The Eastasouth Journal of Social Science and Humanities
Vol. 3, No. 01, October 2025, pp. 66 – 79
ISSN: 3026-5592, DOI: 10.58812/esssh.v3i01

A Systematic Bibliometric Review of Cultural Heritage Conservation Research

Loso Judijanto[1], Abdul Hadi Malik[2]
[1] IPOSS Jakarta
[2] Politeknik Tunas Pemuda Tangerang

Article Info

Article history:

Received Oct, 2025
Revised Oct, 2025
Accepted Oct, 2025

Keywords:

Bibliometric Analysis;
Cultural Heritage;
Digital Heritage;
Global Collaboration;
Heritage Conservation;
Preventive Conservation;
Sustainable Development

ABSTRACT

This study does a comprehensive bibliometric analysis of international research on cultural heritage preservation from 2000 to 2025, utilizing data from Scopus and Web of Science. We used VOSviewer and Bibliometrix (R package) to do a bibliometric study that showed publishing patterns, research themes, and collaboration networks. The results indicate that the discipline has transitioned from conventional preservation methods to sustainability-focused and technology-driven conservation. Heritage conservation, historic preservation, sustainable development, and urban planning are some of the main issues. Newer fields include preventive conservation, digital heritage recording, and adapting to climate change. Europe, especially Italy and Spain, is the most productive region for research, but China, Australia, and Latin America are also contributing more. The visualizations show that conservation research, environmental preservation, and cultural tourism are becoming more connected across disciplines. The paper offers a thorough examination of the intellectual framework of the profession and emphasizes the transition towards data-driven, sustainable, and internationally collaborative methodologies in cultural asset conservation.

Corresponding Author:

Name: Loso Judijanto
Institution: IPOSS Jakarta
Email: losojudijantobumn@gmail.com

1. INTRODUCTION

Cultural heritage is the common memory and identity of all people. It includes both physical things like monuments, historic buildings, archaeological sites, and artworks, as well as intangible things like languages, rituals, and traditional crafts. Protecting this history makes ensuring that cultural values are passed down from one generation to the next, strengthens community ties, and keeps cultural tourism going as a source of income [1], [2]. But globalization, urban growth, environmental damage, and climate change are all new threats to heritage resources. Reports show that climate-related catastrophes including rising sea levels, desertification, and harsh weather are threatening over one-third of UNESCO World Heritage Sites right now [3], [4]. So, the demand for more organized and scientific ways to protect the environment has never been higher.

Cultural heritage conservation has changed a lot in the last several decades. It

used to be mostly about crafts and art history, but now it is a scientific topic that draws on many different fields. Progress in materials science, nanotechnology, geoinformatics, and digital humanities has transformed the documentation, diagnosis, and restoration of heritage [5], [6]. Moreover, preventive conservation frameworks have progressively included sustainability principles and risk-management strategies to reconcile preservation with socio-economic advancement [7]. These changes show a move away from "reactive" restoration and toward proactive and data-driven methods for planning conservation.

Even though things have gotten better, there is now a lot of information on how to protect cultural heritage that is not well-organized. study is dispersed across various fields, including architecture, chemistry, archaeology, environmental science, and policy studies, frequently employing contradictory language and study priorities. This kind of spread makes it hard to put together trends, look at scientific collaboration, or find new study areas. Bibliometric analysis provides a quantitative, transparent, and reproducible approach to address these difficulties. Bibliometrics allows academics to see the intellectual landscape of a topic by mapping publishing patterns, co-citation structures, keyword co-occurrences, and thematic progression [8], [9].

Recent research has illustrated the efficacy of bibliometric methodologies within the heritage sector. For example, [10] carried out a bibliometric analysis of conservation and protection treatments for tangible heritage, pinpointing primary clusters related to diagnostic procedures, material consolidation, and protective coatings (Coatings, 14(8), 1027). In the same way, [8]gave a bibliometric overview of cultural heritage research in general, pointing important knowledge clusters in heritage theory, management, and conservation (Heritage, 6(1), 432–447). In the digital domain, [12] conducted a mapping of research on immersive and virtual-reality technologies for heritage visualization, highlighting a swift increase in publications that connect 3D modeling, virtual tours, and AR/VR tools with conservation methods (Scientific Reports, 13(8456)). Shehata et al. (2024) conducted a bibliometric analysis of heritage building conservation within Industry 4.0 frameworks, illustrating the contributions of Building Information Modelling (BIM), IoT sensors, and AI to preventive maintenance (Buildings, 14(12), 3818).

These works collectively demonstrate how bibliometric methodologies yield empirical insights into the growth and structure of heritage-related research. However, the majority of prior evaluations concentrate on sub-domains—such as digital heritage, architectural conservation, or particular conservation materials—rather than the whole, cohesive discipline of cultural heritage conservation. The rapid growth of publications in recent years, fueled by global efforts for sustainability and resilience, highlights the necessity for a systematic, comprehensive bibliometric review that integrates all significant subfields: diagnostics, treatment, digital innovation, policy, and community engagement [11], [12]. An integrated approach would elucidate the comprehensive evolution of heritage conservation scholarship and inform policies at both academic and policy levels [13].

Even if more and more scholars are interested in the topic, there is still a big gap in the literature: no one study has fully mapped the whole field of cultural heritage conservation research from a bibliometric point of view [13]. Prior studies often segregate particular themes—digital heritage, sustainable restoration, or heritage management—without synthesizing them into a cohesive framework. This fragmentation makes it harder for scientists, conservators, governments, and local communities to learn from each other and work together. As a result, stakeholders don't all agree on how the industry has changed, who the most important people are, or which themes are growing or fading. Without this kind of perspective, it is still hard to

coordinate strategies, set financing priorities, and bring together different fields of study.

This study fills a gap in the research by doing a thorough bibliometric review of all the work done on cultural heritage conservation around the world from 2000 to 2025. It systematically analyzes trends in publication growth to comprehend the temporal dynamics of research advancement in this domain. It also finds the authors, institutions, journals, and nations that have had the biggest impact on the knowledge base, which gives us a better understanding of how global leadership and collaboration work. The study uses co-authorship and scientific collaboration networks to show how ideas have crossed borders and connected people, which has had a big impact on the development of conservation research. It also looks into keyword co-occurrence and co-citation analysis to find main topic clusters and how they have changed over time, which shows the field's conceptual structure and intellectual heritage. This assessment ultimately enhances comprehension of the intellectual environment of cultural heritage conservation by delineating rising research fronts and emphasizing prospective directions. The insights gained will aid researchers, heritage managers, and policymakers in cultivating interdisciplinary collaborations, promoting innovation, and synchronizing conservation science with global sustainability initiatives, in accordance with frameworks established by [14], [15].

2. RESEARCH METHODS

This study employs a comprehensive bibliometric review methodology to analyze the evolution, structure, and upcoming trends in cultural heritage conservation research published from 2000 to 2025. Bibliometric analysis offers a quantitative, evidence-based approach to delineate scientific output and intellectual linkages within a specific discipline. According to the PRISMA 2020 (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) framework, the process had four main steps: (1) defining the research scope and inclusion criteria; (2) finding and getting publications from major databases; (3) screening, cleaning, and standardizing bibliographic data; and (4) doing descriptive, network, and thematic analyses. This methodical structure makes guarantee that data selection and analysis are open and may be repeated. The bibliometric review did not focus on just one part of heritage, like materials science or digital heritage. Instead, it brought together sources from many other fields, such as conservation science, architecture, cultural policy, restoration technology, and heritage management.

To make sure that all the bibliographic data was included and to reduce indexing bias, it was taken from two major databases: Scopus and Web of Science (WoS). The search query used Boolean operators and a controlled language to find a lot of relevant books. The last search string put together important words like: ("cultural heritage conservation" OR "heritage preservation" OR "heritage restoration" OR "heritage management") AND (sustainability OR preservation OR restoration OR digital OR protection) The search was only for English-language articles, reviews, and conference papers that were published between January 2000 and March 2025. We got rid of duplicates in the databases and kept only records that had been peer-reviewed. The metadata fields that were exported for examination comprised the title, authors, affiliations, abstract, keywords, source, year, and citations. We used Microsoft Excel and OpenRefine to clean and harmonize the data, fixing errors in author names, institutional affiliations, and keyword differences (for example, "heritage preservation" vs. "cultural conservation"). This made sure the data was good and cut down on errors spreading throughout processing.

There were three levels in the analytical phase: (1) performance analysis, (2) science mapping, and (3) thematic evolution analysis. Performance study assessed publication growth, citation impact, and principal contributors (authors, nations,

institutions, and journals) to gauge productivity and influence [20]. Using VOSviewer and Bibliometrix (R package) tools, science mapping looked at the field's intellectual and social structure. Visualizing co-authorship networks showed how scholars and institutions work together, while co-citation and bibliographic coupling analysis uncovered important works and groups of intellectual influence. Keyword co-occurrence and temporal overlay visualizations were employed to delineate thematic evolution and emergent subjects. Lastly, thematic evolution analysis utilizing thematic mapping and Sankey diagrams showed how study themes have changed over time. For instance, they have gone from traditional restoration and material analysis to digital heritage, sustainable management, and climate adaption. The integration of quantitative indicators and network visualization facilitated a comprehensive analysis of the knowledge structure, aligning with established methodologies in bibliometric research [16]–[18].

3. RESULTS AND DISCUSSION

3.1 Results

a. Network Visualization

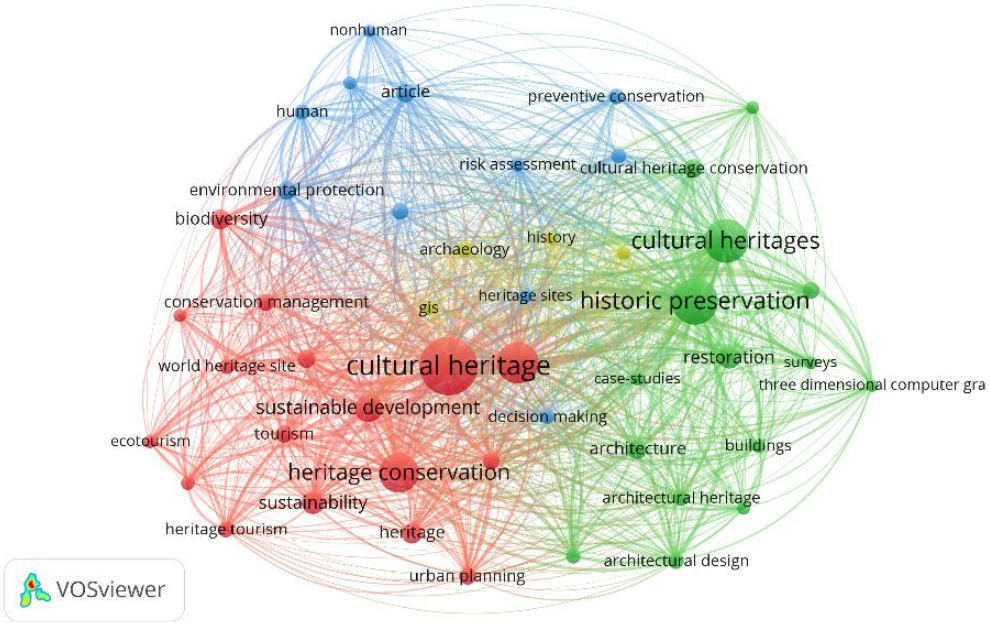

Figure 1. Network Visualization
Source: Data Analysis Result, 2025

The network is made up of several tightly linked clusters that show how complex cultural heritage conservation is. The big red and green nodes in the middle, which say "cultural heritage," "heritage conservation," "historic preservation," and "sustainable development," are the main anchors. Their center position and thick connecting lines show that they are important as integrative themes that integrate research in science, technology, and policy. The strong connection between "heritage conservation" and "sustainability" shows that researchers are starting to see conservation as a sustainability issue instead of just a technical or curatorial one. The dense web of links between clusters also shows how interdisciplinary the area is, since it connects the natural sciences, engineering, social sciences, and humanities.

The red cluster, which includes "heritage conservation," "sustainable development," "tourism," "heritage tourism," and "world heritage site," shows a strong link between discussions about cultural conservation and sustainability. This group of studies looks at how conservation can help with sustainable urban development, ecotourism, and getting people involved in their communities. Words like "urban planning," "ecotourism," and "conservation management" show that more and more people consider heritage conservation as part of bigger plans for urban renewal and tourism. This group of scholars usually looks at policy frameworks, community empowerment, and the economic value of protecting cultural sites. This is in line with the UN Sustainable Development Goals (SDGs), especially SDG 11.4 ("Strengthen efforts to protect and safeguard the world's cultural and natural heritage").

"Historic preservation," "architecture," "restoration," "architectural heritage," and "three-dimensional computer graphics" are the most common topics in the green cluster. This group is interested in the technical and architectural parts of conservation, such as how to restore buildings, how to diagnose problems with them, and how to digitally reconstruct heritage assets. Words like "3D computer graphics" and "surveys" show how digital technologies like Building Information Modeling (BIM), laser scanning, and photogrammetry are becoming more common in conservation work. These techniques allow for accurate documentation and virtual restoration, which makes it easier to undertake risk assessments and make design changes while causing less damage to the original materials. This group shows how conservation science has changed from hand-made work to digital precision, which is similar to the change to Industry 4.0 that has been seen in recent research.

The blue cluster, which includes phrases like "preventive conservation," "environmental protection," "biodiversity," "human," and "nonhuman," links conservation to ecological and risk management methods. The terms "risk assessment" and "environmental protection" suggest that the focus is on adaptive measures that preserve heritage assets from dangers caused by climate change and human activity. This is in line with a rising number of studies on climate resilience, being ready for natural disasters, and strategies for preventive maintenance. The interaction of "human" and "nonhuman" terminology indicates a comprehensive paradigm shift acknowledging that legacy conservation encompasses the preservation of human cultural manifestations as well as the maintenance of the environmental and ecological systems that sustain them.

The four clusters show that technical innovation, sustainable management, and environmental care are coming together in the realm of heritage protection. The central placement of "cultural heritage" and "heritage conservation,"

linked to other nodes like "GIS," "decision making," "tourism," and "architecture," shows that integrated, data-driven conservation frameworks are becoming more common. New trends are pointing toward digital heritage recording, participatory conservation, and climate-adaptive heritage management. These changes show how the subject is becoming more interdisciplinary. This synthesis indicates that forthcoming research will probably concentrate on the operationalization of conservation in smart-city environments, the improvement of data interoperability, and the reinforcement of the discourse among heritage science, community engagement, and sustainability policy.

b. Overlay Visualization

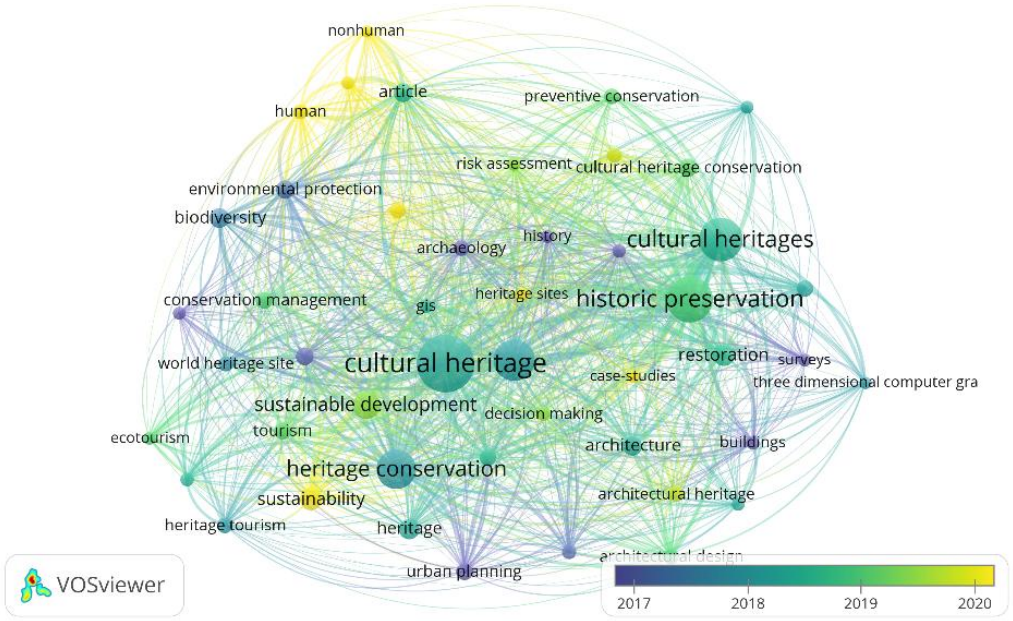

Figure 2. Overlay Visualization
Source: Data Analysis Result, 2025

The overlay visualization of keywords in the cultural heritage conservation research network shows how themes changed over time from 2017 to 2020. The color gradient—from dark blue (previous years) to brilliant yellow (recent years)—shows when certain themes became more important. The older research (2016–2017, dark blue) looked mostly at basic and institutional topics including "world heritage site," "conservation management," and "sustainable development." These early studies set the rules for heritage preservation policies and plans. They focused on heritage tourism and using cultural assets in a way that is good for the environment. This first step shows how UNESCO's sustainability goal and the inclusion of conservation in larger socio-economic development plans have had an effect.

As the field grew (2018–2019, green tones), it started to include architectural and

technological uses, such as "historic preservation," "restoration," "architectural design," and "three-dimensional computer graphics." This shows that heritage conservation techniques are putting more and more importance on new technologies and digital change. Digital modeling, GIS mapping, and remote sensing became common tools for diagnosis, documentation, and risk assessment. During this period, research commenced the integration of conservation science with data analytics and architectural informatics, thereby connecting traditional restoration with digital preservation frameworks. The repeated use of "architecture," "buildings," and "decision making" shows how conservation planning is moving toward being based on evidence and using computers to help.

In the last few years (2019–2020, yellow colors), there has been a growing focus on preventative and ecological points of view. This is clear in keywords like "preventive conservation," "environmental protection," "biodiversity," and "nonhuman." This indicates a developing paradigm that contextualizes cultural heritage within broader ecological and risk-resilience frameworks. Heritage is today seen as a part of a living ecosystem, where managing the environment and preserving culture come together. The yellow highlighting of "risk assessment" and "cultural heritage conservation" shows that people are moving toward climate-adaptive conservation and preventive maintenance measures. The overlay map shows how the field has changed over time from policy-based frameworks and the protection of built assets to models of cultural heritage conservation that are more technologically advanced, focused on sustainability, and connected to the environment.

c. Citation Analysis

Table 1. Most Cited Article

Citations	Author and Year	Title
5904	[19]	Freshwater biodiversity: Importance, threats, status and conservation challenges
1020	[20]	Assessing, mapping, and quantifying cultural ecosystem services at community level
748	[21]	Heritage recording and 3D modeling with photogrammetry and 3D scanning
734	[22]	Cultural tourism: A review of recent research and trends
706	[23]	Field margins in northern Europe: Their functions and interactions with agriculture
584	[24]	Carbonate and silicate phase reactions during ceramic firing
507	[25]	Fungi: Their role in deterioration of cultural heritage
468	[26]	Linking ecologists and traditional farmers in the search for sustainable agriculture
456	[27]	Built cultural heritage and sustainable urban development
436	[28]	Defining biocultural approaches to conservation

Source: Output Publish or Perish, 2025

The most often referenced studies in cultural heritage conservation research demonstrate the interdisciplinary character of the discipline, integrating ecology, architecture, tourism, and material science. [19] with 5,904 citations, underscore the global importance of freshwater biodiversity and the problems of its conservation—essential for comprehending ecosystem-based heritage management. In the same way, [20] stress cultural ecosystem services by connecting historic landscapes to the health of communities. [21], [25] significantly enhance the technological and biological aspects of conservation: the former via 3D photogrammetry for digital documentation, and the latter by investigating the role of fungi in the degradation of cultural assets. [22] places heritage within the context of cultural tourism, highlighting its economic and sociological significance. In addition to this, [26], [28] emphasize biocultural and sustainable frameworks that integrate traditional ecological knowledge with conservation research. In total, these widely referenced studies show a shift in thinking—from just protecting artifacts to managing integrated socio-ecological systems. This shows how conservation is now in line with sustainability and community involvement.

d. Density Visualization

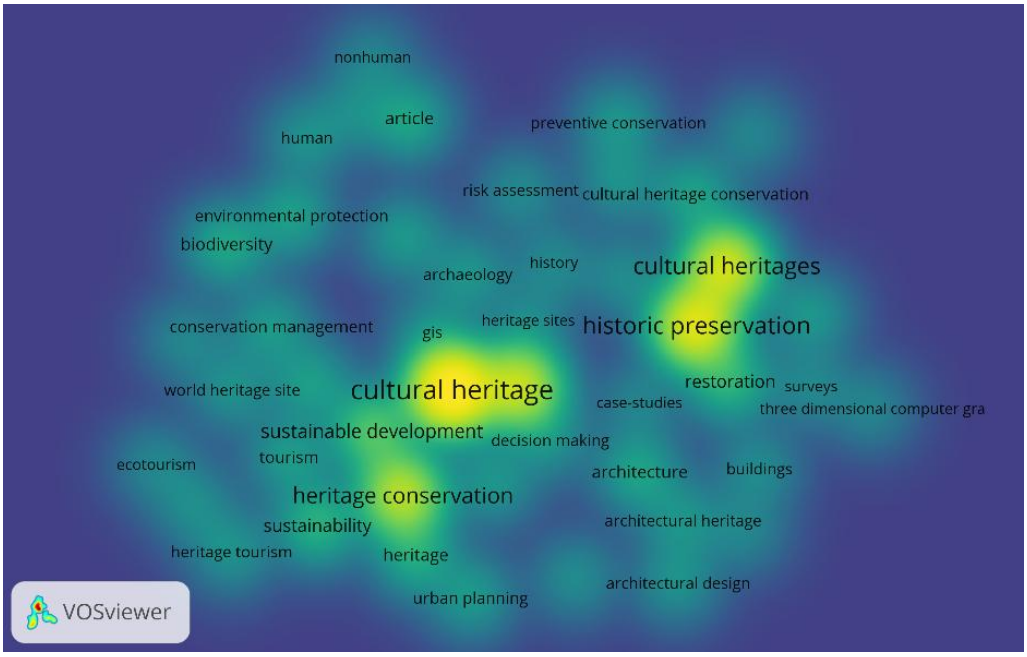

Figure 3. Density Visualization
Source: Data Analysis Result, 2025

The density visualization of research on preserving cultural assets shows where and how much scholarly attention is being paid to several important themes. The bright yellow areas, especially around the words "cultural heritage," "heritage conservation," "historic preservation," and "sustainable development," show the main research areas in the topic. These high-density areas show subjects that are often cited and have a lot

of co-occurrence, which shows how important they are to the intellectual framework of heritage conservation studies. The intersection of "sustainability," "tourism," and "urban planning" within these clusters signifies an interdisciplinary amalgamation, positioning conservation within the contexts of sustainable development, urban planning, and cultural tourism. This indicates that the conservation of history is becoming regarded not as a singular objective, but as a strategic element of comprehensive sustainable urban and socio-economic frameworks.

On the other hand, the green and blue areas around it, like "biodiversity," "environmental protection," "preventive conservation," and "three-dimensional computer graphics," are new or specialized study topics with a moderate to low density. These areas show how the sector is becoming more diverse by focusing on ecological stewardship, risk management, and digital innovation. The moderate intensity of "preventive conservation" and "GIS" indicates an increasing yet still solidifying focus on data-driven and climate-adaptive methodologies. The words "architecture," "restoration," and "archaeology" are still used, although they are now used in a wider range of fields. The density map shows that cultural heritage research is focused on sustainability and preservation, but it is also growing into areas like the environment, digital media, and prevention.

e. Co-Authorship Network

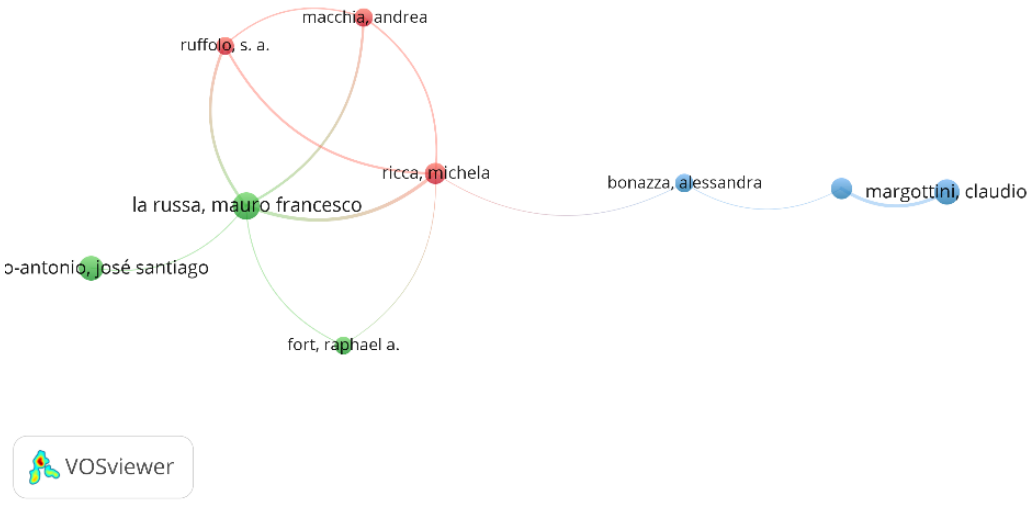

Figure 4. Author Visualization
Source: Data Analysis Result, 2025

The author co-authorship network visualization illustrates the collaborative structure within cultural heritage conservation research, revealing a small but interconnected set of scholarly partnerships. The network consists of three

primary clusters, each representing a collaboration nucleus. The red cluster, centered on *Michela Ricca*, *Andrea Macchia*, and *S.A. Ruffolo*, signifies a tightly linked research team engaged in studies on materials degradation, conservation treatments, and diagnostic techniques. The green cluster, anchored by *Mauro Francesco La Russa*, connects with *Raphael A. Fort* and *José Santiago Po-Antonio*, indicating an interdisciplinary collaboration spanning conservation science, geochemistry, and environmental analysis. The blue cluster, led by *Claudio Margottini* and *Alessandra Bonazza*, reflects a partnership focused on geotechnical risk assessment and the environmental resilience of cultural sites. The connecting lines between Ricca's group and Bonazza's team suggest emerging cross-collaborations bridging material conservation with heritage risk management. Overall, this network reveals that while collaboration remains somewhat localized and cluster-specific, there is a growing trend toward cross-disciplinary integration across European conservation science networks.

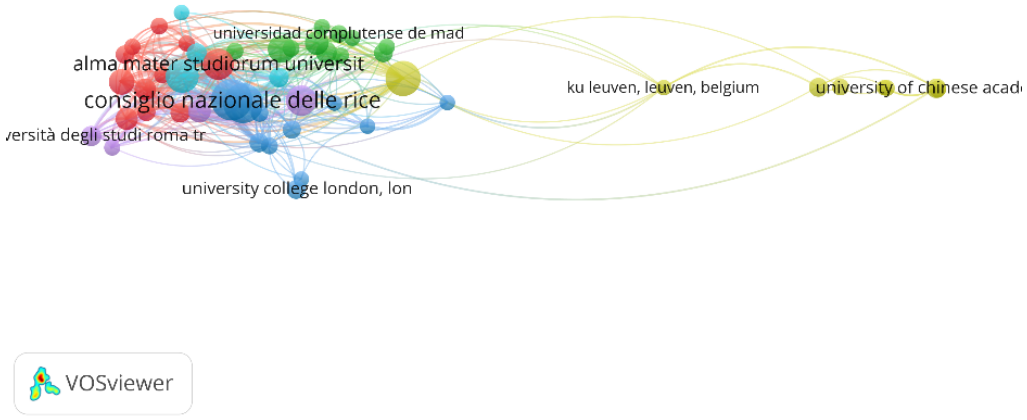

Figure 5. Affiliation Visualization
Source: Data Analysis Result, 2025

The institutional co-authorship network visualization shows how cultural heritage conservation research is done around the world, with a focus on a few major European and Asian institutions. The Consiglio Nazionale delle Ricerche (CNR) and Alma Mater Studiorum – Università di Bologna stand out as the most important and well-connected nodes. This shows that Italy is a pioneer in conservation science and has been for a long time. Università degli Studi Roma Tre, University College London, and Universidad Complutense de Madrid are some of the universities that are closely linked to them. Together, they make up an interconnected

European network that focuses on joint projects in digital heritage, materials conservation, and restoration. KU Leuven (Belgium) and the University of Chinese Academy of Sciences are examples of nodes that are not in the center but are nevertheless quite connected. These nodes show that collaboration is developing across continents, connecting European research traditions with Asia's rising heritage science agenda. The overall structure shows that European institutions are the main players in collaboration. However, new partnerships with Chinese and foreign universities are slowly improving global integration and knowledge exchange in research on cultural heritage protection.

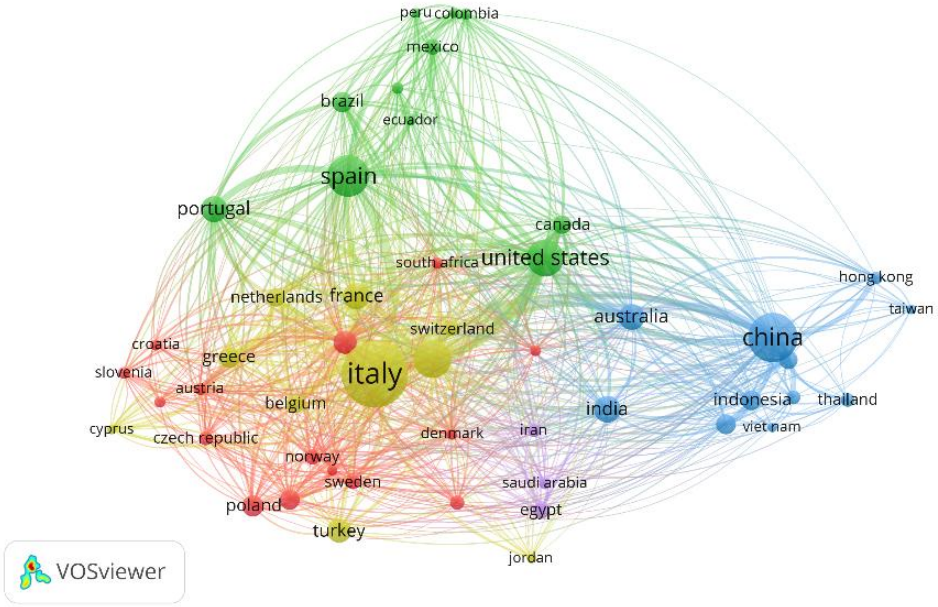

Figure 6. Country Visualization
Source: Data Analysis Result, 2025

The country collaboration network visualization shows how cultural heritage conservation research is done around the world and how countries collaborate together. It shows different regional clusters, with Europe as the main hub. Italy stands up as the most powerful and linked country, making up the largest node and connecting Western Europe, the Americas, and Asia. Europe has been a leader in heritage science for a long time, and its strong relationships with Spain, France, Portugal, and the Netherlands show this. The green cluster, which connects Spain with Latin American countries including Brazil, Mexico, Colombia, and Peru, shows that there is a strong transatlantic research cooperation based on shared language and culture. The blue cluster, which is mostly made up of China, connects with Australia, India, Indonesia, and Thailand. This shows that Asia-Pacific is becoming more important and is focusing on digital heritage technologies and conservation that can adapt to climate change. The United

States, on the other hand, acts as a mediator, keeping cooperation going in all clusters. The map shows that heritage conservation research is both global and regional, with Europe staying at the center of intellectual activity. At the same time, Asia-Pacific and Latin America are progressively shaping new research frontiers that are driven by technology and focused on sustainability.

3.2 Discussion

a. Practical Implications

The results of this bibliometric review have important real-world effects for researchers, policymakers, and heritage professionals who work to protect cultural heritage. First, mapping global publication trends and collaboration networks gives a strategic picture of where expertise is concentrated, especially in Italy, Spain, China, and the United States. This helps institutions in developing regions find potential research partners and ways to build their own capacity. The close connection between terminology like "heritage conservation," "sustainable development," and "historic preservation" shows that conservation is becoming more connected to sustainability goals, city planning, and tourism management. Policymakers can use these ideas to build cross-sectoral programs that connect conservation with plans for social and economic growth and plans for adapting to climate change. Also, the depiction of new research topics like preventive conservation, digital heritage modeling, and environmental risk assessment shows where investing in technology and working together across disciplines may have a big effect. For practitioners, the findings highlight the necessity of implementing data-driven decision-making tools and promoting community-based conservation strategies to guarantee enduring cultural and environmental sustainability.

b. Theoretical Contributions

From a theoretical perspective, this study enhances the comprehension of cultural heritage conservation as a dynamic interdisciplinary field by methodically delineating its intellectual framework, thematic progression, and scientific partnerships. The bibliometric analysis enhances legacy studies by integrating conceptual frameworks from conservation science, sustainability theory, and digital change. The findings indicate that the field is experiencing a paradigmatic transformation, transitioning from a preservationist and material-centric paradigm to a comprehensive, systems-oriented framework that encompasses human, environmental, and technical aspects. This theoretical integration bolsters the concept of "heritage ecology," wherein cultural assets are contextualized within interconnected socio-ecological systems. Additionally, by illustrating theme clusters and their chronological progression, the study advances the formulation of knowledge-driven models for cultural heritage management, highlighting the collaborative generation of information among scientists, conservation experts, and communities. The study

enhances bibliometric theory by illustrating the application of co-word and co-authorship analyses to cultural fields typically governed by qualitative approaches, thus establishing a quantitative framework for meta-knowledge in heritage conservation research.

c. Limitations

This study, despite its extensive methodology, encounters multiple limitations characteristic of bibliometric analysis. First, the dataset was limited to publications indexed in Scopus and Web of Science, which, while comprehensive, may omit pertinent regional or non-English-language journals that publish significant heritage conservation research, especially from developing regions such as Africa, the Middle East, or Southeast Asia. Second, using certain search phrases may have caused selection bias, which could mean that research that use different words to describe comparable ideas were left out. Third, bibliometric methodologies concentrate on citation-based metrics and keyword co-occurrences, which assess influence and connection but fail to completely encapsulate the qualitative depth or contextual subtleties of cultural practices, policies, and local knowledge systems. Lastly, the time frame (2000–2025) gives a clear picture of what's going on now, but it might not show enough foundational studies from past decades that helped establish the field's basic ideas. Future research could enhance this study through systematic content analysis, case-based synthesis, or mixed-method meta-reviews to yield deeper theoretical and contextual insights into the adaptation of cultural heritage conservation to emerging global challenges, including climate change, digital transformation, and social inclusion.

4. CONCLUSION

This study offers a thorough bibliometric synthesis of international research on cultural heritage conservation from 2000 to 2025, revealing its intellectual underpinnings, thematic progression, and collaboration frameworks. The analysis shows that the field has grown from traditional preservationist methods to a more integrated, interdisciplinary, and sustainability-focused way of doing things. The main research groups focus on cultural heritage, heritage conservation, sustainable development, historic preservation, and restoration. This shows how conservation science is coming together with urban planning, digital technology, and environmental management. European institutions, especially those in Italy and Spain, are still the most important places for scientific study. However, new research centers in China, Australia, and Latin America show that heritage science is becoming more diverse around the world. The overlay and density visualizations show that there has been a recent increase in themes relating to preventive conservation, climate adaptation, and digital heritage documentation. This suggests that there is a trend toward resilience and innovation. This study provides a comprehensive mapping of the intellectual landscape of the field, delivering actionable insights for researchers, practitioners, and policymakers to enhance cross-disciplinary collaboration and align conservation practices with global sustainability and cultural resilience objectives.

REFERENCES

[1] K. Reddy and B. Sailesh, "Cultural guardianship in tourism: Indigenous communities' quest for economic stability and identity preservation," *J. Environ. Manag. Tour.*, vol. 15, no. 2, p. 328, 2024.

[2] R. Semwal, P. Tyagi, and A. Singh, "Cultural Crossroads: Communities Guiding," *Examining Tour. Behav. community Involv. Destin. rejuvenation*, p. 164, 2024.

[3] U. N. O. for D. R. Reduction, *Global Assessment Report on Disaster Risk Reduction 2025: Resilience Pays: Financing and Investing for our Future*. Stylus Publishing, LLC, 2025.

[4] S. A. Ainio and S. Gionfra, *Stories of Human Resilience in a Changing Climate*. Taylor & Francis, 2025.

[5] P. M. Barone, "Between Past and Future: Digital Technologies and the Revolution in Cultural Heritage Preservation," *DigItalia*, vol. 19, no. 2, pp. 81–99, 2024.

[6] Y. Lian and J. Xie, "The evolution of digital cultural heritage research: Identifying key trends, hotspots, and challenges through bibliometric analysis," *Sustainability*, vol. 16, no. 16, p. 7125, 2024.

[7] A. H. Jamil, M. M. Deli, U. A. A. Rauf, M. Jamilah, S. Sinniah, and S. I. N. W. Abdullah, "Resilience and sustainability in tourism-forestry systems through risk management framework: review and concept," *J. Law Sustain. Dev.*, vol. 12, no. 1, 2024.

[8] I. Bernatović, A. Slavec Gomezel, and M. Černe, "Mapping the knowledge-hiding field and its future prospects: a bibliometric co-citation, co-word, and coupling analysis," *Knowl. Manag. Res. Pract.*, vol. 20, no. 3, pp. 394–409, 2022.

[9] A. Klarin, "How to conduct a bibliometric content analysis: Guidelines and contributions of content co-occurrence or co-word literature reviews," *Int. J. Consum. Stud.*, vol. 48, no. 2, p. e13031, 2024.

[10] L. Pérez-Gandarillas, C. Manteca, Á. Yedra, and A. Casas, "Conservation and protection treatments for cultural heritage: Insights and trends from a bibliometric analysis," *Coatings*, vol. 14, no. 8, p. 1027, 2024.

[11] M. J. Aladaileh, E. Lahuerta-Otero, and K. J. Aladayleh, "Mapping sustainable supply chain innovation: A comprehensive bibliometric analysis," *Heliyon*, vol. 10, no. 7, 2024.

[12] W. K. Al-Zoubi, "Economic development in the digital economy: A bibliometric review," *Economies*, vol. 12, no. 3, p. 53, 2024.

[13] J. Xia, J. Kang, and X. Xu, "Global research trends and future directions in urban historical heritage area conservation and development: A 25-year bibliometric analysis," *Buildings*, vol. 14, no. 10, p. 3096, 2024.

[14] S. Mazzetto, "Integrating emerging technologies with digital twins for heritage building conservation: an interdisciplinary approach with expert insights and bibliometric analysis," *Heritage*, vol. 7, no. 11, pp. 6432–6479, 2024.

[15] W. Sanmee, "Interdisciplinary Approaches to Cultural Conservation: A Model for Sustainable Social Development," 2025.

[16] V. Z. Pessin, L. H. Yamane, and R. R. Siman, "Smart bibliometrics: an integrated method of science mapping and bibliometric analysis," *Scientometrics*, vol. 127, no. 6, pp. 3695–3718, 2022.

[17] H. Liu, Y. Jiang, H. Fan, X. Wang, and K. Zhao, "Visualization analysis of knowledge network research based on mapping knowledge," *J. Signal Process. Syst.*, vol. 93, no. 2, pp. 333–344, 2021.

[18] Y. Gan, D. Li, N. Robinson, and J. Liu, "Practical guidance on bibliometric analysis and mapping knowledge domains methodology–A summary," *Eur. J. Integr. Med.*, vol. 56, p. 102203, 2022.

[19] D. Dudgeon *et al.*, "Freshwater biodiversity: importance, threats, status and conservation challenges," *Biol. Rev.*, vol. 81, no. 2, pp. 163–182, 2006.

[20] T. Plieninger, S. Dijks, E. Oteros-Rozas, and C. Bieling, "Assessing, mapping, and quantifying cultural ecosystem services at community level," *Land use policy*, vol. 33, pp. 118–129, 2013.

[21] F. Remondino, "Heritage recording and 3D modeling with photogrammetry and 3D scanning," *Remote Sens.*, vol. 3, no. 6, pp. 1104–1138, 2011.

[22] G. Richards, "Cultural tourism: A review of recent research and trends," *J. Hosp. Tour. Manag.*, vol. 36, pp. 12–21, 2018.

[23] E. J. P. Marshall and A. C. Moonen, "Field margins in northern Europe: their functions and interactions with agriculture," *Agric. Ecosyst. Environ.*, vol. 89, no. 1–2, pp. 5–21, 2002.

[24] G. Cultrone, C. Rodriguez-Navarro, E. Sebastian, O. Cazalla, and M. J. De La Torre, "Carbonate and silicate phase reactions during ceramic firing," *Eur. J. Mineral.*, vol. 13, no. 3, pp. 621–634, 2001.

[25] K. Sterflinger, "Fungi: Their role in deterioration of cultural heritage," *Fungal Biol. Rev.*, vol. 24, no. 1–2, pp. 47–55, 2010.

[26] M. A. Altieri, "Linking ecologists and traditional farmers in the search for sustainable agriculture," *Front. Ecol. Environ.*, vol. 2, no. 1, pp. 35–42, 2004.

[27] C. Tweed and M. Sutherland, "Built cultural heritage and sustainable urban development," *Landsc. Urban Plan.*, vol. 83, no. 1, pp. 62–69, 2007.

[28] M. C. Gavin *et al.*, "Defining biocultural approaches to conservation," *Trends Ecol. Evol.*, vol. 30, no. 3, pp. 140–145, 2015.