Artificial Intelligence and Historical Heritage Preservation in India: An Analytical Study of Opportunities, Challenges and Sustainable Conservation

Chetan D. Patel
Associate Professor,
Department of History
Shri M. R. Desai Arts And E. E. Laher Kosadiya Commerce College, Chikhli

Abstract:

India has one of the richest and most varied cultural and historical heritages in the world. This includes ancient sites, monuments, old cities, manuscripts, paintings, sculptures, traditional knowledge, languages, performing arts, and living cultural traditions. Traditionally, keeping this heritage safe has relied on archaeology, physical restoration, keeping records, expert knowledge, and the involvement of local communities. However, new challenges are coming from climate change, pollution, urban development, tourism, natural wear and tear, poor record-keeping, human activities, and the slow loss of traditional knowledge.

At the same time, new tools like artificial intelligence, machine learning, computer vision, natural language processing, 3D modeling, remote sensing, and predictive analytics are opening up new ways to document, monitor, understand, and share heritage.

This paper looks at how AI can help in preserving historical heritage in India, especially focusing on the opportunities, difficulties, and ways to conserve it sustainably.

The study uses secondary data, including reports, government documents, UNESCO materials, and academic writings.India has 45 sites listed on the UNESCO World Heritage List, with 37 being cultural sites.There are many more cultural and natural sites on the tentative list.

UNESCO's Recommendation on the Ethics of Artificial Intelligence encourages countries to use AI for protecting and making cultural heritage accessible, whether it is physical, written, or intangible.

The paper says that AI should not replace experts like archaeologists, historians, artisans, or local communities. Instead, it should be a tool that helps and supports them in a system that is centered on people.AI can help with automatically analyzing images, checking for structural problems, finding damage, digitally restoring heritage, making content available in many languages, organizing archives, predicting when something might need repair, creating virtual heritage experiences, and helping to save endangered languages.

However, there are still many issues to deal with, such as biased algorithms, lack of good heritage data, questions about authenticity, ownership of intellectual property, access to technology, cybersecurity, over-reliance on technology, environmental impacts, and the risk of making incorrect or inappropriate reconstructions.

The paper proposes an AI-enabled framework for sustainable heritage conservation built on six key principles: documentation, diagnosis, prediction, conservation, involvement of communities, and ethical governance. It concludes that India's growing AI environment, including the India AI Mission and AI Kosh, offers a chance to create AI applications that are

rooted in culture and support heritage preservation, as long as these technologies are used in a way that respects historical truth, community rights, and sustainable practices.

1. Introduction:

Heritage is the memory, identity, and cultural knowledge that a society carries forward. In India, heritage isn't just about big buildings. It includes old ruins, temples, forts, caves, old towns, manuscripts, paintings, statues, traditional crafts, stories passed down by people, local knowledge, languages, music, dance, and religious activities. So, heritage has many sides—physical, social, cultural, economic, and symbolic.

India's heritage is huge and varied. According to UNESCO, India has 45 places on the World Heritage List, including 37 cultural sites, 7 natural sites, and 1 mixed site. Recently, new additions have been made, like the Maratha Military Landscapes in 2025 and the Ancient Buddhist Site of Sarnath in 2026.India also has many more places on its tentative list, showing how much heritage the country has to protect.

Keeping all this heritage safe is a big job. Old buildings face risks like pollution, dampness, plant growth, temperature changes, earthquakes, floods, city expansion, too many tourists, and physical damage. Things like ancient objects and manuscripts can get old, break, or get damaged if they're not stored or handled properly. Intangible heritage, like traditional knowledge, can be lost if people stop speaking certain languages or passing down customs from one generation to the next.

Traditional methods of preserving heritage are still important, but today's heritage management needs more than just saving things. It requires ongoing recording, using data, and predicting risks.This is where Artificial Intelligence (AI) comes in. AI is a type of technology that can do tasks people usually do with their minds, like recognizing patterns, sorting things, making predictions, understanding languages, and helping with decisions. In heritage work, AI can quickly process large amounts of information—like photos, old documents, maps, building details, and sensor data—faster than humans can.

UNESCO has said that AI should be used carefully in heritage work. It encourages using AI to protect, improve, understand, promote, manage, and make cultural heritage easier to access.It also suggests paying attention to endangered and indigenous languages and encouraging communities to be involved.

In India, AI is getting more attention because the country is building its own AI system. The Indian government's AI Mission is making computing more accessible, improving data quality, developing its own AI tools, supporting AI experts, and promoting AI that is good for society and ethical.This mission has seven main areas, including computing power, AI models,

data sets, AI applications, training people, supporting startups, and making sure AI is safe and trustworthy.

So, the main idea of this paper is that AI can help India protect its heritage, but only if technology is combined with scientific methods, historical research, community input, ethical rules, and sustainability.

2. Review of Literature and Conceptual Background

2.1 Heritage Preservation in the Digital Era

Digital heritage preservation means turning physical, written, and intangible heritage into digital formats. This helps in recording, analyzing, accessing, and keeping heritage safe over time. Technologies like digital photography, GIS, digital archives, 3D scanning, photogrammetry, and virtual reality have already changed how we document heritage.

AI is the next step in this digital process. Unlike simple digitization, AI can look at digital data to spot patterns or unusual things. For example, a database with thousands of pictures of monuments can be used to find cracks, signs of decay, plant growth, or changes over time.

So, AI's value isn't just about making digital copies—it's about turning heritage data into useful knowledge.

2.2 AI and Cultural Heritage

UNESCO believes AI can help with cultural diversity, making heritage more accessible, and preserving it. Its AI ethics guidelines also highlight the importance of human rights, respect, transparency, fairness, and ensuring that humans are in control.

The UNESCO Global AI Ethics and Governance Observatory says that the use of AI in culture is still in its early stages. Its reports show that only a few countries have policies that use AI specifically for heritage protection, suggesting there is a lot of room for more development. The same report also notes that India is an important example of using AI and digital tools to include different cultures and languages.

This is important for India because heritage isn't just about buildings.

The country's many languages offer great opportunities for AI to help with language documentation, translation, transcription, and preserving knowledge.

2.3 AI as an Augmentation Technology

It is important to clearly understand the difference between automation and augmentation. Automation tries to take over human work by using computer processes.

Augmentation, on the other hand, uses technology to help humans make better decisions. In the field of heritage preservation, the right approach is augmentation.

For example, a computer vision model can spot a possible crack in a building, but it is up to a conservation architect to decide how important that crack is and what action should be taken.AI can create a digital copy of a damaged part of a structure, but it is up to historians and archaeologists to check if that copy is based on real evidence.

So the best way to manage heritage is:

Human knowledge + heritage information + AI analysis + expert judgment = responsible heritage management.

This method helps prevent people from treating AI results as if they are actual historical facts.

3. Research Methodology

3.1 Research Design

This study uses a qualitative, analytical, and descriptive approach.

It is based on information that has already been collected from other sources.

The study does not aim to test how well a particular AI system works at a specific monument in India.

Instead, it looks at how AI can be used in heritage preservation by bringing together information from policies, institutions, and scholarly work.

3.2 Sources of Data

The information used comes from the following sources:

1. UNESCO World Heritage Centre resources;
2. UNESCO's Recommendation on the Ethics of Artificial Intelligence;
3. Publications from the Government of India;
4. Reports from the Ministry of Electronics and Information Technology;
5. Resources from the India AI Mission;
6. AI Kosh resources;
7. Scholarly research on AI and cultural heritage;
8. Reports and policy documents related to digital heritage and conservation.

The UNESCO World Heritage Centre offers official details about India's World Heritage sites, sites on the tentative list, and reports on the condition of these sites.

3.3 Objectives of the Study

The study has the following goals:

1.To look into how AI can help preserve India's historical heritage.

2.To find out the main chances that AI-based heritage tools can bring.

3.To look at the technological, ethical, institutional, and cultural difficulties that may come up.

4.To understand how AI connects with sustainable conservation efforts.

5.To create a framework using AI for managing Indian heritage.

6.To suggest policies and institutional steps for using AI responsibly.

3.4 Research Questions

The study focuses on these questions:

- How can AI help in preserving historical heritage in India?

- Which areas of conservation are best suited for AI involvement?

- What technological and ethical issues might occur?

- How can AI support sustainable conservation?

- What kind of institutional setup is needed for responsible AI use?

4. Opportunities for AI in Historical Heritage Preservation

4.1 AI-Based Digital Documentation

One of the most important uses of AI is in documenting heritage on a large scale.

Historic buildings can be recorded using photos, drones, LiDAR, photogrammetry, satellite images, and 3D scans.

AI can then organize and analyze all this information.

For example, an AI system for heritage documentation could:

- find architectural details;
- categorize building parts;
- compare old and new photos;
- see signs of damage;
- create searchable digital records;
- link images to specific locations;
- track changes over time.

This would be especially helpful for big heritage sites with many buildings and parts.

4.2 Automated Damage Detection

Computer vision can help spot visible damage to historical sites.

AI models may help find:

- crack zones;
- surface wear;
- water damage;
- growth like moss or lichen;
- color changes;

- missing pieces;
- stone decay;
- roof issues;
- structural bends.

Instead of waiting for regular manual checks, conservation groups could build systems that compare images from different times.

This kind of monitoring can help move from fixing issues after they occur to preventing them before they happen.

4.3 Predictive Conservation

Predictive analysis is an important future use.

If historical weather data, sensor readings, and past conservation work are combined, AI models can predict the chances of future damage.

For example:

Environmental data â† ’ AI analysis â† ’ risk of damage â† ’ priority for conservation â† ’ action taken

This method can help heritage groups use their limited resources more wisely.

UNESCO's recent decision on the Sacred Ensembles of the Hoysalas shows how important it is to monitor effects like air pollution and create ways to reduce them.

(UNESCO World Heritage Centre) AI could help in this process by mixing environmental and visual data, but real use would need to be tested on each site.

4.4 Digital Reconstruction of Damaged Heritage

AI can help researchers see parts of buildings that are missing or damaged.

By using old photos, drawings, written accounts, archaeological findings, and existing building styles, artists can guess what the original structures looked like.

But it's important to always say whether the reconstructed parts are just guesses unless there's strong evidence.

This is important because digital reconstructions should not create the impression of certainty where there is only uncertainty.

4.5 Preservation of Manuscripts and Archival Materials

India has a rich history of writing and documentation.

AI can help with:

- recognizing text from photos (OCR);
- reading handwriting;
- identifying scripts;

- sorting documents;
- making metadata;
- translation;
- fixing damaged text;
- finding key words;
- searching through archives.

Old documents may be in many languages like Sanskrit, Prakrit, Persian, Arabic, Gujarati, Tamil, Telugu, Bengali, Marathi, Hindi, and others.

AI that works in multiple languages can make these collections easier for researchers and the general public to use.

4.6 Preservation of Intangible Heritage

Heritage protection should also cover cultural practices and traditions.

AI can help with:

- oral histories;
- folk songs;
- traditional stories;
- thriving languages;
- local words and phrases;
- traditional crafts and knowledge;
- cultural customs.

Speech recognition can turn oral recordings into text, while language processing tools can help translate and classify these materials.

UNESCO especially focuses on endangered and indigenous languages and knowledge when using AI for cultural applications.

(UNESCO)

For India, this offers a chance to use AI to keep track of diverse languages and traditions.

4.7 AI-Based Virtual Heritage Experiences

AI can help create virtual museums, smart guides, and interactive learning tools.

Visitors can use AI to learn about:

- historical eras;
- building styles;
- engravings;
- sculptures;

- cultural traditions;
- historical figures;
- archaeological finds.

Such systems can also help people who can't visit sites in person.

This can make heritage more accessible and also reduce the stress on heavily visited places.

4.8 Heritage Tourism

AI can help manage heritage tourism in a sustainable way by studying how people move around and predicting when places get too crowded.

AI systems can help with:

- distributing visitors to less busy areas;
- providing information in different languages;
- suggesting responsible routes;
- identifying very busy spots;
- optimizing visiting times;
- enhancing accessibility.

The goal shouldn't just be to increase the number of tourists.

Rather, AI should help find a balance between tourism, local income, and protection of heritage.

4.9 AI and Heritage Education

AI can make learning about history more engaging.

Students can explore virtual models of ancient cities, compare building styles, or interact with digital characters based on real sources.

Universities and colleges might start working on projects that mix several fields together, like History, Archaeology, AI, Computer Science, Architecture, Conservation, and Sociology.

This approach could help create a new group of experts who are skilled in different areas and can work well with others from different backgrounds.

5. Major Challenges and Risks

5.1 Data Scarcity and Data Quality

AI systems need reliable data to work properly.

Many Indian heritage sites don’t have:

- high-quality digital records
- standardised information about the data

- long-term tracking of changes
- full architectural blueprints
- digitised old documents
- records that can be easily read by machines.

If the data used to train an AI system is not complete or has bias, the AI might produce wrong results. So, poor data leads to a poor AI model, which leads to poor decisions about conserving heritage. Digitizing and organizing data properly must come first before using AI on a large scale.

5.2 Authenticity and Historical Accuracy

A big worry is that AI-created reconstructions may be confused with real historical evidence. Although AI can make very realistic images, being realistic does not mean it is historically accurate.

Therefore, every AI-generated reconstruction for heritage should include:

- the sources used
- how certain the reconstruction is
- where the information came from
- when the reconstruction was made
- which organization did the work
- the difference between actual evidence and interpretations.

5.3 Algorithmic Bias

AI systems reflect the data they are trained on.

If the data mostly includes famous monuments, elite groups, or major languages, then smaller communities and local traditions may not be represented. This can recreate existing cultural inequalities. UNESCO warns that AI can repeat or even worsen existing biases. They stress the importance of fairness, transparency, and human supervision.(UNESCO)

5.4 Community Ownership

Heritage does not belong to just governments or technology companies. Many Indian heritage practices are alive and passed down by communities. If traditional knowledge is digitized without community permission, it can lead to ethical issues like:

- who owns the data
- cultural rights
- possible commercial use
- sacred knowledge
- privacy concerns
- intellectual property rights.

Therefore, communities must be involved in AI projects related to heritage.

5.5 Digital Colonialism

There is a risk that heritage data from developing countries might become controlled by foreign platforms. If Indian heritage data is stored, processed, or managed by external systems, questions can arise about:

- who owns the data
- being too dependent on outside technology
- who gets to access the data
- who owns the data commercially
- how to preserve the data long-term.

India's IndiaAI Mission highlights the importance of developing local AI skills and infrastructure. This offers a way to address this issue. The Mission focuses on building domestic AI systems, data, models, skills, and responsible AI.(MeitY)

5.6 Cost and Infrastructure

High-quality tools like 3D scanning, LiDAR, cloud computing, sensor networks, and AI systems are expensive. Smaller museums, local archives, and state heritage institutions may not have enough money or technology. So, a single national system may not be enough.

Regional universities and local institutions should also be part of digitizing heritage.

5.7 Cybersecurity and Digital Preservation

Digitized heritage collections are valuable.

They can face issues like:

- unauthorized access
- altering of data
- ransomware attacks
- accidental deletion
- outdated technology
- incompatible file formats.

AI-based heritage preservation must include strong digital security and preservation strategies.

5.8 Environmental Cost of AI

AI uses a lot of energy and infrastructure for training and running large models. This means it has an environmental impact. So, sustainable heritage preservation should also consider the environmental cost of technology. The goal should be: digital sustainability + physical conservation + environmental responsibility.

5.9 Skill Gaps

Heritage experts may not always know much about AI, and AI experts may not understand history or conservation. This creates a big gap in skills between different fields.

India needs training programs that combine:

AI + Archaeology + Conservation + Heritage Management.

6. AI and Sustainable Heritage Conservation: An Integrated Framework

Based on the analysis, this paper suggests an AI-enabled Sustainable Heritage Conservation Framework (AI-SHCF) that has six connected steps.

Step 1: Documentation

The first step is making detailed digital records.

Tools used include photography, drones, LiDAR, photogrammetry, GIS, 3D scanning, and digitization.

The result is a well-organized heritage database.

Step 2: Diagnosis

AI looks at the collected data to find signs of damage.

Tools used are computer vision, image classification, anomaly detection, and pattern recognition.

The result is an assessment of the current condition.

Step 3: Prediction

AI uses historical and environmental data to predict future risks.

Tools used are machine learning, predictive analytics, and sensor-based monitoring.

The result is risk maps and priorities for conservation.

Step 4: Conservation

Experts use AI-based information to plan actions.

Tools used include decision-support systems, digital twins, and conservation databases.

The result is conservation plans that are supported by evidence.

Step 5: Participation

Local people, historians, researchers, students, and visitors can share their knowledge and feedback.

Tools used are crowdsourcing, multilingual AI, digital archives, and participatory platforms.

The result is heritage knowledge that includes everyone.

Step 6: Ethical Governance

Every AI system needs to be watched over.

Important principles include:

- transparency;
- accountability;
- human oversight;
- data protection;
- cultural sensitivity;
- authenticity;
- inclusiveness;
- protection of intellectual property.

This framework fits with UNESCO's focus on human rights, dignity, fairness, transparency, and human oversight in AI management.
(UNESCO)

7. India's Emerging AI Ecosystem and Heritage Opportunities

India's growing AI infrastructure offers a strong base for heritage applications.

The Government of India's IndiaAI Mission is built around seven main areas: compute power, foundation models, datasets, application development, future skills, startup support, and safe AI.(MeitY)

The AIKosh platform is especially relevant because it is a national platform for datasets, models, toolkits, and AI resources. (AIKosh) It can provide a technological base for special sector datasets, including future heritage data. India's AI infrastructure also includes services for translation, transliteration, OCR, and audio processing, which are useful for manuscripts, inscriptions, archives, and multilingual heritage.(India AI Cloud Computing) This suggests several national-level ideas.

Proposed Initiative 1: National AI Heritage Dataset

A national repository can collect:

- images of monuments;
- architectural drawings;
- inscriptions;
- manuscripts;
- old photographs;
- conservation records;
- GIS data;
- environmental observations;
- 3D models;

- oral history recordings.

Proposed Initiative 2: Heritage Digital Twin Programme

Important heritage sites can have digital twins that are regularly updated.

A digital twin can include:

3D model + GIS + condition data + environmental data + historical records + conservation history.

Proposed Initiative 3: Indian Heritage AI Models

India can create specific AI models trained on Indian architecture, scripts, languages, inscriptions, and cultural records.

These models may work better with Indian heritage materials than models trained mainly on global data.

Proposed Initiative 4: Heritage AI Centres of Excellence

Universities can set up interdisciplinary centers including:

- archaeology;
- history;
- architecture;
- computer science;
- artificial intelligence;
- conservation;
- museum studies;
- anthropology.

Proposed Initiative 5: Community Heritage AI

Local communities should be encouraged to share photos, oral histories, traditional knowledge, and local stories.

This involvement would prevent heritage preservation from being only driven by institutions.

8. Findings, Recommendations and Conclusion

8.1 Major Findings

The study shows the following important results:

First, AI has a lot of potential to help India better document and monitor its heritage.

Technologies like computer vision, machine learning, OCR, NLP, GIS, and 3D can turn large amounts of heritage data into useful information for conservation.

Second, AI will be most helpful in preventing and predicting the damage to heritage.

Instead of waiting until things get worse, heritage managers can use ongoing digital monitoring to spot risks early.

Third, AI can make heritage more accessible.

Systems that work in many languages, virtual museums, and smart platforms for interpreting heritage can help students, researchers, tourists, people with disabilities, and international audiences.

Fourth, AI can help preserve intangible heritage.

India's rich linguistic and cultural diversity makes it especially good for using AI in speech recognition, translation, transcription, and digital documentation.

Fifth, using AI without proper ethics can create new risks.

Misinformation, biased algorithms, incorrect reconstructions, and misuse of cultural knowledge can harm preservation instead of helping it.

Sixth, AI should help, not replace, professional judgment in conservation.

Historical authenticity can't be decided only by machines.

Seventh, India's growing AI infrastructure can help create heritage tools that are rooted in local culture.

The IndiaAI Mission's focus on datasets, local skills, and safe AI gives a good environment for this.

8.2 Recommendations

Based on the study, these recommendations are suggested:

1. Make a National AI Heritage Policy that connects AI with existing cultural and archaeological policies.

2. Create standardised heritage datasets with common rules for metadata, documentation, and sharing.

3. Develop AI systems in Indian languages for manuscripts, inscriptions, oral history, and endangered languages.

4. Set up Heritage AI Centres at universities and research institutions that bring together different fields.

5. Use AI mainly for predicting risks, monitoring, and helping in decisions, not for doing physical reconstruction automatically.

6. Require experts to check and approve AI-generated interpretations and reconstructions.

7. Add labels to show where AI was used in creating heritage visuals.

8. Protect the intellectual and cultural rights of communities, especially those with traditional knowledge.

9. Encourage open and compatible standards to reduce dependence on certain technologies and digital fragmentation.

10. Include cybersecurity and digital preservation in every major digital heritage project.

11. Check the environmental impact of AI systems and use energy-efficient models when possible.

12. Train people in heritage-AI skills through university courses, professional training, and interdisciplinary research.

13. Encourage partnerships between the public and private sectors, but make sure heritage data is under appropriate public oversight.

14. Test AI tools at specific sites before using them nationwide.

15. Let communities participate in creating digital heritage databases so their knowledge is included.

9. Conclusion

India's historical heritage is a vital store of memory, identity, knowledge, and cultural variety. Keeping this heritage safe in the 21st century needs more than just physical protection.The size and complexity of India's heritage require careful documentation, ongoing monitoring, risk assessment, digital accessibility, and sharing knowledge across generations. AI can play an important role in this change. It can help detect damage, classify heritage items, analyse historical documents, support predictive conservation, protect languages, offer virtual access, and bring together scattered information.UNESCO's global AI ethics guidelines already see the potential of AI in protecting and improving access to all kinds of cultural heritage. However, having advanced technology doesn't mean having the right to decide about heritage. While AI can find patterns, create images, or predict risks, the true meaning and authenticity of heritage depend on human judgment, historical evidence, and cultural context.The future of Indian heritage is not about replacing people like archaeologists, historians, architects, conservators, artisans, or communities with algorithms. It is about creating a team where AI supports human expertise. The AI-enabled Sustainable Heritage Conservation Framework proposed here focuses on documentation, diagnosis, prediction, conservation, community involvement, and ethical oversight. This approach can help India shift from reactive, fragmented preservation to a more intelligent, proactive, and sustainable way of managing heritage. India's growing AI infrastructure gives a good chance to build this system. The IndiaAI Mission, AIKosh, and other national AI projects could help in developing culturally relevant datasets, multilingual tools, and heritage-specific applications. The goal

should not be to make heritage artificially smart.The goal should be to make heritage preservation better informed, more proactive, welcoming to everyone, easier to access, and more lasting by using smart and responsible methods.

References

- International Council on Monuments and Sites. (1964). *The Venice Charter: International charter for the conservation and restoration of monuments and sites*. ICOMOS.
- Ministry of Electronics and Information Technology. (2025). *Annual report 2024–2025*. Government of India.
- Ministry of Electronics and Information Technology. (2026). *Annual report 2025–2026*. Government of India. (MeitY)
- Ministry of Electronics and Information Technology. (2026). *IndiaAI Mission*. Government of India.
- UNESCO. (2021). *Recommendation on the ethics of artificial intelligence*. United Nations Educational, Scientific and Cultural Organization. (UNESCO)
- UNESCO. (2022). *Recommendation on the ethics of artificial intelligence*. UNESCO. (UNESDOC)
- UNESCO. (2025). *Social and cultural dimension: Culture*. Global AI Ethics and Governance Observatory. (UNESCO)
- UNESCO World Heritage Centre. (2026). *India: Properties inscribed on the World Heritage List*. UNESCO. (UNESCO World Heritage Centre)
- UNESCO World Heritage Centre. (2025). *Tentative lists: India*. UNESCO. (UNESCO World Heritage Centre)
- UNESCO World Heritage Committee. (2025). *Decision 47 COM 7B.73: Sacred Ensembles of the Hoysalas (India)*. UNESCO. (UNESCO World Heritage Centre)
- AIKosh. (2026). *AIKosh: India's national platform for AI datasets and innovation*. Government of India. (AIKosh)
- IndiaAI. (2026). *IndiaAI Mission and AI ecosystem resources*. Ministry of Electronics and Information Technology, Government of India. (India AI Cloud Computing)