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Bibliometric Perspectives on Digital Technologies in Cultural Heritage Analyzing Research Trends and Innovations

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ABSTRACT

This study provides a comprehensive bibliometric analysis of research on digital technologies in cultural heritage, focusing on key trends, innovations, and interdisciplinary collaborations. By analyzing co-occurrence networks, author collaborations, and publication density, the study reveals a growing emphasis on the integration of technologies such as augmented reality (AR), virtual reality (VR), and 3D scanning in the preservation and promotion of cultural heritage. These digital tools are increasingly used to create immersive experiences and preserve both tangible and intangible heritage. The study also highlights the rising importance of addressing climate change's impact on heritage sites and explores ethical concerns related to data ownership, authenticity, and equitable access. Despite the many benefits of digital preservation, challenges such as the digital divide and the potential commodification of heritage remain significant obstacles. The analysis underscores the need for interdisciplinary collaborations and the development of sustainable, inclusive digital heritage initiatives to ensure that these technologies benefit all stakeholders. The study concludes by identifying key areas for future research, including the integration of artificial intelligence (AI) and blockchain technologies into cultural heritage management and the exploration of climate change's long-term impact on heritage preservation.

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1. INTRODUCTION

The swift progression of digital technologies has transformed various areas, including cultural heritage protection. In recent years, the incorporation of digital tools and approaches has created unparalleled potential to document, conserve, and exhibit cultural assets. Technologies such as digital imagery, virtual reality (VR), augmented reality (AR), and 3D reconstruction have improved the accessibility and comprehension of historical locations and objects for both specialists and the general populace [1]. This shift corresponds with an increasing trend to enhance cultural heritage's inclusivity and interactivity via digital platforms, enabling global audiences to virtually access these assets, irrespective of geographic limitations [2]. The growing dependence on these tools signifies the

continuous digitization of cultural assets as a tactical reaction to issues including degradation, restricted access, and financial constraints [3].

Simultaneously, scholarly interest in digital technologies related to cultural heritage has increased significantly. Bibliometric studies, which examine research trends and publication patterns, have become essential instruments for monitoring scholarly production in this field. Bibliometric analyses elucidate the evolution of research goals in response to technology improvements through the examination of citation networks, co-authorship patterns, and keyword trends [4]. Researchers have increasingly concentrated on topics such as digital preservation, immersive experiences, and user interaction with cultural material. The transition towards digital innovation is represented in the growing volume of publications and the expanding interdisciplinary collaboration among subjects such as archaeology, computer science, and museum studies [5].

Moreover, when cultural legacy increasingly undergoes digital mediation, ethical and practical issues arise. Concerns encompass data ownership, authenticity, and the digital divide, which may marginalize minority people from engaging in or reaping the benefits of technological breakthroughs [6]. Digital technologies have the potential to democratize access to cultural material; nevertheless, if not applied with care, they may also reinforce existing inequities [7]. These problems underscore the necessity for a balanced approach, wherein technology advancements are directed by ethical principles and cultural awareness. Thus, current research in this domain aims to tackle both the technological advancements and the wider societal ramifications of digital interventions in cultural property [8].

Despite these advancements, there is still a need for a comprehensive understanding of how research in digital technologies for cultural heritage has developed over time. While individual studies have explored specific technologies or case studies, a broader perspective on the field's evolution is essential. This gap in the literature calls for a bibliometric analysis that can synthesize the diverse body of work and provide insights into the trends and innovations shaping the field. By analyzing the existing literature through a bibliometric lens, researchers can identify key areas of focus, gaps in knowledge, and future directions for digital technologies in cultural heritage.

The integration of digital technologies in cultural heritage has expanded significantly, yet there is limited understanding of the research landscape's evolution in this domain. Most studies tend to focus on specific applications or case studies without providing a holistic view of the field's broader trends and innovations. Additionally, the rapid pace of technological change and the interdisciplinary nature of this field make it difficult for scholars to stay abreast of emerging research trends. A lack of comprehensive bibliometric studies addressing the intersection of digital technologies and cultural heritage creates a research gap. This gap prevents stakeholders from fully understanding how scholarly attention is distributed across various themes, regions, and innovations within the field.

The objective of this study is to conduct a bibliometric analysis of research on digital technologies in cultural heritage, with the aim of identifying key trends, influential works, and emerging innovations. This study seeks to map out the evolution of scholarly research in this area by examining publication patterns, citation networks, and keyword co-occurrence. By doing so, the research will provide insights into how the field has developed, highlight the major contributions and collaborations, and suggest future research directions. Ultimately, this study aims to contribute to a more comprehensive understanding of how digital technologies are shaping the preservation and promotion of cultural heritage worldwide.

2. LITERATURE REVIEW

2.1 *Digital Technologies in Cultural Heritage*

The use of digital technologies in the preservation and dissemination of cultural heritage has been a growing trend in recent years. Digital tools have enabled the documentation, conservation, and visualization of cultural heritage in ways that were previously impossible. For instance, technologies such as 3D scanning, digital imaging, and virtual reality (VR) have been employed to preserve deteriorating heritage sites, reconstruct historical environments, and offer immersive experiences for global audiences. These tools have not only enhanced public engagement but also supported researchers and conservators in their efforts to protect and study heritage assets. Numerous case studies have demonstrated how digital technologies can be applied to both tangible and intangible heritage, making preservation efforts more efficient and accessible [1], [2], [9].

Several key studies have explored the applications of digital technologies in different cultural contexts. For example, [10] highlights how 3D scanning has been used to digitally archive endangered heritage sites, allowing researchers to study the architectural features and historical significance of structures that might otherwise be lost. Similarly, VR and augmented reality (AR) technologies are increasingly being used in museums and heritage sites to provide visitors with interactive and educational experiences. [11] examined how VR applications in museums have transformed visitor engagement, allowing them to explore digitally recreated artifacts and spaces. These technologies have proven particularly valuable in environments where physical access to the heritage site is limited or impossible, whether due to geographic distance or ongoing conservation efforts [12].

At the same time, digital technologies have raised ethical and practical concerns. Questions about the authenticity of digitally recreated heritage, the potential for commodification, and the risks of data monopolization by tech companies have surfaced. Some scholars argue that while digital technologies democratize access to cultural heritage, they also introduce new layers of complexity in terms of data ownership and representation [13]. Others point to the potential digital divide, where only those with access to certain technologies are able to fully engage with digital heritage resources. As the use of digital tools in cultural heritage continues to expand, these challenges must be addressed to ensure equitable access and representation in heritage conservation efforts [14].

2.2 *Research Trends in Digital Cultural Heritage*

Research on digital technologies in cultural heritage has evolved significantly over the past few decades, and bibliometric studies have proven instrumental in understanding these trends. Bibliometric analyses provide insights into the publication patterns, collaborations, and thematic focuses within this field, offering a macro-level view of how scholarly research has developed over time. The results of such analyses can help to identify dominant research areas, key contributors, and potential gaps in the literature [4], [5].

Several bibliometric studies have already been conducted to assess the state of research on digital cultural heritage. [15] conducted a comprehensive bibliometric analysis of publications related to digital heritage, identifying several key trends. First, the volume of publications has steadily increased over the past decade, reflecting the growing academic interest in this area. Second, there has been a noticeable shift toward interdisciplinary

collaboration, with scholars from fields such as archaeology, computer science, and museum studies increasingly working together to address complex heritage preservation issues. This trend underscores the importance of integrating technological and cultural perspectives when developing digital heritage solutions.

Additionally, [16] explored the use of bibliometric analysis to examine the development of digital archaeology, a subfield that applies digital tools to the study of ancient sites and artifacts. Harris's study found that digital archaeology has grown exponentially in recent years, with increasing collaboration between archaeologists and technologists. The research also highlighted several key innovations, such as the use of machine learning algorithms for analyzing archaeological data and the deployment of drones for site surveying. These technological advancements have accelerated the pace of archaeological research and enabled more precise documentation of heritage sites, particularly in remote or fragile environments.

Emerging themes in digital cultural heritage research include the use of AI for artifact restoration, the application of blockchain for provenance tracking, and the role of social media in promoting and preserving intangible heritage. [17] conducted a bibliometric study that mapped the evolution of these emerging themes and found that AI applications in heritage are particularly promising. AI can assist in restoring damaged artifacts by predicting their original forms based on existing fragments, a process that could significantly reduce the time and resources required for traditional restoration methods. Blockchain technology, meanwhile, has been explored for its potential to create transparent and immutable records of artifact ownership and provenance, addressing concerns about forgery and illegal trade in cultural objects.

2.3 Innovations in Digital Heritage Preservation

Innovations in digital heritage preservation continue to reshape the field, with new technologies offering more sophisticated methods for documenting, analyzing, and disseminating cultural heritage. One of the most notable innovations is the use of AI and machine learning in heritage conservation. These technologies enable automated analysis of large datasets, allowing for more efficient detection of patterns and trends that would be difficult to identify manually. For example, machine learning algorithms have been used to analyze satellite imagery to detect changes in landscapes that may indicate the presence of unexcavated archaeological sites [18]. This approach has been particularly valuable in regions where traditional archaeological surveys are challenging due to environmental or political constraints.

Another key innovation is the use of 3D printing in heritage restoration. 3D printing allows for the creation of accurate replicas of artifacts and architectural elements, which can be used for restoration or educational purposes. In some cases, 3D-printed replicas have been displayed in museums to allow visitors to interact with the objects in ways that would not be possible with the original, often fragile, artifacts [19]. This technology not only enhances visitor engagement but also provides a valuable tool for conservators, who can use 3D-printed replicas to test restoration techniques before applying them to the original artifacts [20].

Blockchain technology is also emerging as a valuable tool in heritage management, particularly in the context of provenance tracking and ensuring the authenticity of artifacts. By creating an immutable ledger of transactions,

blockchain can help to combat the illicit trade in cultural heritage objects and ensure that artifacts are accurately documented and traced throughout their lifecycle [18]. This technology offers a potential solution to longstanding issues of artifact theft and forgery, which have plagued the cultural heritage sector for decades.

3. METHODS

This study employed a bibliometric analysis to examine research trends and innovations in the application of digital technologies to cultural heritage. Data were collected from the Google Scholar database, focusing on peer-reviewed articles published between 2000 and 2024. The search terms included keywords such as "digital technologies," "cultural heritage," "virtual reality," "augmented reality," "3D scanning," and "digital preservation." VOSviewer was used to visualize citation networks, co-authorship patterns, and keyword co-occurrence, enabling the identification of influential publications, collaboration patterns, and emerging themes in the field. The analysis involved a two-stage process: (1) data extraction and cleaning to remove duplicates and irrelevant entries, and (2) network analysis to map research trends and collaborations.

4. RESULTS AND DISCUSSION

4.1 Results

Table 1. Research Data Metrics

Metrics Data	Information
Publication years	2000-2024
Citation years	24
Papers	980
Citations	124342
Cites/year	1751.30
Cites/paper	126.88
Cites/author	74842.20
Papers/author	562.79
Authors/paper	2.43
h-index	178
g-index	281
hI,norm	131
hI,annual	1.85
hA, index	44
Paper with ACC > =	1,2,5,10,20:979,962,793,471,196

Source: Output Publish or Perish, 2024

Table 1 presents the research data metrics for the study on digital technologies in cultural heritage, covering publications from 2000 to 2024. Over this 24-year period, 980 papers were published, receiving a total of 124,342 citations, which translates to an average of 1,751.30 citations per year. Each paper, on average, garnered 126.88 citations, while the average citation per author stood at 74,842.20. With a publication rate of 562.79 papers per author and an average of 2.43 authors per paper, the collaboration in this field appears moderate. The h-index of 178 indicates that 178 papers have received at least 178 citations, while the g-index of 281 suggests that the top 281 papers have collectively received a high level of citations. The hI,norm and hI,annual indexes, at 131 and 1.85, respectively, reflect the authors' citation impact normalized by their career length. The hA index of 44 measures the highest impact of authors in the dataset. Additionally, papers with at least 1, 2, 5, 10, and 20 citations were 979, 962, 793, 471, and 196, respectively, showcasing

the extensive reach and influence of the research in this domain.

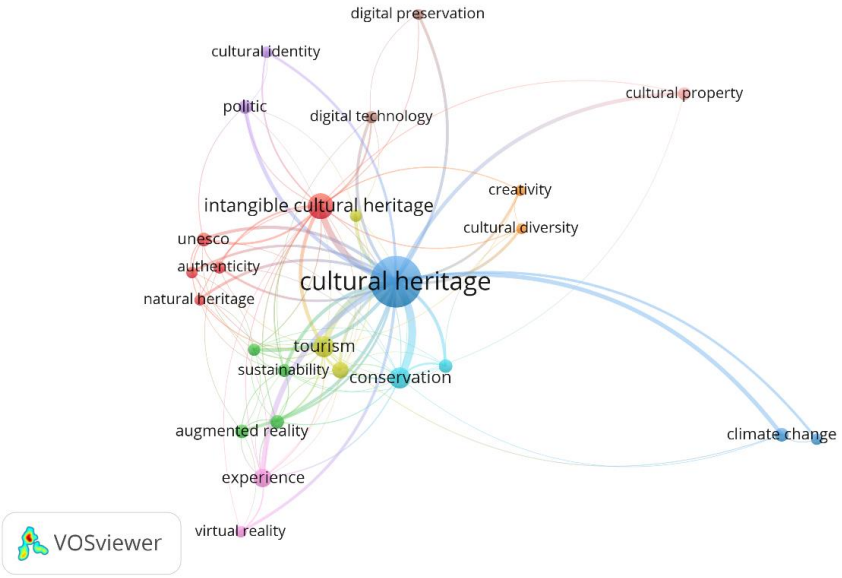

Figure 1. Network Visualization
Source: Data Analysis, 2024

The figure represents a VOSviewer network visualization of keyword co-occurrence in research related to cultural heritage. The primary node in the network is "cultural heritage," the most significant keyword, underscoring its crucial importance in this research domain. This keyword is associated with numerous other significant terms, including "intangible cultural heritage," "conservation," "tourism," and "climate change," indicating that these issues are often examined collectively in the literature. The correlations among these phrases are illustrated by lines, with the thickness of the lines indicating the strength of the associations based on co-occurrence in scholarly articles. The varied colors signify separate thematic clusters, denoting the different subfields or study areas that are tightly interconnected.

A significant cluster focuses on "intangible cultural heritage," closely associated with concepts such as "authenticity," "natural heritage," "UNESCO," and "cultural identity." This cluster likely signifies a body of research concentrating on the non-material dimensions of cultural heritage, including traditions, customs, and practices. The affiliation with "UNESCO" signifies the organization's commitment to the promotion and preservation of intangible cultural assets worldwide. Terms such as "authenticity" and "cultural identity" underscore significant issues in this research domain, illustrating the role of intangible heritage in shaping the identity and authenticity of communities and nations.

A notable cluster centers on "conservation" and its associations with "tourism," "sustainability," "augmented reality," and "virtual reality." This cluster indicates an increasing interest in employing digital technology for the preservation and promotion of cultural assets. The phrases "augmented reality" and "virtual reality" signify the application of modern technologies to develop immersive experiences for heritage conservation and tourism. "Sustainability" and "tourism" are interconnected, indicating a significant research emphasis on reconciling

cultural heritage preservation with sustainable tourism practices. This cluster highlights the significance of digital innovation in preserving cultural heritage and enhancing its accessibility to global audiences.

A significant cluster pertains to "climate change," linked to "cultural property" and "cultural diversity." This cluster indicates a nascent field of study that investigates the effects of climate change on cultural assets. The connection between "cultural property" and "climate change" underscores apprehensions regarding the impact of climatic alterations on physical historic sites and artifacts. The connection to "cultural diversity" implies that climate change may disproportionately impact varied cultural populations and their legacy, prompting inquiries over equity and the safeguarding of at-risk cultural places. This cluster signifies the growing recognition of the necessity to incorporate environmental sustainability into heritage conservation initiatives.

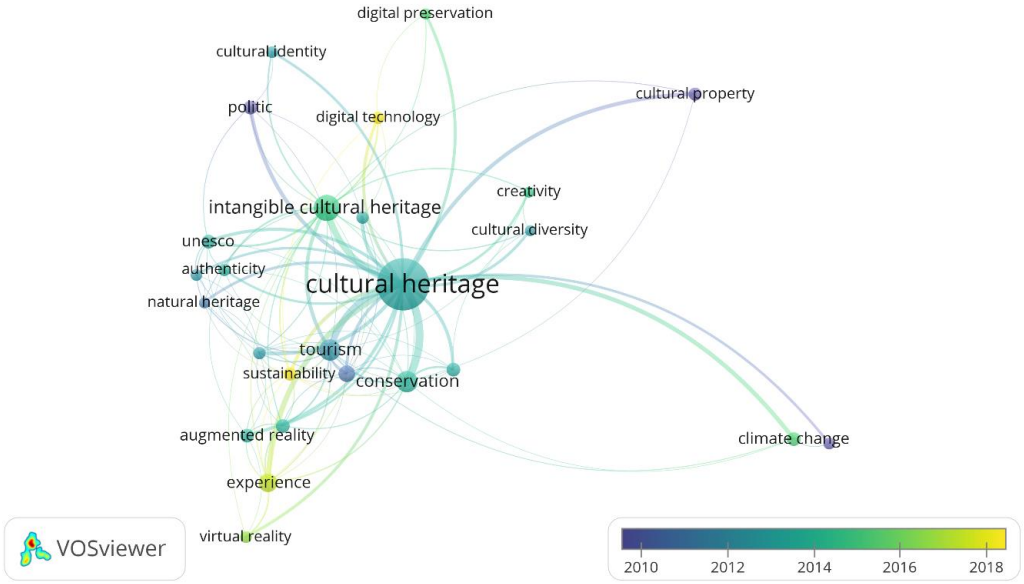

Figure 2. Overlay Visualization
Source: Data Analysis, 2024

The figure shows a VOSviewer network visualization that depicts the chronological progression of term co-occurrence in research pertaining to cultural heritage. The color gradient at the bottom signifies the temporal scale, with darker blue denoting earlier years (around 2010) and lighter green or yellow signifying more recent studies (up to 2018). The primary node, "cultural heritage," is the most prominent keyword, indicating a sustained study emphasis over the years. The pale hues linked to certain keywords and hyperlinks indicate recent advancements in particular domains of cultural heritage study.

The relationships among "cultural heritage," "intangible cultural heritage," "tourism," and "conservation" underscore the persistent significance of these concepts among the scholarly community. Nonetheless, the chronology indicates that certain subjects have garnered heightened interest in recent years, particularly terms like "augmented reality," "virtual reality," and "digital preservation." The application of technology in the protection of cultural heritage has become a vital domain of innovation, as

illustrated by the yellow and green nodes. This transition signifies an increasing academic focus on utilizing digital technology to improve the accessibility, preservation, and interpretation of cultural heritage, consistent with contemporary worldwide digitization trends.

Notably, terms like "climate change" and "sustainability" are represented in lighter colors, suggesting that the intersection of cultural heritage and environmental concerns has gained momentum in more recent years. This development reflects an emerging awareness of the impact of climate change on cultural heritage sites and the increasing need for sustainable conservation practices. The connections between "cultural property," "climate change," and "cultural diversity" indicate a multidisciplinary approach to addressing these challenges, emphasizing the importance of both protecting physical heritage and promoting cultural diversity in the face of global environmental changes.

Figure 3. Density Visualization
Source: Data Analysis, 2024

The figure is a VOSviewer density visualization map illustrating the intensity of research related to cultural heritage. The brighter the color (yellow), the higher the density of publications or co-occurrence of keywords, indicating areas of concentrated research activity. The central node, "cultural heritage," appears in bright yellow, showing that it is the most frequently occurring keyword in this domain of study. Closely related terms like "intangible cultural heritage," "tourism," "conservation," and "sustainability" also appear near the bright yellow area, suggesting significant attention has been paid to these topics within the literature. This highlights the strong focus on how cultural heritage intersects with tourism and conservation efforts, as well as its intangible aspects like customs, traditions, and practices.

In contrast, terms such as "climate change," "cultural property," and "augmented reality" are located on the periphery and represented by cooler colors (green and blue), indicating these areas have been researched less frequently in comparison to the central cluster. However, their presence still signifies emerging or specialized areas of interest. The link between "cultural heritage" and these peripheral terms

suggests growing scholarly interest in examining the impact of climate change on cultural sites, the role of digital technologies like augmented reality in heritage preservation, and discussions surrounding cultural property rights. This visualization emphasizes both the established themes in cultural heritage research and the expanding areas that are gaining momentum in recent studies.

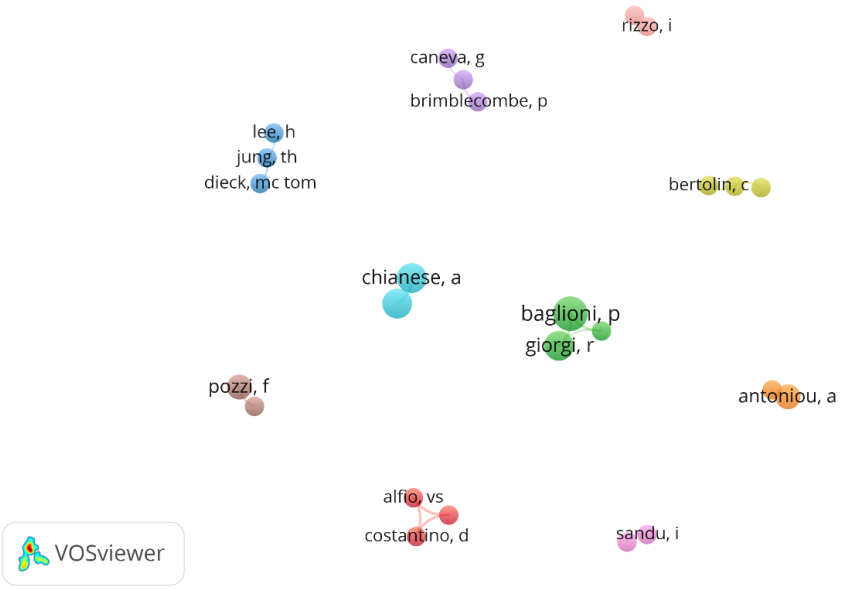

Figure 4. Author Collaboration
Source: Data Analysis, 2024

The illustration is a VOSviewer network visualization depicting author collaboration within the realm of cultural heritage or a pertinent research subject. Each node signifies an author, with the node's size reflecting the quantity of publications or citations linked to that author. The closeness of nodes signifies the intensity of collaboration, with tightly clustered nodes representing frequent co-authorship or joint endeavors. Diverse hues signify separate clusters of authors who frequently collaborate. For example, writers Baglioni, P and Giorgi, R constitute a dense, green cluster, indicating robust collaboration between them. Additional significant clusters are Dieck, MC Tom, and Jung, TH in blue, with Caneva, G and Brimblecombe, P in purple, potentially indicating research organizations or academic teams engaged in analogous subjects. The scattered collaboration patterns of certain writers, such as Antonou, A and Rizzo, I, suggest infrequent or isolated partnerships. This map elucidates the cooperation frameworks within the scientific community.

Table 2. Most Cited Article

Citations	Author and Year	Title
3054	B Mckercher [21]	Cultural tourism: The partnership between tourism and cultural heritage management
1389	M Vecco [22]	A definition of cultural heritage: From the tangible to the intangible
1323	DJ Timothy [23]	Cultural heritage and tourism: An introduction
1147	T Kolar, V Zabkar [24]	A consumer-based model of authenticity: An oxymoron or the foundation of cultural heritage marketing?

Citations	Author and Year	Title
983	AJ McIntosh, RC Prentice [25]	Affirming authenticity: Consuming cultural heritage
944	D Camuffo [26]	Microclimate for cultural heritage: Measurement, risk assessment, conservation, restoration, and maintenance of indoor and outdoor monuments
909	MK Bekele, R Pierdicca, E Frontoni… [27]	A survey of augmented, virtual, and mixed reality for cultural heritage
872	M Mortara, CE Catalano, F Bellotti, G Fiucci… [28]	Learning cultural heritage by serious games
869	C Tweed, M Sutherland [29]	Built cultural heritage and sustainable urban development
837	L Smith [30]	Archaeological theory and the politics of cultural heritage

Source: Output Publish or Perish, 2024

4.2 Discussion

The bibliometric analysis of digital technologies in cultural heritage provides significant insights into the progression of research in this domain, emphasizing critical trends, innovations, and multidisciplinary collaborations. The utilization of digital instruments for the preservation and promotion of cultural heritage has significantly increased in recent years, as demonstrated by the extensive network of associated terminology and the simultaneous emergence of topics such as "conservation," "tourism," and "sustainability." These findings highlight the growing significance of digital techniques in meeting the preservation requirements of heritage monuments and the worldwide demand for accessible, immersive experiences.

a. Evolution of Research in Digital Cultural Heritage

The visualizations in this analysis illustrate a distinct change in research priorities during the past twenty years. The pivotal significance of "cultural heritage" in all visualizations indicates its status as a prominent subject of investigation across all fields. The rise of contemporary themes such as "augmented reality" and "virtual reality" alongside "conservation" and "tourism" signifies a growing emphasis among scholars on the impact of digital advances on the preservation and promotion of heritage. The network maps indicate that augmented reality and virtual reality are increasingly utilized as instruments for developing interactive, immersive experiences, essential for educational objectives and for enhancing tourism at heritage sites.

The bibliometric density maps further reinforce this trend by visually depicting the concentration of research activity around digital preservation and the application of these technologies in heritage management. The bright yellow areas around terms like "cultural heritage" and "intangible cultural heritage" indicate a high density of publications, suggesting that these are well-established topics in the research community. In contrast, the cooler blue and green areas surrounding terms like "climate change" and "cultural property" reflect emerging areas of interest. These findings suggest that while the preservation of tangible heritage has long been a central concern, intangible heritage—such as traditions, customs, and oral histories—is becoming increasingly important in academic discourse, particularly as digital tools offer new ways to document and share these aspects of culture.

b. Emerging Technologies and Innovations

This investigation reveals a growing dependence on digital technologies, including augmented reality (AR), virtual reality (VR), and 3D scanning, for the protection of cultural assets. These technologies enable academics and conservators to produce intricate digital copies of heritage sites and objects, applicable for repair, education, and tourism. The network visualization illustrates the co-occurrence of "augmented reality" and "virtual reality" alongside phrases such as "experience" and "tourism," emphasizing the contribution of these technologies to improving visitor engagement with cultural property. Visitors can now explore heritage places and items through immersive experiences that were previously unattainable due to geographic constraints or conservation concerns.

Furthermore, the presence of "digital preservation" in the network highlights the growing recognition of the need to preserve digital records of cultural heritage for future generations. As physical heritage sites and artifacts deteriorate over time, digital preservation offers a means of safeguarding these assets against environmental and human-induced damage. This trend is particularly important in the context of climate change, as evidenced by the connections between "climate change" and "cultural heritage." The increasing frequency of extreme weather events poses a significant threat to heritage sites, and digital preservation offers a potential solution by creating virtual backups that can be used for restoration or public education in the event of damage or destruction.

In addition to AR and VR, other technologies such as blockchain and artificial intelligence (AI) are also gaining traction in the field of cultural heritage. Although these technologies are still in the early stages of adoption, their potential applications are vast. For example, blockchain technology could be used to create immutable records of artifact provenance, ensuring that cultural objects are not subject to forgery or illegal trade. Similarly, AI has the potential to assist in the restoration of damaged artifacts by predicting their original forms based on existing fragments. These innovations reflect the interdisciplinary nature of digital cultural heritage research, which draws on expertise from fields such as computer science, archaeology, and museum studies to address complex preservation challenges.

c. Ethical Considerations and Challenges

Although digital technologies provide numerous advantages for cultural asset preservation, substantial ethical and practical difficulties remain to be resolved. A significant worry is the issue of data ownership and access. With the proliferation of digital technology, the management of cultural heritage data has emerged as a difficult subject. Heritage data is frequently amassed and preserved by private entities or institutions, prompting issues regarding the rights to access and utilize these digital assets. The network visualization emphasizes the term "politic," indicating that political and legal frameworks significantly influence the governance of cultural heritage data. Maintaining public access to cultural material while safeguarding the intellectual property rights of producers and stakeholders presents a complicated task for meticulous deliberation.

Another ethical concern pertains to the legitimacy of digitally reconstructed heritage. Although

digital technologies has the capability to restore and conserve heritage places and artifacts, there exists a risk that these digital reproductions may fail to accurately depict the genuine things. This poses a significant issue for intangible cultural assets, as the cultural importance of a custom or practice may be diminished when digitized and disseminated beyond its original setting. The simultaneous presence of concepts such as "authenticity" and "cultural identity" within the network underscores the significance of maintaining the integrity of cultural material, even as it is converted into digital media. Researchers and practitioners must recognize the potential for digital technologies to commodify or distort cultural material, especially when offered to global audiences unfamiliar with its original cultural context.

Moreover, the digital divide poses another challenge to the equitable access and representation of cultural heritage. While digital technologies have the potential to democratize access to heritage, there is a risk that only those with access to advanced technologies will benefit from these innovations. The network visualization shows that terms like "digital technology" and "cultural diversity" are connected, suggesting that researchers are increasingly aware of the need to address issues of inclusion and representation in digital heritage projects. Ensuring that underrepresented communities have the opportunity to participate in and benefit from digital heritage initiatives will be critical to the long-term success of these efforts.

d. Interdisciplinary Collaborations and Future Directions

The author collaboration network in the final visualization underscores the interdisciplinary nature of research in digital cultural heritage. The presence of multiple clusters of authors working on different aspects of cultural heritage suggests that this field draws on a wide range of expertise, including archaeology, computer science, conservation, and museum studies. The most densely connected authors, such as "Baglioni, P" and "Giorgi, R," are likely leaders in their respective fields who have contributed significantly to the advancement of digital technologies in cultural heritage. The collaboration network also shows that there is a growing trend toward international and cross-disciplinary partnerships, which are essential for addressing the complex challenges associated with cultural heritage preservation.

Looking ahead, there are several key areas of research that are likely to gain prominence in the coming years. First, the impact of climate change on cultural heritage is likely to become an increasingly important area of study, as reflected in the co-occurrence of "climate change" and "cultural heritage" in the network. As environmental conditions continue to threaten heritage sites, researchers will need to develop new strategies for mitigating these risks and ensuring the long-term sustainability of heritage preservation efforts. Second, the integration of AI and blockchain technologies into cultural heritage management offers exciting possibilities for enhancing the efficiency and transparency of conservation efforts. Finally, as digital technologies continue to evolve, there will be a growing need to address the ethical and regulatory challenges associated with the ownership, access, and representation of digital heritage.

5. CONCLUSION

The bibliometric analysis of digital technologies in cultural heritage indicates a swiftly advancing domain that increasingly depends on interdisciplinary collaborations and technological breakthroughs. Digital tools present novel prospects for the preservation and promotion of cultural heritage; yet, they also pose significant ethical and practical issues that must be resolved to guarantee that these advances serve the interests of all stakeholders. As academics persist in investigating novel methods for incorporating digital technology into heritage management, it is crucial to achieve equilibrium between innovation and the preservation of cultural authenticity and diversity.

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