical considerations were incorporated into the review itself. Particular attention was given to scholarship concerning Indigenous and local communities, culturally sensitive materials, ownership and control of heritage data, informed participation, privacy, intellectual property, and the potential consequences of reproducing or digitally reconstructing culturally significant materials. The review also considered the importance of transparency, human oversight, accountability, and respect for community-defined interpretations when AI technologies are deployed in cultural heritage environments.

2.9 Methodological Limitations

The methodology has several limitations. The review was restricted primarily to English-language literature, which may have excluded relevant research published in other languages and may consequently underrepresent perspectives from particular cultural regions. Differences in terminology across disciplines may also have resulted in some relevant studies being overlooked despite the use of multiple databases and search terms. In addition, the rapid development of generative AI, computer vision, machine learning, and related technologies means that the evidence base is continually evolving. The review therefore emphasizes established themes and documented applications while recognizing that emerging AI capabilities may alter the opportunities, risks, and ethical considerations associated with cultural heritage in the future.

3. Findings and Discussion

The reviewed literature indicates that artificial intelligence (AI) is increasingly becoming an important component of cultural-heritage documentation, interpretation, conservation, education, and public engagement. The evidence, however, suggests that AI adoption remains uneven: technical experimentation and proof-of-concept applications are considerably more common than long-term deployment and rigorous evaluation in operational heritage institutions (Islam, 2023). A recent systematic review of 64 studies identified five principal application domains: restoration and preservation, documentation and digitization, management and decision support, generation and creative reconstruction, and education and visitor experience, with education and experience receiving particularly strong research attention. The same review identified data availability and quality as the most frequently reported adoption challenge and noted that empirical evaluation in operational institutions remains comparatively limited.

3.1 Artificial Intelligence Applications in Cultural Heritage

3.1.1 Digital Documentation, Digitization, and Heritage Preservation

One of the clearest findings of the review is that AI can substantially extend the scale and efficiency of cultural-heritage documentation. Machine learning and computer-vision systems can process photographs, scanned documents, laser scans, point clouds, satellite imagery, and other digital records to identify objects, architectural elements, surface characteristics, inscriptions, and recurring visual patterns. AI-supported documentation can therefore reduce the amount of repetitive manual classification required from heritage professionals while making large collections more searchable and interoperable (Groumpos, 2023). A 2026 systematic review identified documentation and digitization as a major application domain, accounting for 16 of the 64 reviewed studies, with applications including digital reconstruction, handwritten-text recognition, feature recognition, metadata generation, optical character recognition, and digital knowledge repositories. Examples included the classification of traditional artifacts such as Indonesian Keris, recognition of ancient ceramics, transcription of historical manuscripts, recognition of inscription rubbings, and detection of repetitive patterns in archaeological pottery.

The evidence further demonstrates the importance of AI in three-dimensional documentation. Machine learning can assist with semantic segmentation of laser-scanned point clouds and the organization of complex spatial information, while AI-supported image processing can help identify architectural components and reconstruct incomplete digital models. Such applications are particularly relevant to monuments and archaeological sites where comprehensive manual documentation can be time-consuming and difficult to repeat (Sanchez, 2025). Recent reviews identify recognition, reconstruction, virtual restoration, monitoring, and prediction as major task-oriented applications of machine learning and deep learning in cultural heritage. At the same time, digitization should not be equated with preservation in the physical or cultural sense. A high-quality digital representation cannot substitute for conservation of the original material, contextual information, provenance, or cultural significance (Bulut, 2024). Standardized documentation practices remain important because differences in acquisition methods, metadata, formats, and 3D implementation can affect the long-term usability of digitized heritage.

AI-assisted restoration also creates opportunities for dealing with incomplete or damaged records. Image-completion and reconstruction techniques can generate plausible representations of missing visual elements, while recognition systems can help associate fragmented records with existing collections. However, these outputs must be clearly differentiated from documented evidence. An AI-generated reconstruction can represent a hypothesis about how an artifact, building, inscription, or artwork may have appeared rather than a verified historical fact (Sonni, 2024). Consequently, expert review, provenance documentation, uncertainty labels, and preservation standards are necessary to prevent computational reconstruction from being mistaken for authentic historical evidence.

3.1.2 AI-Supported Interpretation, Classification, and Knowledge Discovery

The reviewed evidence shows that machine learning, deep learning, computer vision, natural language processing, and related techniques are increasingly being used to interpret large and heterogeneous cultural collections. Classification algorithms can categorize artifacts according to material, form, style, period, or visual characteristics, while computer-vision systems can identify architectural features and archaeological objects. Natural-language-

processing systems can process historical documents and inscriptions, extract entities and relationships, and facilitate searches across extensive textual archives (Yigitcanlar, 2020). A review of 135 archaeological studies found that automatic structure detection and artifact classification were among the most represented machine-learning tasks, followed by taphonomic analysis and archaeological predictive modelling.

These applications demonstrate a significant knowledge-discovery opportunity. Conventional research may require scholars to examine large numbers of documents, images, or objects individually, whereas AI can identify recurring patterns across thousands or millions of records. For example, algorithms can detect similarities among pottery fragments, classify architectural styles, identify recurring motifs in paintings or textiles, or associate historical documents through shared names, locations, dates, or concepts (Ali, 2024). The broader machine-learning literature in cultural heritage shows applications across supervised, semi-supervised, and unsupervised learning, although adoption remains constrained by the specialist nature of heritage data and the difficulty of producing sufficiently representative datasets.

Nevertheless, algorithmic classification does not necessarily constitute historical interpretation. Cultural artifacts often contain ambiguous, contested, incomplete, or context-dependent meanings that cannot be reduced to visual similarity or statistical associations. An algorithm may correctly identify a pattern while providing an inadequate explanation of its cultural significance. The findings therefore support a complementary model in which AI performs computationally intensive recognition and pattern discovery while archaeologists, historians, anthropologists, curators, linguists, and conservators evaluate the cultural and historical meaning of the results (Huang, 2022). This human-AI relationship is particularly important because errors in automated classification can propagate into catalogs, databases, exhibitions, and subsequent research if they are not independently validated.

3.1.3 Virtual Reconstruction, Museums, and Public Engagement

AI is also expanding the ways in which cultural heritage can be experienced outside conventional physical museums and archaeological sites. AI-generated or AI-assisted reconstructions can be incorporated into virtual museums, augmented reality (AR), virtual reality (VR), digital exhibitions, interactive storytelling, and intelligent conversational interfaces. These technologies enable users to explore heritage sites remotely, visualize historical environments, interact with reconstructed artifacts, and receive information through personalized interfaces (Slimi, 2023). Earlier research on AR, VR, and mixed reality identified education, exhibition enhancement, exploration, reconstruction, and virtual museums as important applications of immersive technologies in cultural heritage. More recent systematic reviews similarly show extensive experimentation with AR-based cultural-heritage applications, particularly for visitor engagement and immersive experiences.

The educational implications are particularly significant. Interactive digital environments can allow students to explore sites that are geographically distant or physically inaccessible, while conversational systems can provide explanations at different levels of complexity. Research on participatory AR applications indicates that narrative, gaming, and interactive design can positively influence tourism experiences and engagement with cultural knowledge (Wach, 2023). Similarly, reviews of digital museum transformation indicate increasing use of virtual tours, AR, VR, big data, and AI to enrich exhibition formats and public learning.

However, immersive reconstruction introduces an important authenticity problem. When historical evidence is incomplete, AI may produce visually convincing but historically uncertain environments. A reconstructed building, missing artifact component, reconstructed face, or simulated historical scene may appear authoritative simply because it is presented with high visual realism. This creates a risk of confusing interpretation with evidence. Heritage institutions therefore need to distinguish documented features from reconstructed or hypothetical elements and communicate uncertainty to users (Murire, 2024). The objective should not simply be to create the most visually convincing experience, but to create experiences that preserve historical transparency and cultural context.

3.2 Opportunities Created by Artificial Intelligence for Cultural Heritage

3.2.1 Improved Preservation, Restoration, and Risk Management

A major opportunity identified across the literature is the application of AI to preventive conservation and condition assessment. Traditional heritage inspection frequently depends on periodic site visits, photographic documentation, specialist interpretation, and manually collected measurements. AI can complement these processes by continuously or repeatedly analyzing images, sensor measurements, environmental variables, point clouds, and historical condition records. Computer-vision models can detect cracks, erosion, discoloration, vegetation, moisture-related deterioration, and other visible changes, while machine-learning models can identify patterns that indicate increasing deterioration risk (Garzón, 2025). A recent review of deep-learning methods distinguishes classification, object detection, and segmentation approaches, with segmentation providing detailed pixel-level mapping of damage.

The practical significance is particularly evident in structural-health monitoring. AI-supported systems can process data from sensors and remote observations to assist professionals in identifying changes in structural condition and prioritizing sites or components requiring closer examination. Reviews of heritage structural-health monitoring indicate that monitoring data can contribute to cost-effective and sustainable maintenance while supporting the principle of minimum intervention that is central to historic-building conservation (Stahl, 2022). Similarly, systematic evidence on AI and IoT integration indicates that IoT systems can facilitate real-time environmental and structural monitoring while AI can analyze these data to generate predictive insights.

AI can consequently support a shift from reactive conservation toward more preventive and risk-informed management. For example, an institution could combine historical photographs, humidity and temperature measurements, structural sensor data, and recent imagery to identify areas where deterioration is accelerating. Such information could help conservation managers prioritize inspections and allocate scarce resources. Nevertheless, predictive outputs remain dependent on data quality and model generalizability (Adams, 2023). Heritage structures are often unique, and historical buildings differ substantially in materials, construction techniques, environmental exposure, and previous interventions. Recent reviews therefore identify model generalization, limited benchmark datasets, external validation, and real-world deployment as continuing challenges.

3.2.2 Increased Accessibility, Education, and Cultural Participation

AI provides important opportunities to make cultural heritage more accessible to audiences with different linguistic, geographical, educational, and physical needs. Optical character recognition can convert scanned historical materials into searchable text, while speech recognition and synthesis can support audio-based access. Natural-language processing can facilitate translation, question answering, summarization, and conversational interaction with collections. Image-captioning and multimodal systems can potentially assist users who cannot easily interpret visual museum displays (Chen, 2024). Human-centered AI research in cultural heritage emphasizes accessibility, participatory design, pedagogical design, natural-language processing, image captioning, and explainable AI as important directions for widening access to heritage experiences.

The implications extend beyond museums. Students may access digitized manuscripts that are geographically distant, researchers may search large archival collections without physically visiting repositories, and international audiences may engage with heritage through multilingual platforms (Wamba, 2025). Recent work on conversational AI for museums also demonstrates growing interest in integrating conversational agents into accessibility-oriented cultural experiences. AI can therefore contribute to a more participatory model of heritage in which users interact with collections rather than simply receiving information through conventional labels and displays.

However, increased digital access does not automatically produce digital inclusion. Users require suitable devices, reliable connectivity, digital literacy, language support, and accessible interfaces. Institutions in regions with limited technological infrastructure may not be able to provide the same AI-enabled experiences as well-resourced museums. Moreover, automated translation or speech systems may perform poorly for minority and endangered languages because the training data available for those languages are limited (Oniani, 2023). Consequently,

accessibility strategies should include community participation, local-language resources, alternative non-digital access routes, and human support rather than assuming that AI itself resolves inequalities.

3.2.3 Support for Research, Cultural Tourism, and Heritage Management

AI can strengthen heritage research by allowing scholars and institutions to process cultural data at scales that would be difficult through manual methods alone. Semantic search can connect records according to concepts rather than exact keywords, while machine learning can identify relationships across images, documents, geographical information, archaeological findings, and museum databases (Morgan, 2020). Predictive modelling can also assist archaeological surveys and heritage-risk assessment by identifying locations or objects that warrant further investigation. The literature indicates that archaeological machine-learning applications already span structure detection, artifact classification, taphonomy, and predictive modelling.

For cultural-tourism management, AI can potentially support visitor-flow analysis, personalized recommendations, multilingual information services, demand forecasting, and site-monitoring systems. Combining visitor information with environmental and spatial data could help institutions understand patterns of use and manage pressure on vulnerable sites. Interactive AR and VR systems can additionally provide alternative experiences when physical sites are overcrowded, fragile, inaccessible, or geographically remote (Islam, 2026). Evidence from reviews of immersive heritage applications suggests that interactive and participatory experiences can enhance engagement and learning, although evaluation methods remain inconsistent across studies.

The evidence nevertheless requires cautious interpretation. Much of the current research remains concentrated on prototypes, demonstrations, and experimental applications rather than long-term institutional implementation. The 2026 systematic review of AI adoption specifically found that current studies are dominated by technical development and proof-of-concept systems, while empirical evaluation within operational cultural-heritage institutions remains limited. Therefore, claims concerning efficiency, visitor satisfaction, research productivity, or economic benefits should be distinguished from demonstrated institutional outcomes (Tiribelli, 2024). More longitudinal research is needed to determine whether experimental AI systems continue to provide value after deployment, maintenance, staff training, data updating, and technological changes are taken into account.

3.3 Risks and Limitations of Artificial Intelligence in Cultural Heritage

3.3.1 Bias, Cultural Misrepresentation, and Algorithmic Errors

The reviewed evidence demonstrates that AI systems inherit many of the limitations of their training data. Cultural-heritage datasets are rarely neutral or comprehensive; they reflect previous collecting practices, institutional priorities, colonial histories, digitization choices, language availability, and differences in documentation resources. If a dataset contains predominantly well-documented European, elite, urban, or institutionally collected heritage, an AI model trained on that dataset may perform better for those categories than for local, Indigenous, minority, oral, or underrepresented traditions (Panoni, 2024). UNESCO has specifically emphasized that AI systems can embed and amplify existing power asymmetries in knowledge production and cultural representation.

This problem is particularly important for intangible cultural heritage. Oral traditions, traditional knowledge, rituals, indigenous languages, craft practices, and community narratives may not fit easily into standardized datasets. Automated systems can simplify culturally specific meanings or interpret them through categories developed outside the communities concerned (Ghaith, 2024). UNESCO has consequently highlighted the distinctive characteristics of Indigenous data and the need to respect Indigenous peoples' rights regarding how their knowledge is collected, interpreted, and used in AI systems.

Algorithmic errors can also have practical consequences. Incorrect artifact classification may enter collection databases; inaccurate transcription may alter the interpretation of historical documents; and generative systems may produce plausible but unsupported historical narratives. These problems become more serious when AI outputs are presented without uncertainty indicators or human review (Islam, 2026). The findings therefore support systematic validation procedures, diverse datasets, transparent documentation of model limitations, and meaningful

involvement of relevant cultural communities. AI should function as an analytical aid rather than an unquestionable authority on cultural meaning.

3.3.2 Data Ownership, Intellectual Property, and Cultural Sovereignty

Data governance represents another major ethical challenge. Digitization can make cultural materials technically accessible without resolving who has legitimate authority to control their reproduction, interpretation, licensing, or commercialization. This distinction is especially important for traditional knowledge, sacred materials, Indigenous cultural expressions, community archives, and culturally sensitive collections (Wang, 2025). The fact that an artifact or document has been digitized does not necessarily mean that unrestricted computational use of its digital representation is ethically or legally appropriate.

UNESCO's recent work on AI, culture, and intellectual property emphasizes that existing intellectual-property frameworks face difficulties in addressing the collective nature of cultural data used for AI training. UNESCO also identifies concerns about non-consensual commodification of knowledge and emphasizes digital cultural sovereignty, particularly in Global South contexts (Fu, 2025). This is important because conventional copyright frameworks often focus on identifiable individual or institutional rights holders, whereas cultural heritage may involve collective ownership, customary authority, community consent, or restrictions that are not adequately represented by conventional licensing systems.

Consequently, responsible AI use in cultural heritage requires more than copyright compliance. Institutions need clear provenance records, licensing information, consent procedures where appropriate, access controls, and mechanisms for community participation in decisions about sensitive cultural data (Shaikhon, 2025). The central issue is therefore not simply whether a dataset can legally be accessed, but whether its use is consistent with the cultural rights, expectations, and governance arrangements associated with the material. This is particularly important when AI-generated outputs are subsequently commercialized or used to create new cultural products.

3.3.3 Technological Dependence, Digital Inequality, and Sustainability

The final major finding concerns the institutional and environmental limitations associated with AI adoption. AI systems require computing infrastructure, high-quality datasets, technical expertise, cybersecurity measures, regular maintenance, and sometimes dependence on external commercial platforms. These requirements can create significant barriers for smaller museums, community archives, archaeological institutions, and heritage organizations in low-resource settings (Pisoni, 2021). The 2026 review of AI adoption identifies data quality and availability as particularly prominent barriers and further shows that organizational readiness can be more important than purely technical factors.

Technological dependence can also create long-term preservation risks. A heritage institution may develop a collection around a proprietary AI platform or closed data format and subsequently face difficulties if the provider changes its pricing, service availability, technical specifications, or data-access policies. Cybersecurity presents another concern because digitized cultural collections may contain valuable intellectual property, sensitive archaeological information, personal data, or culturally restricted materials (Islam, 2023). Sustainable digital preservation therefore requires institutional control over core records, interoperable formats, documented workflows, backup strategies, and long-term preservation planning rather than reliance solely on external AI services.

Finally, AI itself has environmental and computational costs. Training and operating advanced models can require substantial computing resources, while heritage institutions already face the broader sustainability challenge of maintaining large digital repositories, servers, sensors, and immersive technologies. The appropriate objective is therefore not maximal AI adoption but context-sensitive adoption in which the conservation, educational, research, or accessibility benefit justifies the technological and environmental cost (Zamchalova, 2023). Recent conservation literature similarly emphasizes that AI implementation remains constrained by computational requirements, dataset

limitations, model generalization, and the difficulty of integrating experimental systems into real conservation workflows.

3.4 Ethical Challenges and Governance of AI in Cultural Heritage

3.4.1 Authenticity, Provenance, and Historical Integrity

The reviewed evidence indicates that authenticity and historical integrity represent some of the most significant ethical challenges associated with artificial intelligence in cultural heritage. AI can reconstruct damaged monuments, generate missing architectural elements, enhance deteriorated photographs, restore visual features, and recreate historical environments that are no longer physically observable. These applications can substantially improve interpretation and public engagement, particularly where archaeological or historical evidence is incomplete (Laohaviraphap, 2024). However, the ability of generative AI to produce visually convincing content creates a fundamental distinction between heritage evidence and digital interpretation. An AI-generated reconstruction may appear historically accurate while containing assumptions, interpolations, or details for which there is insufficient archaeological or documentary evidence. Consequently, visual realism should not be treated as equivalent to historical authenticity.

The findings suggest that this problem is particularly important when AI-generated reconstructions are presented without adequate contextual information. For example, an AI system reconstructing a partially destroyed archaeological site may infer architectural details from comparable buildings rather than from evidence directly associated with the site. Although such reconstruction can provide an educational visualization, presenting it as an exact representation of the original structure could create a misleading historical narrative (Floridi, 2023). Similar concerns arise when AI is used to colourize historical photographs, reconstruct the appearance of historical figures, restore damaged manuscripts, or generate missing portions of artifacts. In these circumstances, the boundary between restoration and interpretation becomes ethically important because users may be unable to distinguish what survives from what has been algorithmically inferred.

Provenance documentation therefore emerged as an essential requirement for responsible AI-assisted heritage work. Every digitally reconstructed or AI-enhanced heritage object should ideally retain information about the original source, digitization process, datasets used, algorithmic interventions, restoration decisions, and degree of uncertainty. This approach is consistent with broader principles of digital preservation and cultural-heritage documentation, where the ability to trace an object's history and modifications is central to establishing reliability (Raso, 2018). AI-assisted outputs should consequently be accompanied by metadata identifying whether content is original, digitally restored, algorithmically reconstructed, or entirely synthetic. Where historical evidence is incomplete, uncertainty should also be communicated rather than concealed.

The evidence further indicates that transparency should extend beyond simple labelling. Heritage institutions need to explain, in accessible language, how AI contributed to the resulting representation and which elements are supported by historical evidence. For instance, a reconstructed medieval building could distinguish surviving archaeological features from historically supported reconstructions and speculative AI-generated elements (Islam, 2023). Such differentiation allows researchers and visitors to engage critically with digital heritage rather than assuming that every visual element represents established historical fact. Accordingly, AI should function as a tool for interpreting evidence rather than as an unquestioned authority capable of determining what the past looked like.

3.4.2 Community Participation, Indigenous Rights, and Cultural Consent

The review demonstrates that AI-based cultural-heritage practices cannot be considered ethically responsible when communities connected to the heritage are excluded from decisions concerning its digitization, interpretation, or transformation. Cultural heritage is not simply a collection of objects available for technological processing; it can embody collective identity, ancestry, spirituality, memory, language, and traditional knowledge. Consequently, digitizing cultural materials and subsequently using them to train or operate AI systems can create questions concerning ownership, consent, access, representation, and benefit sharing (Groumpos, 2023). These issues are

particularly pronounced for Indigenous and local communities whose cultural materials may be held in museums, archives, universities, or digital repositories outside the communities from which they originated.

The findings indicate that conventional institutional assumptions about open access may conflict with community-defined cultural protocols. Some cultural knowledge may be intended only for particular individuals, genders, age groups, ceremonies, seasons, or community members. When such material is incorporated into publicly accessible datasets or AI training systems, the original cultural restrictions may be weakened or eliminated (Sanchez, 2025). An AI model may subsequently reproduce or transform culturally sensitive knowledge in contexts that the originating community never approved. Therefore, technical accessibility should not automatically be interpreted as ethical permission to reuse cultural materials.

Community participation offers an important mechanism for addressing these concerns. Rather than involving communities only after digitization has occurred, responsible heritage projects should incorporate community representatives during decisions about what should be collected, how it should be described, which materials may be digitized, who should access them, and how AI-generated outputs may be used. Meaningful participation requires more than consultation; it involves recognition of community knowledge and authority in determining appropriate forms of representation (Bulut, 2024). This is especially important where institutional classifications or external researchers' interpretations may differ from community understandings of identity, history, sacredness, or ownership.

The review also highlights the importance of culturally appropriate consent and benefit sharing. Communities contributing knowledge, oral traditions, images, languages, or other heritage materials should have a meaningful opportunity to understand proposed AI applications and their potential consequences. Where commercial or institutional benefits arise from AI systems developed using community heritage, appropriate mechanisms for recognition, participation, or benefit sharing should be considered (Sonni, 2024). Such approaches can help move cultural-heritage digitization away from extractive models in which institutions acquire data while communities have limited control over its subsequent use.

These findings are particularly relevant to Indigenous languages and intangible cultural heritage. AI systems trained on Indigenous linguistic or cultural datasets may contribute to language revitalization and preservation, but poorly governed systems may also reproduce stereotypes, misinterpret culturally specific concepts, or make restricted knowledge more widely accessible than intended (Yigitcanlar, 2020). Responsible AI therefore requires culturally grounded governance structures that recognize communities as knowledge holders and active participants rather than merely as sources of training data.

3.4.3 Transparency, Accountability, and Responsible AI Governance

The reviewed literature indicates that transparency and accountability are fundamental conditions for integrating AI into cultural-heritage institutions. AI systems can involve complex datasets, machine-learning models, automated classifications, and generative processes that make it difficult for heritage professionals and users to understand how particular outputs were produced (Ali, 2024). This creates risks when AI-generated classifications or reconstructions influence decisions concerning conservation priorities, historical interpretation, collection management, or public representation. The responsibility for such decisions should therefore not be transferred entirely to automated systems.

Human oversight emerged as a central governance principle. AI can process large collections and identify patterns more rapidly than conventional methods, but heritage decisions frequently require contextual, historical, ethical, and cultural interpretation. A system may identify similarities between artifacts or predict missing visual features, for example, without understanding their cultural significance or the consequences of a particular interpretation (Huang, 2022). Qualified heritage professionals should therefore retain authority over consequential decisions, with AI outputs treated as evidence or recommendations requiring professional evaluation rather than as definitive conclusions.

Dataset documentation and auditability are equally important. Heritage institutions should maintain records concerning where training or reference data originated, how datasets were selected, whether cultural restrictions apply, and what transformations were performed. Such documentation can help identify biases and enable researchers to reproduce or challenge AI-assisted findings. It can also make it easier to identify errors introduced through incomplete datasets, inappropriate classifications, or algorithmic assumptions (Slimi, 2023). In this respect, responsible AI governance should cover the entire data lifecycle, from acquisition and digitization to model development, deployment, updating, and long-term preservation.

The evidence further supports multidisciplinary governance. AI developers may possess advanced technical expertise but limited knowledge of archaeological interpretation, conservation ethics, Indigenous rights, museum practice, or cultural protocols. Conversely, heritage specialists may understand cultural and historical contexts without possessing sufficient technical knowledge to evaluate algorithmic systems (Wach, 2023). Collaboration among computer scientists, historians, archaeologists, conservators, museum professionals, legal experts, ethicists, and community representatives can therefore provide a more comprehensive basis for decision-making. Institutional ethical review procedures can complement this collaboration by assessing potential risks before AI systems are introduced into heritage collections and public-facing applications.

3.5 Future Directions for Responsible AI Integration in Cultural Heritage

3.5.1 Development of Ethical and Culturally Inclusive AI Frameworks

The findings indicate a need for AI frameworks specifically adapted to the distinctive characteristics of cultural heritage. Generic AI governance principles provide important foundations concerning transparency, fairness, privacy, accountability, and human oversight, but cultural heritage introduces additional concerns involving authenticity, provenance, collective ownership, cultural sensitivity, historical evidence, and intergenerational responsibility (Murire, 2024). Future heritage-specific frameworks should therefore integrate technological principles with established conservation ethics, human rights, cultural rights, and community governance.

A major priority is the development of culturally representative datasets. Current AI systems may disproportionately reflect materials that are already digitized, catalogued, and available through major institutions. This can create geographical, linguistic, cultural, and historical imbalances because communities with fewer digitization resources may be underrepresented. AI trained predominantly on institutional collections may consequently reproduce institutional perspectives rather than the full diversity of cultural heritage (Garzón, 2025). Future systems should therefore prioritize broader and more representative datasets while recognizing that inclusion does not mean that all cultural knowledge should be publicly accessible.

Participatory design provides an important pathway toward culturally inclusive systems. Heritage communities should be involved in determining how their cultural materials are represented, described, accessed, and transformed. Frameworks could incorporate community-defined permissions, culturally specific metadata, access restrictions, provenance records, and mechanisms for correcting inaccurate representations (Stahl, 2022). This would allow AI systems to recognize that cultural materials may have different levels of sensitivity and different rules governing their use.

Future frameworks should also establish explicit accountability requirements for AI-generated heritage content. Digital reconstructions, synthetic historical images, automated translations, and AI-generated interpretations should be traceable to their sources and clearly distinguished from primary evidence. Where uncertainty exists, systems should communicate it rather than generating unwarranted confidence (Adams, 2023). These principles would help establish AI as a transparent interpretive technology rather than an invisible mechanism for rewriting cultural history.

3.5.2 Human–AI Collaboration and Capacity Building

The evidence suggests that the most sustainable future model is likely to involve collaboration between humans and AI rather than complete automation of heritage decision-making. AI can support professionals by rapidly

analysing images, identifying patterns in large collections, detecting deterioration, organizing archival materials, translating selected texts, generating preliminary reconstructions, and identifying relationships across multimodal datasets (Chen, 2024). However, final decisions concerning authenticity, conservation, cultural interpretation, and access should remain subject to qualified human judgement, particularly where decisions involve uncertainty or culturally sensitive materials.

Human–AI collaboration will require substantial capacity building within heritage institutions. Museum professionals, archivists, archaeologists, conservators, historians, and cultural-resource managers increasingly need basic AI literacy to understand algorithmic strengths, limitations, bias, uncertainty, and data governance. Such knowledge would allow professionals to critically evaluate AI outputs rather than accepting them because they appear technically sophisticated (Wamba, 2025). Training should therefore extend beyond operating AI software to include questions of data provenance, model limitations, ethical risk, copyright and cultural rights, documentation, and responsible interpretation.

Capacity building must also occur on the technology-development side. AI developers working with heritage data require an understanding of conservation principles, archaeological evidence, cultural protocols, Indigenous rights, archival standards, and the distinction between restoration and speculative reconstruction (Morgan, 2020). Partnerships between universities, museums, heritage organizations, governments, technology companies, and source communities could provide interdisciplinary training environments in which technical and cultural expertise are developed together.

Such partnerships could also address disparities in technological capacity. Major museums and research institutions may have access to advanced computing infrastructure and specialist personnel, whereas smaller museums, local archives, and community organizations may lack these resources (Oniani, 2023). Shared platforms, open standards, training programmes, technical support, and collaborative research networks could help prevent AI innovation from becoming concentrated among institutions with the greatest financial and technological resources.

3.5.3 Emerging Research Priorities and Sustainable Heritage Innovation

The reviewed evidence identifies several emerging areas that require further research before AI can be integrated responsibly and sustainably across cultural-heritage practice. Trustworthy generative AI is particularly important because increasingly realistic synthetic images, texts, voices, and three-dimensional environments create both major opportunities and significant risks (Tiribelli, 2024). Future research should investigate methods for preserving source attribution, communicating uncertainty, detecting synthetic content, and preventing AI-generated interpretations from being mistaken for historical evidence.

Explainable AI represents another important research priority. Heritage professionals need systems that can provide understandable reasons for classifications, restoration suggestions, object associations, or conservation predictions. Explainability is particularly valuable where AI recommendations influence decisions about fragile artifacts or historically significant sites (Pansoni, 2023). Research should consequently move beyond measuring technical accuracy toward evaluating whether heritage professionals can understand, interrogate, and appropriately use AI outputs.

Culturally sensitive language models also deserve greater attention. AI can contribute to the preservation and revitalization of endangered languages, oral histories, traditional narratives, and other forms of intangible cultural heritage. However, future systems must address linguistic bias, community ownership, culturally inappropriate outputs, and restrictions on sensitive knowledge (Ghaith, 2024). Community-controlled datasets and locally governed language technologies may provide more appropriate alternatives to unrestricted incorporation of cultural materials into general-purpose models.

AI-assisted conservation, digital twins, multimodal heritage databases, and three-dimensional reconstruction also present significant opportunities. Digital twins could create continuously updated virtual representations of historic

buildings or archaeological sites, integrating spatial, visual, environmental, and conservation information. Multimodal databases could connect photographs, manuscripts, oral histories, maps, archaeological records, and three-dimensional models, enabling researchers to identify relationships that are difficult to detect through isolated collections (Islam, 2026). Nevertheless, these systems require rigorous documentation and long-term preservation strategies to prevent today's digital heritage from becoming tomorrow's inaccessible or obsolete data.

Long-term digital sustainability is therefore a critical research issue. AI systems depend on software environments, computational infrastructure, file formats, metadata standards, and institutional resources that may change rapidly. Sustainable heritage innovation requires preservation strategies that maintain not only digital objects but also information about how AI-generated or AI-assisted materials were created (Wang, 2025). Future research should examine interoperable metadata, persistent provenance records, reproducible workflows, model documentation, and preservation architectures capable of supporting future reinterpretation.

Taken together, the findings demonstrate that the future value of AI in cultural heritage will depend not simply on increasing computational capability but on establishing appropriate relationships between technology, evidence, people, and cultural values. AI can expand the capacity of museums, archives, archaeological institutions, researchers, and communities to document, analyse, preserve, and communicate heritage. At the same time, its use can introduce risks of synthetic historical representation, cultural appropriation, biased interpretation, loss of provenance, and exclusion of source communities (Fu, 2025). Responsible integration therefore requires a framework in which authenticity, provenance, cultural rights, human expertise, community participation, transparency, and accountability remain central to technological innovation. Under such conditions, AI can function not as a replacement for cultural-heritage expertise but as a carefully governed instrument for strengthening preservation, research, interpretation, and sustainable access to cultural heritage.

4. Conclusion

Artificial intelligence is increasingly reshaping the preservation, interpretation, management, and dissemination of cultural heritage by enabling advanced digitization, automated documentation, image and text analysis, virtual reconstruction, predictive conservation, and personalized public engagement. The reviewed evidence indicates that AI can significantly expand the capacity of cultural heritage institutions to process large and complex collections, identify deterioration patterns, reconstruct damaged or lost heritage assets, and improve access to cultural knowledge through digital and immersive technologies. However, these opportunities are accompanied by substantial risks, including algorithmic bias, cultural misrepresentation, data ownership and copyright concerns, privacy challenges, technological dependence, unequal access to AI infrastructure, and the potential marginalization of indigenous and local knowledge systems. The findings therefore suggest that AI should be understood as a supporting technology rather than a replacement for historians, conservators, archaeologists, archivists, curators, and communities that hold cultural knowledge. Responsible application requires transparent and explainable systems, high-quality and culturally representative datasets, appropriate intellectual-property protections, community participation, human oversight, and governance frameworks that recognize cultural rights and provenance. Ultimately, the sustainable integration of AI into cultural heritage depends not only on technological innovation but also on ethical accountability, interdisciplinary collaboration, and respect for the communities and traditions represented in digital heritage systems. Future research should consequently focus on developing culturally sensitive AI methodologies, evaluating long-term impacts of automated heritage management, and establishing internationally applicable governance principles that balance technological advancement with authenticity, inclusivity, cultural sovereignty, and the responsible stewardship of heritage for future generations.

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References

- [1] Adams, C., Pente, P., Lernermeier, G., & Rockwell, G. (2023). Ethical principles for artificial intelligence in K-12 education. *Computers and Education: Artificial Intelligence*, 4, 100131.
- [2] Ali, G., Mijwil, M. M., Buruga, B. A., Abotaleb, M., & Adamopoulos, I. (2024). A survey on artificial intelligence in cybersecurity for smart agriculture: state-of-the-art, cyber threats, artificial intelligence applications, and ethical concerns.
- [3] Bulut, O., Beiting-Parrish, M., Casabianca, J. M., Slater, S. C., Jiao, H., Song, D., ... & Morilova, P. (2024). The rise of artificial intelligence in educational measurement: Opportunities and ethical challenges. *arXiv preprint arXiv:2406.18900*.
- [4] Chen, H. (2024). The Ethical Challenges of Educational Artificial Intelligence and Coping Measures: A Discussion in the Context of the 2024 World Digital Education Conference. *Science Insights Education Frontiers*, 20(2), 3263.
- [5] Floridi, L. (2023). The ethics of artificial intelligence: Principles, challenges, and opportunities.
- [6] Fu, Y., Shi, K., & Xi, L. (2025). Artificial intelligence and machine learning in the preservation and innovation of intangible cultural heritage: Ethical considerations and design frameworks. *Digital Scholarship in the Humanities*, 40(2), 487-508.
- [7] Garzón, J., Patiño, E., & Marulanda, C. (2025). Systematic review of artificial intelligence in education: Trends, benefits, and challenges. *Multimodal Technologies and Interaction*, 9(8), 84.
- [8] Ghaith, K. (2024). AI integration in cultural heritage conservation—Ethical considerations and the human imperative. *International Journal of Emerging and Disruptive Innovation in Education: VISIONARIUM*, 2(1), 6.
- [9] Groumpos, P. P. (2023, July). A critical historic overview of artificial intelligence: issues, challenges, opportunities, and threats. In *Artificial Intelligence and Applications* (Vol. 1, No. 4, pp. 181-197).
- [10] Huang, C., Zhang, Z., Mao, B., & Yao, X. (2022). An overview of artificial intelligence ethics. *IEEE transactions on artificial intelligence*, 4(4), 799-819.
- [11] Islam, A., & Jantan, A. H. B. (2023). The mediation effect of affective organizational commitment on the relationship between HRM practices and turnover intention in the RMG industry. *Research Journal in Business and Economics*, 1(1), 24-38.
- [12] Islam, A., Jantan, A. H. B., Khalifa, G. S., Islam, A., Islam, B., & Hossian, A. (2023). Effects of Decision Making and Work-life Balance on Productivity of Female Employees in the RMG Industry of Bangladesh. The Mediating Role of Work Motivation. *Research Journal in Business and Economics*, 1(1), 48-59.
- [13] Islam, M. A., Khalifa, G. S. A., Gherbi, E. A. H., Waked, H. N., & Goyal, S. B. (2026). Leveraging eco-innovation for enhancing corporate performance in telecommunication industry: the role of competitive advantage. *International Journal of Electronic Business*, 22(3), 331-351.
- [14] Islam, M. A., Segumpan, R. G., Alam, S., Barua, P., Islam, M. B., & Sultana, M. T. (2026). Global Competitiveness: International Talent Attraction in Malaysian Higher Education. *New Ideas Concerning Arts and Social Studies* Vol. 8, 184-207.
- [15] Laohaviraphap, N., & Waroonkun, T. (2024). Integrating artificial intelligence and the internet of things in cultural heritage preservation: a systematic review of risk management and environmental monitoring strategies. *Buildings*, 14(12), 3979.
- [16] Morgan, F. E., Boudreaux, B., Lohn, A. J., Ashby, M., Curriden, C., Klima, K., & Grossman, D. (2020). *Military applications of artificial intelligence: ethical concerns in an uncertain world* (No. RR31391).
- [17] Murire, O. T. (2024). Artificial intelligence and its role in shaping organizational work practices and culture. *Administrative Sciences*, 14(12), 316.
- [18] Oniani, D., Hilsman, J., Peng, Y., Poropatich, R. K., Pamplin, J. C., Legault, G. L., & Wang, Y. (2023). Adopting and expanding ethical principles for generative artificial intelligence from military to healthcare. *NPJ Digital Medicine*, 6(1), 225.
- [19] Pansoni, S., Tiribelli, S., Paolanti, M., Di Stefano, F., Frontoni, E., Malinverni, E. S., & Giovanola, B. (2023). Artificial intelligence and cultural heritage: Design and assessment of an ethical framework. *International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences*, 48, 1149-1155.
- [20] Pisoni, G., Díaz-Rodríguez, N., Gijlers, H., & Tonolli, L. (2021). Human-centered artificial intelligence for designing accessible cultural heritage. *Applied Sciences*, 11(2), 870.
- [21] Raso, F. A., Hilligoss, H., Krishnamurthy, V., Bavitz, C., & Kim, L. (2018). Artificial intelligence & human rights: Opportunities & risks. *Berkman Klein Center Research Publication*, (2018-6).
- [22] Sanchez, T. W., Brenman, M., & Ye, X. (2025). The ethical concerns of artificial intelligence in urban planning. *Journal of the American Planning Association*, 91(2), 294-307.
- [23] Shaikhon, A. M. H. (2025). Contextual ethical framework for artificial intelligence in the management of cultural heritage. *STAR: Science & Technology of Archaeological Research*, 11(1), e2564519.
- [24] Slimi, Z., & Carballido, B. V. (2023). Navigating the ethical challenges of artificial intelligence in higher education: An analysis of seven global AI ethics policies. *TEM journal*, 12(2), 590.
- [25] Sonni, A. F., Hafied, H., Irwanto, I., & Latuheru, R. (2024). Digital newsroom transformation: A systematic review of the impact of artificial intelligence on journalistic practices, news narratives, and ethical challenges. *Journalism and Media*, 5(4), 1554-1570.
- [26] Stahl, B. C., Antoniou, J., Ryan, M., Macnish, K., & Jiya, T. (2022). Organisational responses to the ethical issues of artificial intelligence. *Ai & Society*, 37(1), 23-37.

- [27] Tiribelli, S., Pansoni, S., Frontoni, E., & Giovanola, B. (2024). Ethics of artificial intelligence for cultural heritage: Opportunities and challenges. *IEEE Transactions on Technology and Society*, 5(3), 293-305.
- [28] Wach, K., Duong, C. D., Ejdyś, J., Kazlauskaitė, R., Korzynski, P., Mazurek, G., ... & Ziemba, E. (2023). The dark side of generative artificial intelligence: A critical analysis of controversies and risks of ChatGPT. *Entrepreneurial Business and Economics Review*, 11(2), 7-30.
- [29] Wamba, S. F., Queiroz, M. M., Randhawa, K., & Gupta, G. (2025). Generative artificial intelligence and the challenges to adding value ethically. *Technovation*, 144, 103235.
- [30] Wang, H., Gong, Y., Zhang, Y., & Li, F. (2025). Artificial intelligence for sustainable cultural heritage: practical guidelines and case-based evidence. *Sustainability*, 17(20), 9192.
- [31] Yigitcanlar, T., Desouza, K. C., Butler, L., & Roozkhosh, F. (2020). Contributions and risks of artificial intelligence (AI) in building smarter cities: Insights from a systematic review of the literature. *Energies*, 13(6), 1473.
- [32] Zamchalova, I. Y. (2023). Artificial intelligence: risks and perspectives of culture. *Intellect. Innovations. Investments*, (5), 102-110.