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Conflicts of Adapting Cultural Heritage Preservation Technologies in Architecture Field

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Abstract

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The increasing use of technologies such as 3D scanning, photogrammetry, IoT-based monitoring, and digital twins has brought new approaches to the preservation of architectural heritage. However, concerns regarding authenticity, technological sustainability, and social acceptance persist. This research focuses on the impact of digital protection technologies on perceptions of authenticity and public trust, while also addressing the ethical and social issues arising from the implementation of these technologies. To examine these issues, the study combined a thematic analysis of the literature with data collected through a Likert-scale survey (n=18). The findings show that although digital tools improve accessibility and documentation, they are not perceived as adequate alternatives to physical heritage. Most participants emphasized the importance of sensory experience and found digital reproductions insufficient for preserving cultural value. Concerns about authenticity, misrepresentation, and data security were also found to affect trust in digital heritage practices. The findings highlight a continuing gap between technological progress and public acceptance, underscoring the need for more transparent, participatory, and ethically based conservation practices.

Keywords: Digital Heritage Preservation, Architectural Conservation, Cultural Authenticity, Conflict Mitigation, Creswell & Clark Mixed Methods

1. Introduction

1.1. Digital Heritage Preservation and Emerging Challenges

Architectural heritage represents cultural identity, historical knowledge, and social continuity, and is therefore of paramount importance for preservation for future generations. Today, heritage faces increasing threats such as armed conflicts (as seen in the deliberate targeting of cultural assets in Ukraine), climate change, and rapid urbanization. While traditional, material integrity-based preservation (Jokilehto, 1999) remains fundamental, "digital transformation" has led to a paradigm shift. Technologies such as 3D scanning, photogrammetry, IoT-based monitoring, and digital twins are no longer merely environmental; they have become central to documenting war crimes, planning remediation, and managing structural health in real time (Neglia et al., 2024; Casillo et al., 2024).

However, these tools are not neutral technical improvements; they represent an "epistemological" intervention that fundamentally alters the representation of the built environment. Preservation is thus evolving from a static, material-centric process to a dynamic field where digital data management redefines the essence of the "monument." This transition raises profound ethical challenges, particularly the risk of losing the unique "here and now" of the original work, which Walter Benjamin described as an "aura." When architectural heritage becomes infinitely replicable through digital "proxies" (Bentkowska-Kafel, 2012), it risks becoming detached from its spatial and temporal context, potentially transforming historical witnesses into consumable digital products. In the digital realm, this raises concerns about the loss, manipulation, or deliberate corruption of cultural records through cyberattacks, data corruption, or unauthorized alterations. Such risks have been addressed within the ethics of digital heritage not merely as technical malfunctions, but as potential threats to the integrity and continuity of cultural memory. The beauty of high-resolution 3D models (Addison, 2008; Kenderdine, 2013) can mask the lack of the original spirit and lead to digital objects failing to capture the auratic quality of the original space.

However, the aim of this critical review is not to reject these technological advances, but to understand their multifaceted impacts; to balance the undeniable benefits in terms of preservation with the risks to cultural integrity.

Furthermore, relying on digital tools reveals the paradox between technological obsolescence and the longevity of stone and mortar. While physical structures are built to last for centuries, the digital formats used to preserve them may become unreadable within decades, creating a sustainability crisis in heritage data management. Moreover, as Smith (2006) points out through "Empowered Heritage Discourse" (AHD), expert-led technical processes often marginalize the perceived "social value" and living meanings of local communities. Decisions about what to record and how to display during

digitization can lead to a loss of social legitimacy by excluding local narratives. If digital tools prioritize static documentation over the "living" relationship between people and places (Harrison, 2013), they risk freezing heritage in a way that serves the technical archive but ignores social reality. Therefore, justifying digital preservation as a critical architectural issue requires addressing how these conflicts affect community trust in and long-term adaptation to digital heritage.

1.2. Research Objectives and Questions

The main objective of this research is to analyze the social conflicts arising from authenticity, technological sustainability, and cultural considerations in the preservation of digital heritage.

The study addresses the following research questions:

- How do digital preservation technologies affect perceived authenticity?
- What risks do technological obsolescence and data sustainability create?
- How do digital preservation practices affect social legitimacy and public trust?
- What factors determine public acceptance of digital heritage technologies?

1.3. Hypotheses

H1: Although digital preservation technologies improve accessibility and documentation capabilities, they are not perceived as sufficient alternatives to replace physical heritage experiences.

H2: Concerns about authenticity, technological sustainability, and security risks negatively impact public trust and acceptance of digital heritage technologies.

1.4. Literature Review

In the era we are in, digital technologies play a central role in the preservation of architectural heritage, offering highly accurate documentation and monitoring solutions against global threats such as armed conflict, climate change, and urban transformation (Casana et al., 2020; Bruno et al., 2010). Tools such as photogrammetry, laser scanning, and digital twins are often positioned within efficiency-oriented, preventive conservation frameworks. However, critical heritage studies challenge this technology-centric view where digital tools are seen as neutral. While Lowenthal (1998) emphasizes that heritage is a selective reconstruction of the past,

Smith (2006) argues that heritage is a socially produced and negotiated value system.

Furthermore, Jokilehto (1999) demonstrates that authenticity is not limited to physical integrity but also encompasses context, continuity, and cultural significance.

Consequently, a clear tension emerges between technical conservation approaches that define success by data accuracy and accessibility, and critical heritage studies that prioritize authenticity, cultural continuity, and social legitimacy.

Rather than representing independent perspectives, these approaches offer competing interpretations of how conservation success should be assessed. This theoretical divergence directly impacts the three research dimensions examined in this study: authenticity and representation, technological sustainability, and social acceptance.

1.4.1. Authenticity and Digital Representation

The relationship between authenticity and digital representation constitutes one of the most debated areas in the digital heritage literature. Digital reconstruction technologies make significant contributions to conservation and education by enabling the re-visualization of lost or damaged heritage (Addison, 2008; Kenderdine, 2010). However, this process introduces interpretive interventions and hypothetical elements, especially in reconstructions based on incomplete data (Agapiou et al., 2020; Champion, 2021). This situation is directly linked to theoretical discussions about the nature of authenticity. While traditional approaches associate authenticity with material integrity, contemporary conservation theories also include abstract dimensions such as cultural meaning, memory, and context (Smith, 2006; Jokilehto, 1999). The inability to reproduce these dimensions in digital environments points to a disconnect frequently discussed through Walter Benjamin's concepts of "aura" and "authenticity."

Bentkowska-Kafel (2017) deepens this rupture by defining digital heritage objects not as direct representations, but as "proxies." High visual realism can obscure historical ambiguities and potentially create a false sense of authenticity.

Conversely, some studies show that digital processes based on participation and co-creation can reconstruct authenticity (Kenderdine, 2010), and that the tension between technical accuracy and cultural meaning lies at the heart of digital heritage.

1.4.2. Technological Sustainability and Obsolescence

A fundamental paradox of digital heritage is the incompatibility between long-term conservation goals and the ephemeral nature of digital technologies. While physical heritage can last for centuries, digital data remains dependent on rapidly changing software, formats, and hardware systems. The literature shows that long-term conservation strategies such as data migration, metadata standards, and inter-system interoperability are often insufficient in digital heritage projects (Stylianidis & Remondino, 2022).

Furthermore, digital sustainability is complicated by the environmental impacts of the necessary technological infrastructure, including energy consumption, and the need for comprehensive stakeholder collaboration (Paschalidou et al., 2022). Cybersecurity threats also create new risk areas. In this context, digital preservation emerges as a paradoxical process that creates new vulnerabilities while mitigating physical risks, highlighting the need to consider technological innovation in conjunction with sustainability-based preservation approaches. Consequently, while authenticity debates focus on representation and understanding, debates on technological obsolescence focus on system resilience; however,

both share a fundamental concern regarding the reliability of digital preservation in transmitting heritage to future generations.

1.4.3. Social Adaptation and Acceptance

The success of digital heritage depends not only on technical capacity but also on social acceptance. Critical heritage studies reveal that heritage survives not only through expert intervention but also through its continuous relationship with the community (Smith, 2006; Harrison, 2013). However, many digital preservation practices are criticized for their technocratic approaches that exclude local communities. Byrne (2009) argues that such practices risk 'objectifying or materializing culture,' reducing living traditions to static data points, eliminating their dynamic, lived dimensions, and triggering social resistance.

These arguments demonstrate that social acceptance is a decisive factor in technological legitimacy. While technical preservation approaches prioritize efficiency and accessibility, critical heritage theories emphasize participation, local interaction, and community ownership. Furthermore, digital technologies can offer more inclusive experiences by expanding accessibility (Economou, 2015), but this also carries the risk of transforming heritage into a consumable product. Consequently, current research argues that participatory and collaborative creation processes play a critical role in increasing social acceptance (Champion, 2021). Nevertheless, empirical studies investigating how these processes shape societal perception remain limited.

1.4.4. Research Gap

Despite the increasing prevalence and adoption of digital technologies in the preservation of architectural heritage, current studies primarily focus on technical performance, documentation accuracy, monitoring systems, and reconstruction capabilities. Limited attention has been paid to the ethical and social impacts of these technologies, particularly issues of authenticity, public trust, and social legitimacy. Consequently, the relationship between technological progress and cultural values, and the social dimension of these advancements, remains insufficiently understood.

2. Materials and Methods

2.1. Research Design

This study adopts a mixed-methods research design based on the framework developed by Creswell and Plano Clark. The choice of this approach is directly related to the research gap identified in the literature. Previous studies on the preservation of digital heritage have primarily focused on technical performance and documentation accuracy, while paying limited attention to ethical concerns, public trust, and social acceptance. Therefore, a mixed-methods approach was deemed appropriate because it allows for the integration of theoretical perspectives with empirical evidence regarding public perceptions. By combining qualitative literature analysis with quantitative survey data, this study offers a broader understanding of the relationship between technological innovation, cultural values, and public trust. The relationship between the overall structure of the research and its main stages is shown in Figure 1.

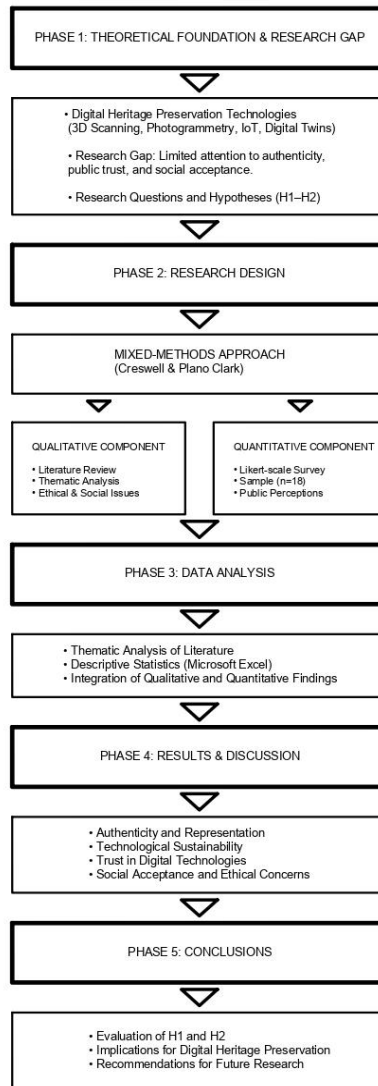


Figure 1. Structure of the Research.

2.2 Sources

The research utilized both primary and secondary data sources. Secondary data consisted of academic literature addressing topics such as digital heritage preservation technologies, authenticity, technological sustainability, and social adaptation. Primary data was collected through a survey designed to investigate public opinion regarding digital preservation practices.

2.3. Data Collection

A purposive sampling strategy was used. Participants were selected from individuals residing near cultural heritage sites in Antalya, Istanbul, and Ankara, and who were assumed to be familiar with the existence of heritage environments in these cities. The study aimed to identify the limits of social adaptation by conducting it among citizens who may have knowledge of the subject at all levels. A total of 18 participants took part in the survey.

The survey was administered online using Google Forms and a five-point Likert scale from "Strongly Disagree" to "Strongly Agree" was used.

2.4 Research Tool

The survey questions were developed based on conceptual themes identified in the literature review. The survey consists of statements grouped under four thematic categories: (1) authenticity and representation, (2) technological sustainability and safety risks, (3) trust in digital technologies, and (4) social acceptance and ethical considerations. This structure enabled a systematic examination of the main variables studied in the research.

2.5 Data Analysis

Qualitative data from the literature were examined through thematic analysis to identify recurring concepts, theoretical debates, and key conflicts within the preservation of digital heritage. Quantitative survey data were analyzed using statistics in Microsoft Excel. The findings were then organized according to three analytical dimensions: authenticity and representation, technological sustainability, and social acceptance.

3. Results

The survey findings are presented in line with the study's core analytical dimensions: originality and representation, visual perception, technological sustainability, trust in digital technologies, and social acceptance.

3.1. Awareness of Digital Preservation Methods

Participants were also asked about their familiarity with digital protection technologies. The results show a moderate level of awareness; 50% of participants indicated prior knowledge of digital protection methods, 33.3% showed limited familiarity, and 16.7% gave a neutral response.

Although awareness levels varied, the findings suggest that digital protection technologies are becoming increasingly visible to the public and provide important context for interpreting attitudes towards issues such as authenticity, trust, and social acceptance.

3.2. Representation and Relation to Physical Heritage

In the survey, 38.9% of participants agreed that digital models could reflect the historical spirit of monuments, while 33.3% disagreed, and 27.8% remained neutral (Figure 2). More importantly, 83.3% stated that sensory qualities such as light, sound, texture, and materiality are essential for understanding cultural heritage. Furthermore, 72.2% agreed that creating only a digital copy would not be sufficient for preserving heritage.

These findings directly answer the study's initial research question, demonstrating that participants continue to associate authenticity primarily with physical and sensory experience rather than digital representation.

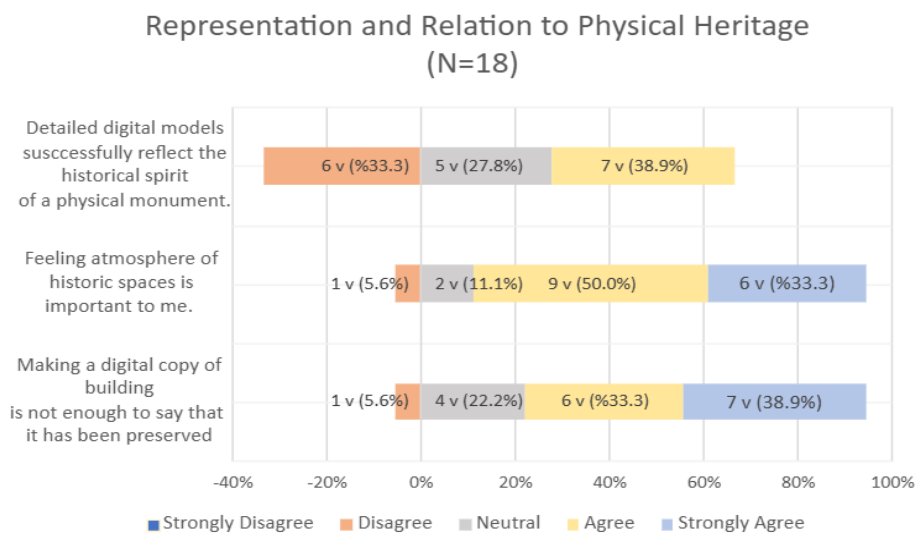


Figure 2. Distribution of responses regarding representation and relation to physical heritage .

3.3. Visual Perception and Technical Details

Participants were also questioned about the ability of digital technologies to accurately reproduce the material characteristics of heritage assets. As shown in Figure 3, 61.1% of participants agreed that digital models cannot fully reflect the craftsmanship and detailed physical qualities. Additionally, 50% reported that highly polished or visually enhanced digital models conceal signs of aging and historical deterioration.

These findings highlight the limitations of digital representations in conveying material and historical characteristics and sensitivities regarding authenticity in the participants' perception.

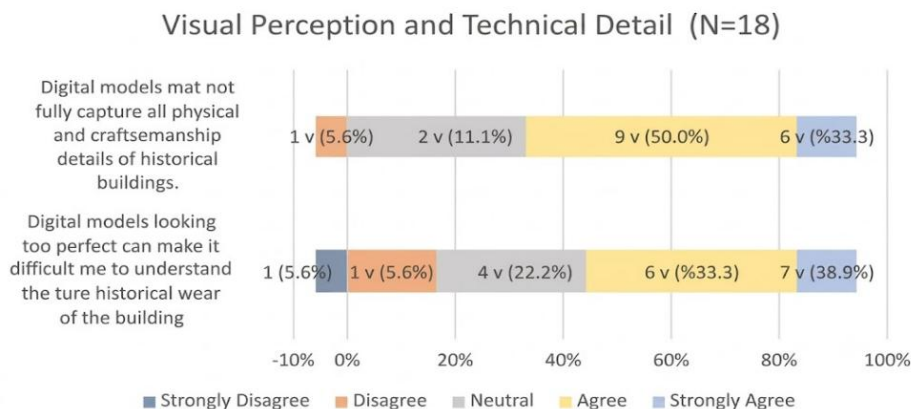


Figure 3. Distribution of responses regarding visual perception and technical detailing.

3.4. Security and Technological Risks

Technological sustainability also emerged as a significant concern. 66.6% of participants considered data theft or manipulation a threat to the preservation of cultural heritage, while 50% expressed concern about the misuse or alteration of digital records (Figure 4).

Subsequently, half of the participants agreed that rapid technological change and software obsolescence could weaken the long-term reliability of digital archives.

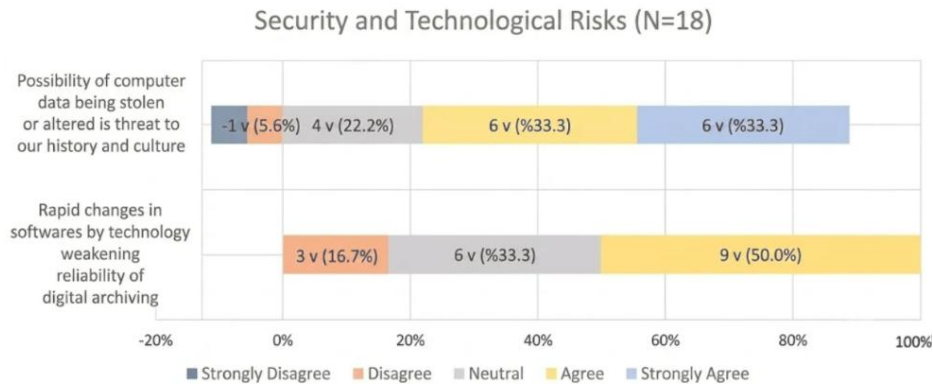


Figure 4. Distribution of responses regarding security and technological risks

3.5. Privacy and Data Sensitivity

Responses to privacy concerns were relatively balanced. While 33.4% of participants disagreed that detailed digital documentation raised privacy concerns, a similar percentage expressed discomfort, and 33.3% remained neutral. The findings highlight differing perceptions of acceptable limits for digital documentation and information sharing. These findings demonstrate that concerns about technological sustainability, security, and long-term accessibility remain significant challenges for preserving the digital legacy.

3.6. Trust in Digital Technologies vs Human Judgment

Participants were cautious about the reliability of digital technologies in the preservation of cultural heritage. Half of the participants agreed that digital measurement technologies could provide more reliable results than human judgment in restoration processes. However, 38.9% chose the neutral option, while only 11.2% disagreed.

This relatively high percentage of neutral responses suggests that public/participant trust in digital technologies is conditional and likely dependent on perceptions of authenticity, transparency, and technological reliability.

4.6. Social Adaptation and Ethical Considerations

The survey findings highlight the importance of public participation in digital heritage initiatives. A majority of participants (61.1%) agreed that involving local communities in conservation processes increases public acceptance (Figure 5). In contrast, 44.4% expressed concern that advanced technological methods could contribute to the loss of traditional crafts and repair skills.

Regarding ethical considerations, participants generally expressed limited concern about the commercial use of digital heritage. 44.4% remained neutral or indifferent to the effects of commercialization, while only 27.8% perceived it as a negative outcome. Finally, 55.6% supported the physical reconstruction of heritage sites using digital records when original structures are damaged or destroyed.

These findings directly address the third and fourth research questions, demonstrating that social acceptance depends not only on technological effectiveness but also on community participation, ethical transparency, and the preservation of cultural values.

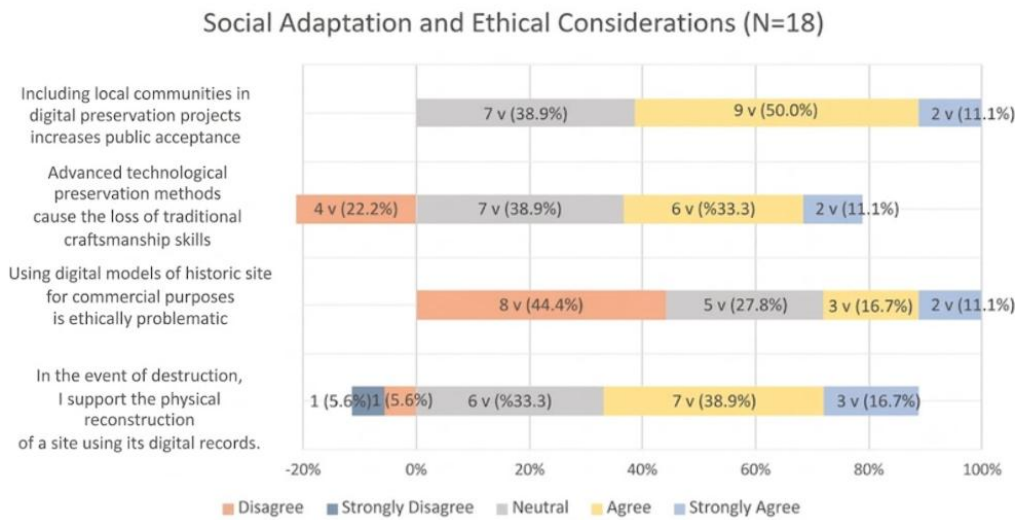


Figure 5. Distribution of responses regarding social adaptation and ethical conditions.

4. Discussion

The findings of this study reveal an ongoing tension between the technological advancements offered by digital heritage preservation and the social and cultural expectations associated with the authenticity of heritage. While digital technologies such as 3D scanning, photogrammetry, digital twins, and IoT-based monitoring have significantly improved documentation, accessibility, and preservation processes, the survey results indicate that these technologies are not perceived as sufficient alternatives to replace physical heritage experiences.

One of the most important findings concerns authenticity. The vast majority of participants emphasized the importance of sensory experience and considered physical presence indispensable for understanding cultural heritage (as evidenced by the 61.1% approval rate in Figure 4). These findings support previous work arguing that heritage values are not only embedded in physical objects but are also constructed through lived experiences, memories, and social interactions. In this context, the results reinforce Smith's concept of "Empowered Heritage Discourse" (2006); This concept, while highlighting the socially constructed nature of heritage, also validates recent studies suggesting that digital representations fail to fully reproduce the abstract and experiential dimensions of heritage.

The findings also show that concerns about authenticity extend beyond physical experience to issues of visual representation. Most participants indicated that digital models did not adequately reflect craftsmanship, material qualities, and signs of aging. This finding challenges technologically deterministic approaches that assume increasingly complex digital models automatically enhance the understanding of heritage (see the 50% concern regarding visual over-subtlety). Instead, the results demonstrate that technological precision does not guarantee perceived authenticity. Consequently, the study reframes current debates by emphasizing that authenticity should be understood not only as technical accuracy but also as cultural credibility and experiential integrity.

Concerns about technological sustainability and data security also emerged as significant factors affecting public trust. Participants expressed concerns about data manipulation, cybersecurity risks, and technological obsolescence. These findings expand upon previous research, which primarily focused on the technical efficiency of digital preservation systems, by demonstrating that long-term public acceptance is equally dependent on issues of credibility, transparency, and digital governance. In this sense, the results support the second hypothesis (H2), showing that increasing concerns about authenticity and technological risks negatively impact trust in digital heritage initiatives.

Another significant contribution of the study concerns social acceptance. A majority of participants agreed that the involvement of local communities in digital heritage processes increased public acceptance. This finding addresses a research gap identified in the literature where the social and participatory dimensions of digital heritage often receive limited attention. The results suggest that digital preservation projects need to adopt more inclusive and participatory approaches to strengthen legitimacy and public trust. Therefore, digital technologies should be considered as complementary tools rather than replacements for traditional preservation practices.

The findings also empirically support the first hypothesis (H1). While participants did not disregard the benefits of digital technologies in improving accessibility and documentation, they generally did not perceive digital preservation as a sufficient alternative to physical heritage. This confirms that digital and physical preservation should work together within integrated preservation frameworks.

Despite these contributions, some limitations need to be considered. First, while providing in-depth initial information, the study is based on a relatively small sample ($n=18$), making it exploratory in nature and limiting the generalizability of the findings. Second, participants were drawn from only three cities in Türkiye, which may not fully represent broader social perceptions. Third, the study relies solely on descriptive statistical analysis; future studies could utilize larger samples and more advanced statistical techniques to investigate the relationships between authenticity, trust, and social acceptance.

Future research could expand the geographic scope of the study, increase the number of participants, compare perceptions across different cultural contexts, and examine the perspectives of professional stakeholders, including preservation experts, architects, and local authorities. Longitudinal studies examining how public attitudes toward

digital heritage evolve over time would also significantly contribute to the field.

In general, this study contributes to the existing literature by focusing on the ethical, social, and cultural impacts of digital preservation technologies rather than their technical performance. The findings demonstrate that the successful implementation of digital heritage initiatives depends not only on technological innovation but also on public trust, authenticity, and meaningful community engagement.

5. Conclusions

This study examined the impacts of digital preservation technologies on architectural heritage through the dimensions of authenticity, technological sustainability, and social acceptance. The findings demonstrate that even though digital technologies significantly expand documentation, accessibility, and preservation capabilities, they do not replace the experiential, cultural, and social values associated with physical heritage.

The study makes a unique contribution to the digital heritage literature by moving beyond primarily technical assessments and empirically examining public perceptions regarding authenticity, trust, and ethical concerns. In doing so, it addresses a significant gap in existing academic work that often overlooks the social consequences of digital heritage interventions. The findings challenge existing theoretical debates by suggesting that authenticity in digital heritage should be understood not only in terms of technical accuracy but also in terms of cultural credibility, sensory experience, and public trust.

From a professional perspective, the results demonstrate that successful digital heritage initiatives require more than just technological innovation. Preservation policies and heritage management practices should adopt participatory approaches that actively involve local communities throughout the documentation, interpretation, and decision-making processes. Furthermore, institutions responsible for digital heritage should establish transparent and controlled protocols on data management, long-term digital sustainability, and ethical use to strengthen public trust.

Based on the evidence presented, this study proposes that digital technologies should be integrated as complementary components within broader conservation frameworks, rather than replacing physical heritage. This approach will support both technological progress and the preservation of ingrained cultural meanings in heritage sites.

In conclusion, the research highlights the need for a socially responsible digital heritage conservation model where technological innovation is balanced with authenticity, ethical responsibility, and community engagement. This conceptual perspective provides a foundation for future research and the development of more inclusive and sustainable heritage conservation strategies, and offers a pathway for evaluating community-focused digital twin applications in diverse historical urban fabrics.

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Conflicts of Interest

The author report no conflicts of interest.

Data Availability Statement

The core data and research materials supporting the findings of this study are available via email from the corresponding author upon reasonable request. Quantitative survey data and qualitative materials are stored in digital formats (Excel spreadsheets and text files) and may be shared provided that the anonymity and confidentiality of participants are strictly protected.

Institutional Review Board Statement

For this study, formal institutional ethics committee approval was not required because the research involved a non-clinical, fully anonymized online survey. All participants were fully informed about the purpose of the research and provided their explicit and informed digital consent prior to participation. To ensure the complete privacy and confidentiality of participants throughout the study, no personally identifiable data, biometric information, or sensitive personal records were collected.

CRedit Author Statement

Cansen Soytürk: Conceptualization; Methodology; Investigation; Data Curation; Software; Validation; Formal Analysis; Visualization; Writing original draft; Writing review & editing; Project administration.

AI Use Statement

Generative AI tools (OpenAI's ChatGPT and Google's Gemini) were used as automated editing assistants to improve the linguistic clarity and textual consistency of the author's own writing. All analysis, interpretations, and final content decisions were undertaken by the author.

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