

AI Integration in Buddhist Cultural Heritage: Preservation, Transmission and Ethical Pathways

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Publication Date: 2026/07/31

Abstract: Buddhist cultural heritage constitutes one of the world's most significant repositories of religious, historical, artistic, and intellectual traditions. It encompasses tangible heritage, including temples, monasteries, sculptures, manuscripts, inscriptions, paintings, and archaeological sites, as well as intangible heritage such as rituals, meditation practices, oral traditions, chanting, philosophical teachings, and monastic customs. These cultural assets face increasing threats from environmental degradation, climate change, urban development, armed conflicts, tourism pressures, material deterioration, and the gradual disappearance of traditional knowledge holders. Recent advances in Artificial Intelligence (AI) have introduced new possibilities for documenting, preserving, restoring, interpreting, and disseminating Buddhist cultural heritage. Technologies including machine learning, computer vision, natural language processing, optical character recognition, generative AI, and digital twins are transforming heritage management by enabling automated manuscript transcription, virtual reconstruction of damaged monuments, multilingual translation of canonical texts, predictive conservation, and interactive educational platforms. Despite these opportunities, AI also presents important ethical, cultural, and governance challenges concerning authenticity, algorithmic bias, data ownership, cultural sensitivity, and the potential misrepresentation of sacred knowledge. This study examines the emerging role of AI in preserving and transmitting Buddhist cultural heritage through a critical review of recent interdisciplinary scholarship. It analyses the applications of AI across tangible and intangible heritage while evaluating their implications for heritage conservation, religious education, and cultural sustainability. The paper argues that AI should complement rather than replace traditional custodianship exercised by monastic communities, heritage professionals, and cultural institutions. Sustainable preservation requires interdisciplinary collaboration among Buddhist scholars, computer scientists, conservators, museums, libraries, governments, and international organizations. The study proposes a human-centred framework that integrates technological innovation with ethical governance and cultural authenticity. Such an approach ensures that AI contributes to safeguarding Buddhist heritage for future generations while respecting its historical integrity, religious significance, and cultural diversity.

Keywords: Artificial Intelligence; Buddhist Cultural Heritage; Digital Heritage; Cultural Preservation; Machine Learning; Buddhist Manuscripts; Cultural Transmission; Digital Humanities.

How to Cite: Ven. Hedeniye Sumedha (2026) AI Integration in Buddhist Cultural Heritage: Preservation, Transmission and Ethical Pathways. *International Journal of Innovative Science and Research Technology*, 11(7), 2179-2194. <https://doi.org/10.38124/ijisrt/26jul896>

I. INTRODUCTION

Buddhist cultural heritage represents more than two and a half millennia of religious philosophy, artistic achievement, literary production, architectural innovation, and cultural exchange across Asia and increasingly throughout the world (Gethin, 1998; Skilton, 2005). Since the emergence of Buddhism in the sixth century BCE, Buddhist communities have produced an extensive body of tangible and intangible cultural assets that continue to shape the religious identities, historical memories, and cultural traditions of numerous societies (Gombrich, 2006). Ancient monasteries, cave temples, stupas, sculptures, mural paintings, palm-leaf manuscripts, inscriptions, ritual performances, meditation

traditions, and oral teachings collectively form an invaluable cultural legacy that transcends national boundaries and contributes significantly to global civilization (Buswell & Lopez, 2014).

The preservation of this heritage has become an increasingly urgent concern during the twenty-first century. Numerous Buddhist heritage sites have experienced deterioration resulting from natural ageing, climate change, earthquakes, flooding, biological decay, pollution, rapid urbanization, armed conflict, uncontrolled tourism, and inadequate conservation resources (ICOMOS, 2019). Equally significant is the gradual disappearance of intangible cultural heritage through the decline of traditional knowledge systems,

reduced intergenerational transmission, language loss, and demographic changes within monastic communities (UNESCO, 2003). These challenges require innovative preservation strategies capable of complementing conventional conservation methods while ensuring cultural authenticity and long-term sustainability.

Digital transformation has substantially altered the practice of cultural heritage preservation. Over the past two decades, digital photography, laser scanning, three-dimensional modelling, geographic information systems, cloud computing, and digital archives have enabled heritage institutions to document and manage cultural resources with unprecedented accuracy (Pavlidis et al., 2007; Remondino & Campana, 2014). More recently, Artificial Intelligence (AI) has emerged as one of the most influential technological developments affecting the heritage sector. Unlike earlier digital technologies that primarily stored or visualized cultural information, AI possesses the capacity to analyse complex datasets, recognise visual and textual patterns, predict deterioration, reconstruct missing artefacts, generate multilingual translations, and support intelligent decision-making (Münster & Ioannides, 2020; Resta & Dicuonzo, 2022).

Artificial Intelligence encompasses computational systems capable of performing tasks that traditionally require human intelligence, including perception, reasoning, learning, language understanding, and pattern recognition. Machine learning algorithms identify relationships within large datasets, computer vision systems recognise architectural features and artistic motifs, natural language processing facilitates multilingual analysis of historical documents, and generative AI creates digital reconstructions of damaged cultural objects (Llamas et al., 2017; Liu et al., 2023). Together, these technologies have expanded the possibilities for documenting, conserving, interpreting, and communicating cultural heritage across diverse audiences.

Within Buddhist heritage studies, AI applications have grown rapidly in recent years. Optical Character Recognition systems trained for ancient scripts assist scholars in digitising fragile palm-leaf manuscripts that were previously accessible only through manual transcription (Cochrane, 2018; Silfeler et al., 2023). Machine learning algorithms improve the restoration of damaged inscriptions and faded manuscripts by reconstructing missing characters and identifying textual patterns (Hsieh, 2019). Computer vision technologies facilitate structural monitoring of Buddhist monuments by detecting cracks, erosion, biological growth, and weather-related deterioration before irreversible damage occurs (Fiorentino et al., 2022). These innovations contribute to preventive conservation by allowing heritage managers to identify potential risks at earlier stages.

AI also supports the preservation of intangible Buddhist heritage. Large language models and natural language processing technologies facilitate the translation and analysis of canonical Buddhist literature across multiple languages, thereby expanding accessibility for international scholars and practitioners (Nehrdich & Keutzer, 2026; Gurusinghe &

Jayatileke, 2026). Digital platforms increasingly employ conversational AI to provide educational guidance regarding Buddhist philosophy, ethics, meditation practices, and historical development. Virtual and augmented reality environments supported by AI enable users to experience historically significant monasteries, archaeological landscapes, and ritual performances regardless of geographical location (Fiorentino et al., 2022; Bonacini, 2011). Such technologies create new opportunities for educational engagement while promoting wider public appreciation of Buddhist traditions.

Several international initiatives demonstrate the growing importance of AI within heritage preservation. Recent projects have successfully integrated AI with hyperspectral imaging, digital reconstruction, predictive modelling, and multilingual information retrieval to preserve ancient manuscripts, reconstruct damaged monuments, and improve public engagement with cultural heritage (Laohaviraphap & Waroonkun, 2024). Similarly, developments in Buddhist digital humanities have produced large-scale corpora of canonical texts in Pali, Sanskrit, Tibetan, Chinese, Sinhala, and other languages that support advanced computational analysis and facilitate future language model development (Bingenheimer, 2014; Gurusinghe & Jayatileke, 2026). These initiatives illustrate the growing convergence between heritage studies, computer science, digital humanities, and religious scholarship.

Despite these promising developments, the integration of AI into Buddhist cultural heritage also raises substantial ethical and methodological concerns. AI-generated reconstructions may prioritise visual plausibility over historical accuracy, potentially introducing interpretations unsupported by archaeological or documentary evidence (Mittelstadt, 2019). Generative models frequently produce convincing yet inaccurate outputs, creating risks of misinformation regarding sacred architecture, iconography, historical chronology, or religious practice. Furthermore, algorithmic systems trained predominantly on Western or commercially available datasets may inadequately represent the cultural diversity of Buddhist traditions across Sri Lanka, India, Nepal, Bhutan, Myanmar, Thailand, Cambodia, China, Korea, Japan, Mongolia, and Tibet (Jobin et al., 2019). Such biases may inadvertently marginalise regional traditions and indigenous knowledge systems.

Questions concerning intellectual property, data sovereignty, community participation, and cultural ownership further complicate AI adoption within heritage preservation (Ryan & Stahl, 2021). Buddhist manuscripts, ritual knowledge, artistic traditions, and sacred spaces often possess religious significance that extends beyond their historical or aesthetic value. Consequently, decisions regarding digitisation, public accessibility, AI training datasets, and digital reproduction require meaningful consultation with monastic communities, heritage professionals, governments, and local stakeholders (ICCROM, 2021). Technological innovation should therefore support rather than replace established systems of cultural stewardship.

The relationship between AI and Buddhist heritage should not be understood as a substitution of human expertise with automated technologies. Instead, AI should function as a decision-support system that enhances documentation, conservation, research, education, and public engagement while preserving the authority of historians, archaeologists, conservators, linguists, Buddhist scholars, and monastic custodians. Human judgement remains indispensable when interpreting historical evidence, resolving textual ambiguities, assessing religious significance, and determining culturally appropriate conservation practices (Floridi & Cowls, 2019).

Against this background, the present study examines the role of Artificial Intelligence in the preservation and transmission of Buddhist cultural heritage. Specifically, it investigates how AI technologies contribute to documenting, conserving, reconstructing, interpreting, and disseminating both tangible and intangible Buddhist heritage. It also critically evaluates the ethical, cultural, and governance challenges associated with AI implementation and proposes principles for responsible adoption within heritage management. By synthesising recent scholarship from digital humanities, heritage science, artificial intelligence, Buddhist studies, and conservation research, the paper contributes to the growing interdisciplinary discourse concerning technology-enabled cultural preservation (Bhowmik & Bhowmik, 2023). Ultimately, it argues that the future of Buddhist heritage conservation depends not solely on technological innovation but on the careful integration of AI with human expertise, ethical governance, community participation, and respect for cultural authenticity.

II. LITERATURE REVIEW

➤ *Artificial Intelligence and Cultural Heritage Preservation*

Artificial Intelligence has become one of the most significant technological developments influencing cultural heritage preservation during the past decade (Resta & Dicuonzo, 2022). Initially, digital heritage initiatives focused primarily on digitisation, documentation, and online accessibility through digital archives, three-dimensional (3D) modelling, and geographic information systems (Pavlidis et al., 2007). Recent advances in AI have expanded these capabilities by enabling automated analysis, pattern recognition, predictive conservation, multilingual information retrieval, and intelligent decision support (Ge, 2024). Consequently, AI is no longer viewed merely as a supporting technology but as an emerging component of heritage management, conservation planning, and public engagement. Recent systematic reviews identify five principal application domains of AI within cultural heritage: documentation, restoration, conservation management, visitor experience, and heritage education (Harmanda et al., 2026; Silva & Oliveira, 2024).

Machine learning and deep learning algorithms have demonstrated considerable effectiveness in recognising architectural patterns, classifying archaeological artefacts, reconstructing damaged monuments, and monitoring structural deterioration (Llamas et al., 2017). Unlike conventional computational methods that rely on manually

programmed rules, AI systems continuously improve their performance through training with large datasets. This capability enables heritage professionals to process extensive collections of historical photographs, manuscripts, inscriptions, and architectural records that would otherwise require substantial human resources. Bibliometric evidence further indicates that recognition, reconstruction, virtual restoration, monitoring, and predictive analysis constitute the dominant research themes in AI-enabled cultural heritage conservation (Cheng et al., 2024; Chen et al., 2024).

UNESCO has also recognised the transformative potential of AI for protecting cultural heritage (UNESCO, 2025). Current initiatives include AI-assisted risk preparedness, digital monitoring of endangered heritage sites, museum management, climate adaptation planning, and protection against illicit trafficking of cultural property. These developments reflect a broader transition from reactive conservation towards predictive and preventive heritage management, where AI assists professionals in identifying conservation priorities before irreversible deterioration occurs (Laohaviraphap & Waroonkun, 2024).

Although technological innovation has significantly improved conservation efficiency, researchers consistently argue that AI should complement rather than replace human expertise (Bhowmik & Bhowmik, 2023). Archaeologists, conservators, historians, architects, and local communities continue to provide the contextual interpretation required to ensure historical authenticity and cultural integrity. Consequently, contemporary scholarship increasingly advocates human–AI collaborative models instead of fully automated conservation systems (Liu et al., 2023).

➤ *Buddhist Cultural Heritage: Tangible and Intangible Dimensions*

Buddhist cultural heritage comprises both tangible and intangible components that collectively preserve the historical development of Buddhist civilisation (Skilton, 2005). Tangible heritage includes temples, monasteries, stupas, cave complexes, sculptures, paintings, inscriptions, ritual objects, archaeological sites, libraries, and manuscripts. Many of these resources have been recognised as World Heritage Sites because of their outstanding historical, artistic, and religious significance (UNESCO, 1972). Countries such as Sri Lanka, India, Nepal, Bhutan, Myanmar, Thailand, Cambodia, China, Japan, Korea, and Mongolia possess extensive Buddhist heritage collections representing diverse architectural traditions and regional interpretations of Buddhism.

Equally important is intangible Buddhist heritage, which encompasses meditation traditions, chanting practices, oral transmission of canonical texts, ritual performances, monastic education, philosophical discourse, festivals, craftsmanship, and traditional conservation knowledge. UNESCO defines intangible cultural heritage as living cultural expressions transmitted across generations through continuous community participation (UNESCO, 2003). Unlike physical monuments, intangible heritage depends upon active practice rather than

material preservation. Consequently, its survival requires continuous transmission between generations.

Traditional Buddhist preservation methods have relied upon monastic institutions for centuries. Palm-leaf manuscripts were copied manually, sacred texts were memorised through oral recitation, and conservation techniques incorporated indigenous knowledge relating to herbal preservation, environmental control, and manuscript storage (Silk, 2008; Cabezón, 1994). These practices remain important today, although they increasingly operate alongside digital technologies, metadata cataloguing, and electronic repositories. Recent studies of Buddhist monastic libraries indicate that digital archives and AI-assisted script recognition are gradually supplementing traditional preservation practices rather than replacing them (Bingenheimer, 2014; Buddhist Digital Resource Center, 2023).

However, Buddhist heritage faces numerous contemporary threats. Climate change, natural disasters, urban expansion, biological deterioration, tourism pressure, armed conflict, inadequate conservation funding, and declining numbers of traditional knowledge holders collectively threaten both physical monuments and living cultural practices (ICOMOS, 2019). These challenges have increased interest in technological approaches capable of improving documentation, monitoring, and educational transmission without compromising cultural authenticity.

➤ *AI Applications in Buddhist Heritage Preservation*

Recent scholarship demonstrates that AI applications within Buddhist heritage extend across documentation, conservation, restoration, interpretation, and education (Harmanda et al., 2026). One of the earliest areas of implementation involves manuscript digitisation. Buddhist canonical literature exists in numerous historical languages, including Pali, Sanskrit, Tibetan, Chinese, Sinhala, Burmese, Thai, Khmer, and Japanese (McBride, 2017). Many manuscripts remain fragile because they were written on palm leaves, paper, silk, or other perishable materials. Optical Character Recognition (OCR) combined with machine learning has substantially improved the digitisation of these collections by recognising ancient scripts and reducing manual transcription time (Cochrane, 2018; Silfeler et al., 2023).

Recent developments in Buddhist digital humanities illustrate this progress. The SiPaKosa corpus, for example, integrates extensive collections of Sinhala and Pali Buddhist texts using AI-assisted OCR, metadata annotation, and language model evaluation (Gurusinghe & Jayatilleke, 2026). Such resources support information retrieval, linguistic analysis, digital preservation, and the development of specialised language models for Buddhist scholarship (Nehrdich & Keutzer, 2026).

Computer vision represents another rapidly developing application. AI algorithms analyse high-resolution photographs, laser scans, satellite imagery, and drone-based observations to identify structural deterioration within temples, stupas, murals, sculptures, and archaeological

remains (Llamas et al., 2017). Crack detection, moisture analysis, erosion monitoring, biological growth identification, and surface deformation analysis enable conservators to undertake preventive interventions before extensive damage occurs. Compared with conventional inspection methods, AI-assisted monitoring offers greater consistency and scalability, particularly for geographically dispersed heritage sites (Laohaviraphap & Waroonkun, 2024).

Generative AI has also expanded possibilities for digital reconstruction. Historical photographs, excavation records, architectural drawings, and archaeological evidence may be integrated to reconstruct damaged monuments or incomplete sculptures (Fiorentino et al., 2022). Virtual reconstructions assist museums, researchers, and educational institutions by visualising heritage that has been partially destroyed through natural disasters or conflict. Nevertheless, scholars emphasise that reconstruction must remain evidence-based rather than aesthetically generated (Mittelstadt, 2019). Human expert validation remains essential to prevent speculative interpretations that compromise historical authenticity.

➤ *AI and the Transmission of Buddhist Knowledge*

Preserving Buddhist heritage involves more than protecting monuments and manuscripts; it also requires maintaining the continuous transmission of Buddhist knowledge. Digital technologies increasingly facilitate this process by expanding public access to canonical texts, commentaries, historical records, and educational resources (Muller, 2013).

Natural Language Processing (NLP) has become particularly important for multilingual Buddhist scholarship. AI-powered translation systems assist researchers in comparing canonical literature across Pali, Sanskrit, Chinese, Tibetan, Sinhala, and other languages (Nehrdich & Keutzer, 2026). Semantic search tools enable scholars to retrieve doctrinal concepts efficiently across extensive textual collections. These developments improve interdisciplinary research while reducing linguistic barriers that previously limited access to Buddhist literature (Hsieh, 2019).

Generative AI further supports educational dissemination through intelligent tutoring systems, conversational assistants, personalised learning environments, and interactive digital museums (Giannini & Bowen, 2019). Virtual guides can explain Buddhist philosophy, historical development, artistic symbolism, and archaeological contexts using accessible language for diverse audiences. Virtual reality and augmented reality applications supported by AI additionally enable immersive exploration of monasteries, cave temples, archaeological landscapes, and museum collections, thereby strengthening public appreciation of Buddhist heritage (Fiorentino et al., 2022; Bonacini, 2011).

Despite these advantages, scholars caution that AI-generated educational content should not replace authoritative religious instruction. Large language models may produce inaccurate interpretations, fabricate references, or simplify complex doctrinal concepts (Mittelstadt, 2019). Consequently, AI is increasingly viewed as an educational support tool rather

than an authoritative source of Buddhist teaching. Human supervision by qualified scholars and monastic communities remains essential to preserve doctrinal accuracy and cultural authenticity.

➤ *Ethical and Governance Challenges*

Although AI offers considerable opportunities for Buddhist heritage preservation, the literature consistently identifies significant ethical concerns. Authenticity remains the most frequently discussed issue. AI-generated reconstructions may produce visually convincing outputs without sufficient archaeological or historical evidence, thereby creating inaccurate representations of sacred architecture, iconography, or historical events (Mittelstadt, 2019). Scholars therefore recommend transparent documentation of AI-assisted reconstruction processes together with expert validation (Floridi & Cowls, 2019).

Algorithmic bias constitutes a second challenge. Most contemporary AI systems are trained using datasets that inadequately represent low-resource languages and regional Buddhist traditions (Jobin et al., 2019). Consequently, smaller textual traditions, local ritual practices, and indigenous artistic styles may receive limited representation within AI applications. This imbalance may unintentionally reinforce existing inequalities in digital heritage preservation.

Data governance presents additional concerns. Questions regarding ownership of digitised manuscripts, access to sacred knowledge, copyright, intellectual property, and community consent remain insufficiently addressed (Ryan & Stahl, 2021). Buddhist heritage possesses religious significance that cannot always be treated as publicly accessible digital content. Community participation therefore becomes essential when determining digitisation priorities, AI training datasets, and access policies. Recent studies on intangible cultural heritage similarly conclude that technology-focused initiatives lacking community engagement risk creating “digital fossilisation,” whereby heritage is digitally preserved but disconnected from its living cultural context (UNESCO, 2003).

International organisations increasingly advocate ethical governance frameworks for AI within cultural heritage. UNESCO emphasises transparency, accountability, inclusiveness, cultural diversity, human oversight, and respect for local communities as fundamental principles for responsible AI adoption (UNESCO, 2021). Such governance models recognise that technological innovation should strengthen rather than undermine cultural identity and community participation (ICCRIM, 2021).

➤ *Research Gap*

Existing scholarship demonstrates substantial progress in applying AI to cultural heritage conservation, manuscript digitisation, digital reconstruction, and heritage education (Resta & Dicuonzo, 2022; Harmanda et al., 2026). Nevertheless, most studies examine AI within the broader field of cultural heritage without specifically addressing the distinctive characteristics of Buddhist heritage. Research frequently concentrates on technical performance, including object recognition, OCR accuracy, image restoration, and

machine learning algorithms, while giving comparatively limited attention to religious authenticity, monastic knowledge systems, ethical governance, and community participation (Bhowmik & Bhowmik, 2023).

Furthermore, studies integrating tangible and intangible Buddhist heritage within a single analytical framework remain limited. Existing research often treats monuments, manuscripts, rituals, education, and oral traditions separately despite their interconnected role in Buddhist cultural transmission. This study addresses these limitations by providing an interdisciplinary analysis that integrates heritage conservation, Buddhist studies, artificial intelligence, digital humanities, and cultural governance. It argues that effective preservation requires a human-centred model in which AI enhances documentation, conservation, and knowledge transmission while respecting religious values, historical authenticity, and the authority of Buddhist custodial communities.

III. RESEARCH METHODOLOGY

➤ *Research Design*

The research methodology for this study is qualitative, employing a combination of systematic literature review (SLR) and thematic analysis (Piyumali & Sandaruwan, 2025). Therefore examine the role of Artificial Intelligence (AI) in the preservation and transmission of Buddhist cultural heritage. A systematic review was selected because the intersection between AI, digital heritage, and Buddhist studies is an emerging interdisciplinary research area characterised by diverse theoretical perspectives and rapidly expanding scholarship (Harmanda et al., 2026). The systematic approach provides a transparent and reproducible method for identifying, evaluating, and synthesising existing knowledge while reducing selection bias.

Unlike traditional narrative reviews, systematic reviews follow explicit procedures for literature identification, screening, eligibility assessment, and data synthesis. This methodology enables researchers to identify major research trends, technological developments, theoretical perspectives, and existing knowledge gaps. Furthermore, qualitative thematic analysis facilitates the interpretation of recurring concepts and emerging themes across publications originating from computer science, digital humanities, archaeology, conservation science, religious studies, library and information science, and heritage management.

The study does not seek to evaluate the technical performance of individual AI algorithms. Instead, it critically examines how AI contributes to preserving Buddhist cultural heritage while identifying the ethical, cultural, technological, and governance challenges associated with its implementation.

➤ *Data Sources*

The literature included in this review was obtained from internationally recognised academic databases to ensure the reliability and academic quality of the selected publications. The principal databases included:

- Scopus
- Web of Science Core Collection
- IEEE Xplore
- ACM Digital Library
- ScienceDirect
- SpringerLink
- Taylor & Francis Online
- Wiley Online Library
- Sage Journals

To incorporate global policy perspectives, publications produced by international organisations were also consulted, including UNESCO, the International Council on Monuments and Sites (ICOMOS), the International Centre for the Study of the Preservation and Restoration of Cultural Property (ICCROM), and the World Intellectual Property Organization (WIPO). These organisations have published influential guidelines concerning digital heritage preservation, ethical AI, and cultural governance that provide an important contextual foundation for the present study (UNESCO, 2021; ICOMOS, 2019; ICCROM, 2021).

➤ Search Strategy

A comprehensive keyword search was conducted using combinations of Boolean operators to identify relevant literature. Search terms included: “Artificial Intelligence” AND “Cultural Heritage”; “Artificial Intelligence” AND “Buddhism”; “Machine Learning” AND “Heritage Conservation”; “Deep Learning” AND “Digital Heritage”; “Computer Vision” AND “Archaeology”; “Natural Language Processing” AND “Buddhist Manuscripts”; “Generative AI” AND “Cultural Heritage”; “Digital Preservation” AND “Buddhist Heritage”; “AI” AND “Religious Heritage”; and “Virtual Heritage” AND “Buddhist Temples”.

Additional manual searches of reference lists were undertaken to identify influential studies that were not retrieved during the initial database search. Citation tracking was also employed to identify recently published research building upon earlier landmark studies.

The review primarily considered publications published between 2015 and 2026, reflecting the rapid evolution of AI technologies during the past decade. Earlier publications were included only when they made significant theoretical contributions to digital heritage preservation or Buddhist cultural studies.

➤ Inclusion and Exclusion Criteria

To ensure consistency throughout the review, predefined inclusion and exclusion criteria were established.

• Inclusion Criteria

The review included studies that examined AI applications within cultural heritage preservation; investigated Buddhist cultural heritage, digital heritage, archaeology, museums, archives, or manuscript preservation; discussed AI technologies including machine learning, deep learning, computer vision, natural language processing, optical character recognition, or generative AI; were

published in peer-reviewed journals, conference proceedings, edited books, or reports issued by recognised international organisations; and were published in English.

• Exclusion Criteria

The following publications were excluded: opinion articles lacking academic evidence; unpublished theses and dissertations; newspaper articles and commercial reports; studies unrelated to heritage preservation; publications focusing exclusively on technical algorithm development without heritage applications; and duplicate publications.

The screening process ensured that only studies directly relevant to the research objectives were incorporated into the final synthesis.

➤ Data Analysis

The selected literature was analysed using qualitative thematic analysis, which enables the identification of recurring concepts, patterns, and relationships across diverse studies. The analytical process consisted of five stages: familiarisation with the selected publications through repeated reading; initial coding of key concepts relating to AI technologies, Buddhist heritage, conservation practices, educational applications, ethical issues, and governance; grouping similar codes into broader thematic categories; comparing similarities and differences among studies originating from different academic disciplines; and synthesising findings into an integrated conceptual framework illustrating the relationship between AI technologies and Buddhist heritage preservation.

The thematic analysis produced six principal themes: (1) AI-assisted documentation and digitisation; (2) intelligent conservation and restoration; (3) preservation of Buddhist manuscripts; (4) transmission of Buddhist knowledge through digital technologies; (5) ethical and governance challenges; and (6) future directions for sustainable AI adoption. These themes provide the analytical structure for the discussion presented in the subsequent section.

➤ Conceptual Framework

The present study proposes a conceptual framework illustrating the relationship between AI technologies and Buddhist cultural heritage preservation. The framework consists of four interconnected components: AI technologies, heritage resources, AI applications, and outcomes.

The first component comprises the principal AI technologies currently applied within heritage preservation, namely machine learning, deep learning, computer vision, natural language processing, optical character recognition, generative artificial intelligence, knowledge graphs, and digital twins. These technologies provide the computational foundation for heritage documentation, analysis, restoration, and educational dissemination (Liu et al., 2023).

The second component consists of Buddhist cultural heritage resources divided into two categories. Tangible heritage includes temples, monasteries, stupas, sculptures, murals, archaeological sites, palm-leaf manuscripts, and stone

inscriptions. Intangible heritage includes meditation traditions, chanting, ritual practices, Buddhist philosophy, oral traditions, monastic education, and traditional craftsmanship.

The third component explains how AI technologies interact with Buddhist heritage through several practical applications, including manuscript digitisation, multilingual translation, digital archiving, predictive conservation, structural monitoring, image restoration, virtual reconstruction, intelligent museum systems, digital education, virtual tourism, and immersive learning environments. Collectively, these applications strengthen documentation, conservation, accessibility, and educational engagement (Fiorentino et al., 2022).

The final component identifies the expected outcomes resulting from responsible AI implementation, including improved preservation of endangered heritage, enhanced accessibility for global audiences, increased research efficiency, stronger educational dissemination, sustainable heritage management, greater public engagement, long-term digital preservation, and protection of cultural identity. However, these positive outcomes remain dependent upon

appropriate ethical governance, transparency, community participation, and human oversight (Floridi & Cowls, 2019).

➤ Ethical Considerations

Although this study does not involve human participants, ethical considerations remain central because it examines religious and cultural heritage. The study recognises that Buddhist cultural heritage possesses profound religious, historical, and cultural significance extending beyond its material characteristics. Consequently, AI technologies should not be regarded as substitutes for traditional custodianship exercised by Buddhist monastic communities, archaeologists, historians, conservators, librarians, and local communities.

The review adopts internationally recognised ethical principles emphasising transparency, accountability, explainability, cultural sensitivity, inclusiveness, respect for religious traditions, community participation, and responsible innovation (UNESCO, 2021; Ryan & Stahl, 2021). The study further acknowledges that AI-generated reconstructions, translations, and educational content require expert validation to prevent historical inaccuracies, doctrinal misinterpretations, or culturally inappropriate representations.

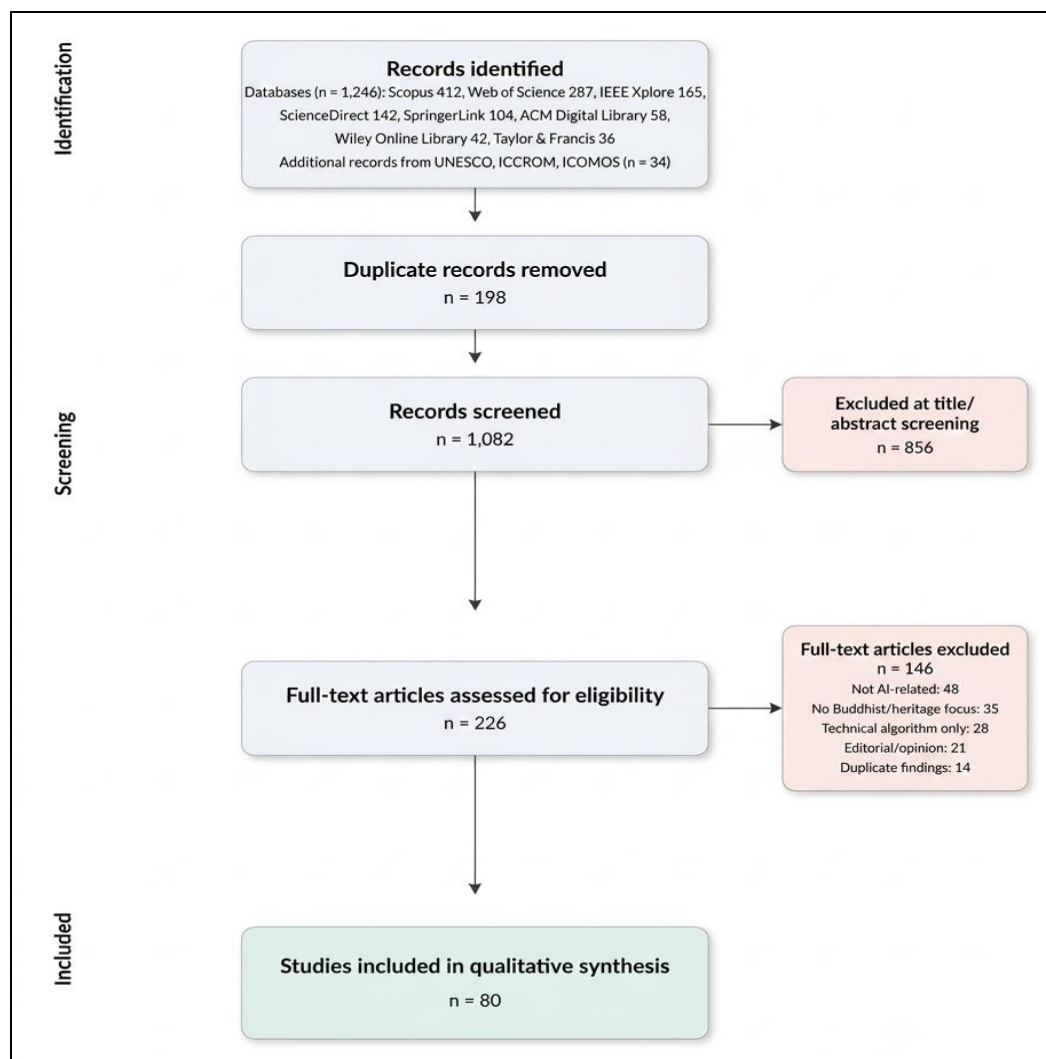


Fig 1 Prisma Workflow 2020

Table 1 Characteristics of the Reviewed Literature

Category	Number of Studies	Percentage
Journal Articles	58	72.5%
Conference Papers	9	11.3%
Book Chapters	5	6.3%
UNESCO/ICOMOS Reports	8	10.0%
Total	80	100%

Table 2 Distribution of Literature by Research Discipline

Research Area	Number
Cultural Heritage	24
Artificial Intelligence	18
Digital Humanities	11
Archaeology	8
Library & Information Science	7
Buddhist Studies	6
Museum Studies	4
Conservation Science	2

Table 3 Major AI Technologies Identified

AI Technology	Primary Application
Machine Learning	Pattern recognition and prediction
Deep Learning	Image restoration and classification
Computer Vision	Temple monitoring and monument inspection
Optical Character Recognition	Palm-leaf manuscript digitisation
Natural Language Processing	Translation of Buddhist scriptures
Generative AI	Virtual reconstruction of damaged heritage
Knowledge Graphs	Semantic linkage of Buddhist texts
Digital Twins	Monitoring heritage sites

Table 4 Buddhist Heritage Categories

Heritage Type	Examples	AI Application
Temples	Anuradhapura, Borobudur	Structural monitoring
Stupas	Ruwanwelisaya	Digital reconstruction
Cave Temples	Dambulla	3D documentation
Palm-leaf Manuscripts	Tripitaka	OCR & NLP
Stone Inscriptions	Brahmi inscriptions	Image enhancement
Sculptures	Buddha statues	Damage detection
Ritual Practices	Chanting	Digital recording
Meditation Traditions	Vipassanā	AI educational systems

Table 5 Research Gaps Identified

Research Gap	Future Research Direction
Limited Buddhist-focused AI studies	Develop Buddhist-specific AI frameworks
Few comparative international studies	Cross-country comparative research
Limited studies on intangible heritage	AI for ritual and oral tradition preservation
Lack of ethical governance models	AI ethics framework for religious heritage
Limited AI evaluation metrics	Heritage-specific AI performance indicators
Few interdisciplinary collaborations	Integrate AI, heritage science, and Buddhist studies

IV. RESULTS AND DISCUSSION

The systematic review identified six major themes concerning the application of Artificial Intelligence (AI) in the preservation and transmission of Buddhist cultural heritage. The first three themes—AI-assisted documentation and digitisation, intelligent conservation and restoration, and the preservation of Buddhist manuscripts—represent the technological foundations upon which broader heritage

management strategies are increasingly being developed. The findings indicate that AI has substantially expanded the capabilities of cultural institutions to document, analyse, and preserve Buddhist heritage (Chen et al., 2024). However, the literature consistently emphasises that technological innovation must remain closely integrated with historical scholarship, conservation ethics, and the custodianship exercised by Buddhist communities.

➤ *AI-Assisted Documentation and Digitisation of Buddhist Cultural Heritage*

The review demonstrates that documentation remains the most mature application of AI within Buddhist cultural heritage preservation. Accurate documentation is a prerequisite for conservation because it creates a permanent digital record of heritage assets that may subsequently experience deterioration, natural disasters, armed conflict, or environmental degradation. Traditionally, documentation relied on manual photography, architectural drawings, written catalogues, and field surveys (Pavlidis et al., 2007). While these approaches continue to provide valuable information, they are labour-intensive, time-consuming, and often limited in their capacity to capture complex architectural or artistic details.

AI has transformed this process by integrating computer vision, machine learning, remote sensing, and automated image analysis into heritage documentation (Münster & Ioannides, 2020). High-resolution photographs, laser scanning, LiDAR technologies, drone imagery, and satellite observations can now be analysed automatically to identify architectural features, classify heritage objects, and generate detailed three-dimensional representations of monuments (Remondino & Campana, 2014). Unlike conventional digital recording, AI systems continuously improve their analytical performance as larger datasets become available, thereby increasing the efficiency and consistency of documentation.

Within Buddhist heritage, these developments have particular significance because many important religious sites are geographically dispersed and located in environmentally sensitive regions. Ancient temple complexes in Sri Lanka, India, Nepal, Myanmar, Thailand, Cambodia, China, Japan, and Tibet contain thousands of structures requiring continuous monitoring. Manual inspection of these monuments is often constrained by financial resources, accessibility, and the availability of conservation specialists. AI-assisted documentation enables heritage managers to monitor large collections of monuments simultaneously while maintaining detailed digital records that support future conservation interventions (Laohaviraphap & Waroonkun, 2024).

The literature further indicates that computer vision algorithms have become increasingly effective in recognising architectural styles, decorative motifs, inscriptions, sculptures, and mural paintings (Llamas et al., 2017). Such automated classification significantly reduces the time required for cataloguing heritage collections and assists museums, archives, and archaeological departments in managing large digital repositories. AI also facilitates semantic metadata generation, allowing digital archives to become searchable through object recognition rather than solely through manually assigned keywords.

Another important contribution concerns the integration of AI with Geographic Information Systems (GIS). Spatial analysis enables researchers to examine relationships among Buddhist heritage sites, pilgrimage routes, settlement patterns, and environmental conditions. Predictive spatial modelling can identify archaeological areas with a high probability of

containing undiscovered heritage resources, thereby improving future archaeological investigations (Ge, 2024).

Despite these advances, documentation should not be understood as a purely technological exercise. Heritage documentation involves decisions concerning historical interpretation, cultural significance, and contextual meaning that cannot be delegated entirely to computational systems. AI may identify architectural features with remarkable accuracy, yet it cannot independently determine their religious symbolism or historical importance. Consequently, archaeologists, historians, architects, conservators, and Buddhist scholars continue to play a central role in validating AI-generated documentation.

The review therefore suggests that AI should be regarded as an intelligent documentation assistant rather than an autonomous heritage expert. Human expertise remains indispensable in interpreting the cultural narratives embedded within Buddhist monuments and ensuring that digital documentation accurately represents historical reality.

➤ *Intelligent Conservation and Restoration*

Conservation and restoration represent the second major area in which AI has significantly influenced Buddhist cultural heritage management. Unlike documentation, which records existing conditions, conservation seeks to prevent deterioration while restoration attempts to recover damaged cultural assets. The literature indicates that AI increasingly supports preventive conservation by enabling continuous monitoring and predictive analysis rather than relying solely on reactive interventions after visible damage has occurred (Chen et al., 2024).

Machine learning algorithms are capable of analysing environmental variables including temperature, humidity, rainfall, air pollution, biological growth, and visitor density. By integrating these variables with historical conservation records, AI systems can estimate the probability of future deterioration affecting monuments, murals, sculptures, or manuscripts (Cheng et al., 2024). Such predictive capabilities enable conservation authorities to allocate limited financial resources more efficiently while reducing long-term restoration costs.

Computer vision has become particularly valuable in structural monitoring. High-resolution images collected periodically from temples, stupas, and cave monasteries may be compared automatically to detect subtle changes that remain invisible during routine human inspections. AI algorithms identify cracks, surface erosion, material displacement, biological colonisation, moisture infiltration, and weather-related deterioration with considerable accuracy (Llamas et al., 2017). Early detection allows conservators to intervene before structural damage becomes irreversible.

Several studies also demonstrate the effectiveness of deep learning techniques in mural restoration. Buddhist temples throughout Asia contain extensive wall paintings that have gradually deteriorated through humidity, smoke, fungal growth, pollution, earthquakes, and ageing. Deep neural

networks trained on historical image datasets can reconstruct faded colours, remove digital noise, and estimate missing visual elements while preserving original stylistic characteristics (Silva & Oliveira, 2024). These technologies assist conservators by producing restoration hypotheses that may subsequently be evaluated against historical evidence.

Generative AI has further expanded possibilities for reconstructing partially destroyed heritage structures. Historical photographs, excavation reports, architectural drawings, and surviving structural elements can be integrated to produce virtual reconstructions of monuments damaged through natural disasters or armed conflict (Bonacini, 2011). Such reconstructions provide valuable educational and research resources while supporting heritage interpretation in museums and virtual exhibitions.

Nevertheless, the review consistently identifies important limitations associated with AI-assisted restoration. The most significant concern relates to historical authenticity. AI systems generate outputs by recognising statistical patterns within training datasets rather than by understanding historical contexts. Consequently, reconstructed architectural features or artistic details may appear visually convincing despite lacking archaeological evidence (Mittelstadt, 2019). Such reconstructions risk creating historical narratives that reflect algorithmic prediction rather than documented reality.

This challenge is particularly sensitive within Buddhist heritage because temples, statues, murals, and ritual objects possess profound religious significance. Restoration decisions frequently involve theological, cultural, and historical considerations that extend beyond technical conservation principles. Buddhist communities often attribute sacred value to material imperfections resulting from historical continuity, whereas AI-generated reconstructions may unintentionally prioritise aesthetic completeness over cultural authenticity.

The findings therefore support internationally accepted conservation principles emphasising minimal intervention, reversibility, transparency, and evidence-based restoration (ICOMOS, 2019). AI should generate restoration alternatives rather than final decisions. Human conservators must evaluate each proposed intervention according to archaeological evidence, historical documentation, material analysis, and religious considerations.

Consequently, successful conservation depends upon collaboration among computer scientists, conservation specialists, archaeologists, architects, material scientists, and Buddhist monastic communities. Such interdisciplinary cooperation ensures that technological innovation strengthens rather than compromises heritage authenticity.

➤ *AI and the Preservation of Buddhist Manuscripts*

Among the various forms of Buddhist cultural heritage, manuscripts constitute one of the most significant beneficiaries of AI technologies. Buddhist canonical literature has been transmitted for centuries through palm-leaf manuscripts, paper manuscripts, inscriptions, printed editions, and oral recitation (Lancaster, 1993a). These

collections preserve religious doctrine, philosophy, law, medicine, linguistics, astronomy, history, literature, and monastic administration. However, many manuscripts remain endangered because of biological deterioration, environmental conditions, fragile writing materials, and limited conservation resources.

Traditional manuscript preservation depended upon manual transcription undertaken by monks and scribes. Although this practice ensured the survival of Buddhist knowledge over many centuries, it required considerable labour and introduced inevitable transcription variations. Modern digitisation programmes have substantially improved preservation by creating digital copies of fragile manuscripts, yet conventional digitisation alone cannot efficiently process the enormous volume of historical material preserved across Asia (Cochrane, 2018).

Optical Character Recognition (OCR) has emerged as one of the most influential AI applications addressing this challenge. Contemporary OCR systems employ deep learning algorithms capable of recognising ancient scripts despite irregular handwriting, faded ink, damaged surfaces, and complex page layouts (Silfeler et al., 2023). Compared with earlier rule-based OCR software, deep learning models demonstrate considerably higher recognition accuracy when trained using historical manuscript collections.

Within Buddhist studies, OCR technologies have been applied to manuscripts written in Pali, Sanskrit, Tibetan, Chinese, Sinhala, Burmese, Thai, Khmer, and Japanese (Lancaster, 1993b). These developments enable researchers to convert manuscript images into searchable digital texts, thereby facilitating linguistic analysis, textual comparison, metadata generation, and long-term digital preservation. The resulting digital corpora significantly improve accessibility for international scholars while reducing physical handling of fragile original manuscripts (Gurusinghe & Jayatilake, 2026).

Natural Language Processing (NLP) further enhances manuscript preservation by supporting automated translation, semantic indexing, keyword extraction, and information retrieval. Rather than relying solely upon manual catalogue descriptions, researchers may search extensive Buddhist textual collections using conceptual relationships, doctrinal terminology, or thematic categories (Hsieh, 2019). Such capabilities substantially improve interdisciplinary scholarship across Buddhist philosophy, history, linguistics, archaeology, and religious studies.

Large Language Models (LLMs) represent a more recent development within Buddhist digital humanities. Specialised language models trained on Buddhist canonical literature may assist scholars in identifying textual similarities, analysing translation variants, summarising doctrinal discussions, and generating preliminary linguistic interpretations (Nehrdich & Keutzer, 2026). However, the review indicates that current LLMs remain insufficiently trained on many low-resource Buddhist languages, particularly Sinhala, Pali, and regional manuscript traditions. Consequently, substantial investment in

multilingual Buddhist datasets remains necessary before these technologies achieve broader scholarly reliability.

The review also identifies several ethical concerns associated with AI-assisted manuscript preservation. Digitising sacred manuscripts raises questions regarding intellectual property, religious authority, cultural ownership, and access to esoteric knowledge traditionally restricted within particular monastic communities (Silk, 2008). Furthermore, automated translation systems occasionally simplify or misinterpret complex philosophical terminology, potentially altering doctrinal meaning.

Accordingly, manuscript preservation should integrate AI technologies with scholarly expertise in Buddhist philology, historical linguistics, textual criticism, and monastic scholarship (Cabezón, 1994; Muller, 2013). AI substantially accelerates digitisation and analysis, but authoritative interpretation continues to depend upon human expertise. The future of Buddhist manuscript preservation therefore lies in collaborative partnerships between technology developers, libraries, archives, universities, and Buddhist monastic institutions, ensuring that digital innovation strengthens rather than diminishes the integrity of Buddhist textual traditions.

➤ *Artificial Intelligence and the Transmission of Buddhist Knowledge*

The preservation of Buddhist cultural heritage extends beyond safeguarding physical artefacts and historical monuments. It also encompasses the continuous transmission of Buddhist philosophy, ethical teachings, meditation traditions, ritual practices, and monastic knowledge across successive generations. Historically, this transmission occurred through oral instruction, monastic education, manuscript copying, public sermons, pilgrimage, and teacher–disciple relationships (Gombrich, 2006). Although these traditional methods remain fundamental to Buddhist practice, rapid technological developments have created new opportunities for disseminating Buddhist knowledge to wider and more diverse audiences. The literature reviewed indicates that AI is increasingly contributing to this process by improving accessibility, multilingual communication, personalised learning, and digital engagement (McBride, 2017).

One of the most significant contributions of AI lies in multilingual knowledge dissemination. Buddhist literature exists in numerous canonical and vernacular languages, including Pali, Sanskrit, Tibetan, Chinese, Sinhala, Thai, Burmese, Khmer, Korean, Japanese, and Mongolian. Language barriers have historically limited access to many canonical texts, particularly for researchers and practitioners lacking specialised linguistic training. Natural Language Processing (NLP) and neural machine translation have substantially improved the translation of Buddhist literature, enabling broader international access to canonical scriptures, commentaries, and historical documents (Nehrdich & Keutzer, 2026).

Recent advances in Large Language Models (LLMs) further support semantic search, automatic summarisation, terminology extraction, and cross-lingual information retrieval. Rather than relying solely on keyword searches, researchers can identify doctrinal relationships, thematic similarities, and historical developments across extensive textual collections. Such capabilities facilitate interdisciplinary scholarship while reducing the time required to analyse large volumes of Buddhist literature (Hsieh, 2019).

AI also contributes to Buddhist education through intelligent tutoring systems and adaptive learning environments. Digital educational platforms increasingly employ AI to personalise learning according to the knowledge level, language preference, and learning pace of individual users. Students studying Buddhist philosophy may receive customised explanations, recommended readings, interactive assessments, and guided learning pathways based on their previous interactions with the system. These developments expand educational accessibility, particularly for learners who lack direct access to monastic institutions or specialised academic programmes (Giannini & Bowen, 2019).

Conversational AI has introduced another dimension to knowledge dissemination. AI-powered virtual assistants can provide introductory explanations concerning Buddhist history, ethical principles, meditation techniques, and philosophical concepts. Museums, libraries, and heritage institutions have begun integrating conversational interfaces into digital exhibitions, enabling visitors to interact with cultural collections through natural language (Pujol & Economou, 2009). Such technologies improve public engagement by making complex historical information more accessible to non-specialist audiences.

Virtual Reality (VR), Augmented Reality (AR), and Mixed Reality (MR), when integrated with AI, further strengthen educational transmission. Users may virtually explore ancient Buddhist monasteries, archaeological sites, cave temples, and museum collections while receiving AI-generated contextual explanations regarding architectural features, artistic symbolism, historical events, and religious practices (Fiorentino et al., 2022). These immersive learning environments offer considerable educational value for schools, universities, museums, and heritage tourism.

Despite these advantages, the literature consistently cautions against viewing AI as an authoritative religious teacher. Buddhist philosophy encompasses complex ethical, metaphysical, and experiential dimensions that cannot be fully represented through algorithmic models. Large Language Models occasionally generate inaccurate interpretations, oversimplify doctrinal concepts, or produce fabricated references. Such limitations are particularly problematic when discussing philosophical topics involving subtle conceptual distinctions (Silk, 2008).

Moreover, Buddhist learning traditionally emphasises personal reflection, meditation, moral discipline, and direct teacher–student interaction. AI systems cannot replicate the experiential dimensions of Buddhist practice or the spiritual

guidance provided by qualified monastic teachers. Consequently, AI should be understood as an educational support tool rather than a replacement for traditional religious instruction.

The findings therefore suggest that successful knowledge transmission requires collaboration between AI developers, Buddhist scholars, educational institutions, and monastic communities. Human expertise remains essential for validating educational content, ensuring doctrinal accuracy, and preserving the cultural authenticity of Buddhist teachings.

➤ *Ethical, Legal, and Governance Challenges*

Although AI presents considerable opportunities for preserving and transmitting Buddhist cultural heritage, the review identifies ethical governance as one of the most significant challenges confronting future implementation. Heritage preservation involves far more than technological efficiency; it also concerns authenticity, cultural identity, religious values, intellectual property, and community participation (Floridi & Cows, 2019). Consequently, technological innovation must be evaluated within broader ethical and cultural contexts.

Authenticity represents the most frequently discussed concern within the literature. AI-generated reconstructions, image restorations, and virtual representations are frequently based upon statistical predictions rather than complete historical evidence. While these outputs may appear visually convincing, they may inadvertently introduce architectural features, artistic details, or historical interpretations unsupported by archaeological evidence (Mittelstadt, 2019).

Within Buddhist heritage, such inaccuracies may have serious implications because temples, sculptures, murals, and ritual objects possess profound religious significance. Sacred spaces are not merely historical monuments but active places of worship and cultural identity. Altering their appearance through speculative AI-generated reconstruction risks compromising both historical integrity and religious authenticity.

Algorithmic bias constitutes a second major challenge. Most contemporary AI systems are developed using datasets originating from technologically advanced regions where digital resources are relatively abundant. Consequently, Buddhist traditions represented through large digital collections particularly Chinese, Japanese, and English-language materials receive greater computational attention than traditions preserved in lower-resource languages such as Pali, Sinhala, Burmese, Khmer, or Tibetan (Jobin et al., 2019).

This imbalance may unintentionally marginalise regional Buddhist traditions while reinforcing existing inequalities within digital heritage preservation. The review therefore highlights the necessity of developing multilingual AI models trained using culturally diverse datasets that adequately represent the full geographical and linguistic diversity of Buddhist civilisation (Ryan & Stahl, 2021).

Data ownership and intellectual property also emerge as important governance issues. Digitised manuscripts, ritual recordings, archaeological data, and digital reconstructions frequently involve multiple stakeholders including governments, museums, universities, monasteries, local communities, and international organisations. Questions concerning ownership, copyright, access permissions, commercial use, and long-term data stewardship remain insufficiently addressed within existing heritage policies (ICCROM, 2021).

Particular attention must also be given to sacred knowledge that has traditionally been transmitted within restricted religious contexts. Certain ritual practices, meditation techniques, and monastic texts possess cultural or spiritual sensitivities that may not be appropriate for unrestricted AI training datasets or commercial applications. Community consultation therefore becomes an essential component of responsible AI implementation.

Privacy and cybersecurity represent additional governance concerns. Large digital heritage repositories increasingly store detailed architectural records, archaeological surveys, manuscript collections, and cultural metadata. Protecting these resources against cyber threats, unauthorised modification, and digital manipulation is becoming an important responsibility for heritage institutions. AI itself may contribute to cybersecurity by detecting suspicious activities and identifying potential vulnerabilities within digital heritage infrastructures.

International organisations increasingly advocate ethical governance frameworks to address these challenges. UNESCO's Recommendation on the Ethics of Artificial Intelligence emphasises transparency, accountability, explainability, fairness, human oversight, cultural diversity, and community participation as guiding principles for responsible AI development (UNESCO, 2021). Similar principles have been incorporated into emerging heritage policies developed by ICOMOS and ICCROM (ICOMOS, 2019; ICCROM, 2021).

The findings therefore indicate that successful AI implementation depends not solely upon technological innovation but equally upon effective governance structures capable of balancing innovation with cultural responsibility. Heritage preservation should remain fundamentally human-centred, with AI functioning as a decision-support technology operating under expert supervision.

➤ *Future Directions: Towards a Human-Centred AI Framework for Buddhist Cultural Heritage*

The systematic review indicates that AI possesses considerable potential to transform Buddhist cultural heritage preservation during the coming decades. However, technological advancement alone cannot ensure sustainable heritage management. The future of AI within Buddhist heritage depends upon developing interdisciplinary frameworks that integrate technological innovation with historical scholarship, conservation science, religious values, and community participation.

Based on the findings of this review, a Human-Centred AI Framework is proposed to guide future research and heritage practice. This framework consists of five interconnected principles.

- **Human Expertise as the Primary Authority.** AI should support rather than replace the expertise of archaeologists, conservators, historians, librarians, linguists, museum professionals, and Buddhist monastic communities. Final decisions concerning conservation, restoration, interpretation, and educational content should remain under human authority. AI should function as an analytical assistant that enhances professional decision-making while respecting established scholarly standards (Floridi & Cowsls, 2019).
- **Evidence-Based AI Applications.** All AI-generated reconstructions, translations, classifications, and educational materials should be supported by verifiable historical, archaeological, and textual evidence. Heritage institutions should clearly distinguish between documented historical information and algorithmically generated interpretations. Transparent documentation of AI methodologies will improve scholarly credibility while reducing the risk of misinformation (Mittelstadt, 2019).
- **Inclusive and Culturally Representative Datasets.** Future AI systems should incorporate multilingual datasets representing the full diversity of Buddhist traditions. Greater attention should be devoted to digitising manuscripts, inscriptions, oral traditions, and historical records preserved in underrepresented languages including Pali, Sinhala, Tibetan, Burmese, Khmer, Lao, and Mongolian. Inclusive datasets will reduce algorithmic bias while promoting equitable digital preservation (Jobin et al., 2019).
- **Community Participation.** Buddhist monastic communities, local custodians, heritage practitioners, and Indigenous knowledge holders should participate actively in AI development, data governance, and conservation planning. Heritage preservation is fundamentally a social process grounded in community values rather than solely a technological undertaking. Participatory governance will strengthen public trust while ensuring that AI applications respect cultural and religious traditions (UNESCO, 2003).
- **International Collaboration.** The preservation of Buddhist cultural heritage requires cooperation among governments, universities, museums, libraries, technology companies, and international organisations. Collaborative digital repositories, shared AI infrastructures, multilingual manuscript collections, and common ethical standards will improve research capacity while reducing duplication of effort. Such international partnerships are particularly important because Buddhist heritage extends across numerous countries and cultural traditions (ICCRUM, 2021).

Collectively, these principles establish a sustainable framework that balances technological innovation with cultural authenticity. Rather than viewing AI as a replacement for traditional heritage practice, the framework positions AI as an enabling technology that strengthens documentation,

conservation, education, and public engagement while preserving the central role of human expertise.

V. CONCLUSION

Artificial Intelligence has emerged as a transformative technology within the field of cultural heritage preservation, offering new possibilities for documenting, conserving, interpreting, and transmitting Buddhist cultural heritage. This study examined the relationship between AI and Buddhist heritage through a systematic review of interdisciplinary literature, demonstrating that AI applications extend across multiple dimensions, including digital documentation, preventive conservation, manuscript preservation, multilingual knowledge dissemination, virtual reconstruction, and educational engagement.

The findings indicate that AI has significant potential to address several longstanding challenges associated with Buddhist cultural heritage preservation. Computer vision and machine learning technologies improve the documentation and monitoring of temples, monasteries, sculptures, murals, and archaeological sites by enabling accurate digital recording and predictive analysis (Chen et al., 2024). These technologies are particularly valuable for endangered heritage sites affected by environmental deterioration, climate change, natural disasters, and limited conservation resources. Similarly, AI-assisted restoration techniques provide new opportunities for recovering damaged visual heritage while supporting conservation professionals in developing evidence-based interventions.

The preservation of Buddhist manuscripts represents another important area where AI contributes substantial value. Optical Character Recognition, natural language processing, and machine translation technologies enable the digitisation, classification, translation, and analysis of extensive Buddhist textual collections preserved across different linguistic traditions (Cochrane, 2018; Nehrdich & Keutzer, 2026). By transforming fragile manuscripts into searchable digital resources, AI enhances accessibility for researchers, educators, and global communities while reducing the physical handling of vulnerable historical materials.

Beyond material preservation, AI also contributes to the transmission of Buddhist knowledge. Intelligent learning systems, conversational AI, virtual museums, and immersive digital environments provide innovative methods for communicating Buddhist history, philosophy, and cultural practices to wider audiences. These developments are particularly significant in an increasingly digital society where younger generations engage with knowledge through interactive technological platforms. AI therefore offers new possibilities for connecting ancient traditions with contemporary modes of learning and cultural participation.

However, the adoption of AI within Buddhist heritage preservation must be approached critically. Technological capability alone cannot guarantee successful heritage conservation. The study identifies several challenges, including algorithmic bias, historical inaccuracy, cultural

misrepresentation, intellectual property concerns, data ownership issues, and insufficient representation of diverse Buddhist traditions within AI datasets (Jobin et al., 2019; Ryan & Stahl, 2021). These concerns demonstrate that heritage preservation is not merely a technical process but a cultural and ethical responsibility.

A central argument of this study is that AI should function as an enabling technology rather than a replacement for human knowledge and cultural authority. Buddhist heritage possesses historical, religious, and social meanings that cannot be fully understood through computational analysis alone. The interpretation of sacred texts, conservation of religious sites, restoration of artistic works, and transmission of philosophical teachings require human judgement, scholarly expertise, and community participation. Therefore, the most sustainable approach is not technological substitution but human–AI collaboration.

Future developments should focus on creating culturally sensitive AI systems specifically designed for heritage contexts. Such systems require diverse multilingual datasets, transparent algorithms, ethical governance mechanisms, and participatory approaches involving Buddhist scholars, monastic communities, heritage professionals, and technology experts. International collaboration will also be essential because Buddhist cultural heritage extends across multiple geographical regions and linguistic traditions. Shared digital infrastructures, collaborative research networks, and common ethical standards can contribute significantly to sustainable preservation.

This study contributes to existing scholarship by integrating perspectives from artificial intelligence research, digital humanities, Buddhist studies, conservation science, and heritage management. While previous research has largely examined AI applications within general cultural heritage contexts (Resta & Dicuonzo, 2022; Liu et al., 2023), this study highlights the distinctive characteristics of Buddhist heritage, particularly the relationship between tangible artefacts and intangible knowledge traditions. By proposing a human-centred AI framework, the study provides a conceptual foundation for future research and practical implementation.

Nevertheless, several limitations should be acknowledged. First, because AI and digital heritage technologies are rapidly developing fields, new applications may emerge beyond the scope of the reviewed literature. Second, although the study examined international scholarship, variations among different Buddhist traditions require further region-specific investigations. Third, future empirical studies involving heritage institutions, Buddhist communities, and technology developers would provide deeper insights into practical implementation challenges.

Future research should therefore explore several important areas. Comparative studies examining AI adoption across different Buddhist countries would provide valuable understanding of cultural and technological differences. Further investigation is also required into AI applications for

intangible heritage, including meditation traditions, chanting practices, oral transmission, and ritual knowledge. Additionally, research should examine legal and ethical frameworks governing the ownership, accessibility, and commercial use of AI-generated cultural heritage content.

In conclusion, Artificial Intelligence represents both an opportunity and a responsibility in the preservation and transmission of Buddhist cultural heritage. When implemented responsibly, AI can strengthen conservation practices, expand educational access, and safeguard endangered cultural resources for future generations. However, the success of AI-driven heritage preservation depends upon maintaining a careful balance between technological innovation and cultural authenticity. The future of Buddhist heritage preservation should therefore be guided by an approach where artificial intelligence supports human wisdom, rather than attempting to replace it.

REFERENCES

- [1]. Bertacchini, E., & Morando, F. (2013). The future of museums in the digital age: New models and challenges for cultural heritage institutions. *Journal of Cultural Economics*, 37, 1–17.
- [2]. Bhowmik, A. K., & Bhowmik, P. (2023). Artificial intelligence and digital transformation in cultural heritage management: A review of emerging approaches. *Journal of Cultural Heritage Management and Sustainable Development*, 13(4), 556–573.
- [3]. Bingenheimer, M. (2014). The digital humanities and Buddhist studies: A survey of current projects. *Journal of Buddhist Studies*, 11, 25–40.
- [4]. Bonacini, E. (2011). New technologies for enhancing visitor experience in cultural heritage sites: The virtual reconstruction of archaeological sites. *Digital Heritage International Congress Proceedings*, 1, 87–94.
- [5]. Buddhist Digital Resource Center. (2023). Using artificial intelligence to generate wisdom: AI applications for Buddhist manuscript preservation.
- [6]. Buswell, R. E., & Lopez, D. S. (2014). *The Princeton dictionary of Buddhism*. Princeton University Press.
- [7]. Cabezón, J. I. (1994). *Buddhism and language: A study of Indo-Tibetan scholasticism*. State University of New York Press.
- [8]. Cameron, F., & Kenderdine, S. (Eds.). (2007). *Theorizing digital cultural heritage: A critical discourse*. MIT Press.
- [9]. Chen, S., Zhang, Y., & Zhang, X. (2024). Artificial intelligence and cultural heritage preservation: Applications, challenges, and future perspectives. *Heritage Science*, 12.
- [10]. Cheng, Y., Huang, J., Zhang, Y., & Peng, N. (2024). Artificial intelligence in cultural heritage conservation. *Chinese Journal of Nature*, 46(4), 261–270. <https://doi.org/10.3969/j.issn.0253-9608.2024.04.003>
- [11]. Cochrane, E. (2018). Digital preservation of Buddhist manuscripts: Challenges and opportunities. *Digital Scholarship in the Humanities*, 33(4), 789–803.
- [12]. Cuno, J. (2011). *Museums matter: In praise of the encyclopedic museum*. University of Chicago Press.

- [13]. Fiorentino, M., Uva, A. E., & Dell'Aversano, A. (2022). Virtual and augmented reality for cultural heritage preservation: A review of applications and challenges. *Virtual Reality*, 26, 1201–1220.
- [14]. Floridi, L., & Cows, J. (2019). A unified framework of five principles for AI in society. *Harvard Data Science Review*, 1(1).
- [15]. Ge, C. (2024). The review of AI and cultural heritage protection Taking the whole process of cultural heritage protection as an example. *Theoretical and Practical Research in Economic Fields*, 71, 1–10. <https://doi.org/10.54254/2755-2721/71/20241666>
- [16]. Gethin, R. (1998). *The foundations of Buddhism*. Oxford University Press.
- [17]. Giannini, T., & Bowen, J. P. (2019). Transforming the museum: Digital technologies and cultural heritage. *Museum Management and Curatorship*, 34(4), 325–346.
- [18]. Gombrich, R. F. (2006). *Theravāda Buddhism: A social history from ancient Benares to modern Colombo* (2nd ed.). Routledge.
- [19]. Gurusinghe, R., & Jayatilke, N. (2026). SiPaKosa: A comprehensive corpus of canonical and classical Buddhist texts in Sinhala and Pali. *arXiv*.
- [20]. Harmanda, T. T., Hidayanto, A. N., Aji, R. F., & Ilin, I. (2026). Artificial intelligence adoption in the cultural heritage sector: A systematic review of trends, application domains, and challenges. *Computers in Human Behavior Reports*, 23, Article 101147.
- [21]. Hsieh, S. (2019). Computational approaches to Buddhist textual studies: New methods for analysing classical Buddhist literature. *Digital Scholarship in the Humanities*, 34(3), 610–625.
- [22]. International Centre for the Study of the Preservation and Restoration of Cultural Property (ICCROM). (2021). *Digital technologies and heritage conservation: Opportunities and challenges*. ICCROM.
- [23]. International Council on Monuments and Sites (ICOMOS). (2019). *The future of our pasts: Engaging cultural heritage in climate action*. ICOMOS.
- [24]. Jobin, A., Ienca, M., & Vayena, E. (2019). The global landscape of AI ethics guidelines. *Nature Machine Intelligence*, 1, 389–399.
- [25]. Lancaster, L. R. (1993a). *The Korean Buddhist canon: A descriptive catalogue*. University of California Press.
- [26]. Lancaster, L. R. (1993b). The movement of Buddhist texts from India to China and the construction of digital Buddhist resources. *Journal of Buddhist Studies*.
- [27]. 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. <https://doi.org/10.3390/buildings14123979>
- [28]. Liu, X., Zhang, W., & Wang, J. (2023). Artificial intelligence applications in cultural heritage conservation: A review of emerging technologies. *Journal of Cultural Heritage*, 60, 1–12.
- [29]. Llamas, J., Leronés, P. M., Medina, R., Zalama, E., & Gómez-García-Bermejo, J. (2017). Classification of architectural heritage images using deep learning techniques. *Applied Sciences*, 7(10), 992.
- [30]. Manovich, L. (2013). *Software takes command*. Bloomsbury Academic.
- [31]. McBride, R. D. (2017). Digital humanities and Buddhist studies: New approaches to classical texts. *Journal of Buddhist Studies*, 14, 1–20.
- [32]. Mittelstadt, B. (2019). Principles alone cannot guarantee ethical AI. *Nature Machine Intelligence*, 1, 501–507.
- [33]. Muller, A. C. (2013). Digital humanities and Buddhist studies: Challenges and opportunities. *Journal of Buddhist Ethics*, 20, 1–15.
- [34]. Münster, S., & Ioannides, M. (2020). Cultural heritage documentation and digital technologies: The role of artificial intelligence. *ISPRS International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences*, XLIII-B2, 123–130.
- [35]. Nehrdich, S., & Keutzer, K. (2026). MITRA: A large-scale parallel corpus and multilingual pretrained language model for machine translation and semantic retrieval for Pāli, Sanskrit, Buddhist Chinese, and Tibetan. *arXiv*.
- [36]. Parry, R. (Ed.). (2010). *Museums in a digital age*. Routledge.
- [37]. Pavlidis, G., Koutsoudis, A., Arnaoutoglou, F., Tsioukas, V., & Chamzas, C. (2007). Methods for 3D digitization of cultural heritage. *Journal of Cultural Heritage*, 8(1), 93–98.
- [38]. Pujol, L., & Economou, M. (2009). Evaluating the social aspects of digital technologies in cultural heritage. *Journal of Cultural Heritage*, 10(1), 1–7.
- [39]. Remondino, F., & Campana, S. (Eds.). (2014). *3D recording and modelling in archaeology and cultural heritage: Theory and best practices*. Archaeopress.
- [40]. Resta, G., & Dicuonzo, F. (2022). Artificial intelligence and cultural heritage: A systematic review of applications and challenges. *Heritage*, 5(4), 3052–3070.
- [41]. Ryan, M., & Stahl, B. C. (2021). Artificial intelligence ethics guidelines for developers and users: Clarifying their content and normative implications. *Journal of Information, Communication and Ethics in Society*, 19(1), 61–86.
- [42]. Piyumali, W. M., & Sandaruwan, L. G. S. U. (2025). Exploring the evolution of cinematic representations: A comprehensive analysis of gender dynamics in the aftermath of the #MeToo movement in Hollywood. *Kalyani Journal of the University of Kelaniya*, 8–38. <https://doi.org/10.4038/kalyani.v36i1.63>
- [43]. Silfeler, M., et al. (2023). Digital preservation of historical manuscripts using artificial intelligence-based optical character recognition. *Digital Scholarship in the Humanities*.
- [44]. Silk, J. A. (2008). The study of Buddhist literature: Texts, traditions and transmission. *Journal of the International Association of Buddhist Studies*, 31(1–2), 1–25.
- [45]. Silva, C., & Oliveira, L. (2024). Artificial intelligence at the interface between cultural heritage and photography: A systematic literature review. *Heritage*,

- 7(7), 3799–3820.
<https://doi.org/10.3390/heritage7070180>
- [46]. Skilton, A. (2005). A concise history of Buddhism. Windhorse Publications.
- [47]. UNESCO. (1972). Convention concerning the protection of the world cultural and natural heritage. United Nations Educational, Scientific and Cultural Organization.
- [48]. UNESCO. (2003). Convention for the safeguarding of the intangible cultural heritage. United Nations Educational, Scientific and Cultural Organization.
- [49]. UNESCO. (2021). Recommendation on the ethics of artificial intelligence. United Nations Educational, Scientific and Cultural Organization.
- [50]. UNESCO. (2025). Artificial intelligence and culture: Report of the Independent Expert Group on Artificial Intelligence and Culture. United Nations Educational, Scientific and Cultural Organization.