# Memory and Loss in Post-war Smart City Reconstruction: Digital Archives and Cultural Heritage in Zaporizhzhia, Ukraine

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**Abstract**

This study examines how digital archives and smart city technologies can preserve collective memory during Zaporizhzhia's post-war rebuilding. Using digital archival research, it explores how digital archives can safeguard intangible heritage (oral histories, traditions, community memory) and architectural heritage during reconstruction. The article reviews scholarship on cultural memory in conflict, digital preservation, and smart city heritage, presenting a study of 312 Zaporizhzhia residents and expert interviews with urban planners, heritage professionals, and technologists. Survey results show strong public support for integrating digital memorial projects into city planning, though participation remains moderate. The discussion offers policy recommendations for preserving history during rebuilding. The article argues that integrating digital archives into smart city reconstruction can bridge the past and the future, honouring loss while building resilient cultural memory.

**Keywords**

post-war reconstruction, digital archives, cultural heritage, smart city, Zaporizhzhia, Ukraine

## Introduction

The scale of Ukraine's urban reconstruction challenge is unprecedented in contemporary European history. The most recent assessment estimates reconstruction costs at $524 billion over the next decade, with regions closest to the frontline sustaining 72% of total damage (World Bank, 2025). Cities such as Mariupol, Kharkiv, Mykolaiv, and Chernihiv face extensive destruction, requiring comprehensive rebuilding strategies that balance physical reconstruction with the preservation of cultural memory. UNESCO (2025) has verified damage to 509 cultural sites across Ukraine as of September 2025, including 152 religious sites, 268 buildings of historical interest, 34 museums, and 33 monuments.

Each affected city confronts unique challenges shaped by its historical identity, economic base, and proximity to active conflict zones. Mariupol's near-total destruction and ongoing occupation prevent immediate reconstruction planning, while Kharkiv pursues recovery through the Norman Foster Masterplan developed with 800 experts and 16,000 citizen participants (Norman Foster Foundation, 2023). Mykolaiv, meanwhile, implements United Nations Economic Commission for Europe (UNECE)-supported reconstruction strategies that emphasise sustainable urban development and digital community engagement platforms (UNECE and One Works, 2023–2024).

Across these contexts, Ukrainian municipalities increasingly recognise that post-war reconstruction must integrate cultural heritage preservation with technological modernisation to maintain urban identity while building future resilience (Becker *et al.*, 2022; Szpak *et al.*, 2024). Several Ukrainian cities have adopted smart city frameworks as strategic responses to wartime destruction, using digital technologies to optimise resource management, strengthen governance transparency, and support citizen engagement platforms during conflict (Sych & Pasinovych, 2025). Kyiv maintains its Smart City initiatives through the Kyiv Digital application, adapted for wartime conditions,

including air raid alerts and displaced persons registration, while cities such as Lviv, Dnipro, and Vinnytsia pursue parallel digital transformation initiatives (Serhiichuk, 2025). This convergence of smart city development with post-conflict reconstruction represents a distinctive approach to 'building back better' through ICT integration and sustainable infrastructure (Cifuentes-Faura, 2023).

Zaporizhzhia presents a particularly instructive case for examining this intersection of memory, technology, and reconstruction. Unlike Mariupol or occupied territories, Zaporizhzhia remains under Ukrainian control while experiencing ongoing bombardment, creating conditions in which reconstruction planning proceeds alongside active conflict. The city's pre-war investment in smart city infrastructure, including 2021 International Finance Corporation (IFC, 2021) funding for a comprehensive smart city platform, provides an existing technological foundation that differentiates it from other affected cities and enables examination of how digital systems can support heritage preservation during reconstruction. Zaporizhzhia's historical significance as the cradle of Cossack identity, anchored by the Khortytsia National Reserve and the legacy of the Zaporizhzhian Sich, creates particularly high stakes for the preservation of cultural memory amid what Ukrainian authorities characterise as cultural destruction not seen in Europe since World War II (Iaromenko *et al.*, 2024). The city's role in hosting internally displaced persons from occupied territories adds urgency to efforts to use digital archives to preserve endangered cultural practices and serve displaced communities.

Research on post-conflict reconstruction emphasises that community participation is key to successful recovery projects and that when local communities are not fully integrated, projects have less impact on reconciliation (Campfens *et al.*, 2023). These factors make Zaporizhzhia an instructive case for understanding how Ukrainian cities can integrate digital heritage preservation into smart city reconstruction frameworks through participatory approaches, offering insights that may be applicable to other affected municipalities as they plan recovery.

## Literature Review

This study integrates cultural memory studies, digital heritage scholarship, and smart city theory to examine heritage preservation during post-conflict reconstruction. Pierre Nora's (1989) concept of *lieux de mémoire* establishes that memory exists in constructed sites and archives when living experience disappears. Jan and Aleida Assmann's distinction between communicative memory (biographical, spanning eighty years) and cultural memory (institutionalised, extending across generations) demonstrates how societies transition from lived experience to archives (Assmann, 2008).

In conflict contexts, this transition accelerates dramatically as destruction threatens both forms of memory simultaneously, requiring immediate archival intervention. Maurice Halbwachs' (1992) theory emphasises that memory depends on physical spaces and social frameworks, making the destruction of urban landscapes particularly devastating for community identity. Digital heritage scholarship extends these concepts into the technological domain.

The digital curation lifecycle model frames preservation as an iterative process requiring active management rather than passive storage (Higgins, 2008; Oliver & Harvey, 2016), proving essential when traditional infrastructure is damaged. Smart city theory contextualises heritage within urban technological systems. Rob Kitchin's (2014) critical perspective emphasises that datafication creates new power relations requiring attention to data sovereignty and cybersecurity, concerns that intensify in wartime. Robert Hollands (2008) distinguishes entrepreneurial smart cities prioritising economic growth from progressive approaches emphasising social equity and democratic participation, a distinction that is crucial for post-conflict reconstruction that prioritises cultural memory alongside infrastructure.

Comparative reconstruction cases reveal recurring challenges. Warsaw's meticulous post-World War II rebuilding became a UNESCO heritage site, recognising reconstruction as a cultural practice (Murzyn-Kupisz, 2013). Beirut's rapid commercial redevelopment marginalised commemoration and was criticised for serving elite interests over collective memory (Bevan, 2006; Macdonald, 2013). Sarajevo retained damaged structures as intentional ruins testifying to destruction while rebuilding the surrounding areas, demonstrating how memory and recovery coexist (Viejo-Rose, 2011). These cases emphasise community participation, multiple narratives, and the integration of memory with practical reconstruction.

The Russia–Ukraine conflict represents unprecedented cultural heritage destruction in contemporary Europe. UNESCO (2025) verified damage to 509 sites as of September 2025, including 152 religious sites, 268 historic buildings, and 34 museums. The Kremlin's denial of Ukrainian nationhood manifests through systematic cultural erasure targeting identity, transforming cultural heritage into a victim of conflict (Dombrowski *et al.*, 2022; Couch, 2022; Ivanysko *et al.*, 2024). Cultural heritage thus becomes a political instrument in warfare, serving strategic goals beyond physical destruction (Munawar & Symonds, 2024). This devastation weakens national identity by disrupting the narratives that define collective consciousness (Anghelescu, 2022; Kosciejew, 2023), creating contested layers of memory and cultural trauma that require reconstruction processes addressing both material loss and psychological healing while shaping future engagement with heritage (LaCapra, 2016; Lähdesmäki *et al.*, 2019; Legnér, 2018).

Saving Ukrainian Cultural Heritage Online (SUCHO, 2025), launched in March 2022, backed up 5,000 websites, collecting 55 terabytes of Ukrainian cultural content. Backup Ukraine uses 3D scanning through Polycam to create cloud-stored digital twins, ensuring survival if structures are destroyed (Neglia, 2024). Grassroots initiatives like 'Postcards from Ukraine' document before-and-after images, while oral history projects and social media create 'living archives' during the conflict, with museums adapting their operations for the digital era to reframe conflict narratives (Marino, 2024; Olzacka, 2023). International frameworks emphasise documenting damage and community involvement in recovery, with legal scholars identifying obligations of non-parties to safeguard Ukrainian heritage and European Commission expert groups recommending monitoring (Culture and Creativity, 2024; Jakubowski, 2023).

Smart city frameworks provide technological infrastructure for heritage preservation. Scholars propose extending urban digital platforms to cultural heritage management through augmented reality (AR) reconstructions and interactive histories (Borda & Bowen, 2017; Koukopoulos & Koukopoulos, 2016). Ukrainian cities, including Kyiv, Lviv, and Kharkiv, maintain smart initiatives adapted for wartime crisis management (Cifuentes-Faura, 2023; Serhiichuk, 2025). Zaporizhzhia exemplifies this integration. Before the invasion, the city secured a €35 million International Finance Corporation loan (IFC, 2021) to implement a comprehensive smart city platform alongside green transport modernisation.

The platform was designed for real-time utility monitoring, traffic optimisation, transit information boards, and integrated municipal services, employing decentralised digital twin ecosystems that enable city-level co-creation (Kanai *et al.*, 2024). IDOM (2022) consultancy provided strategic advisory, analysing best practices and creating data flow architecture connecting devices to central platforms. The February 2022 invasion disrupted but did not halt implementation. The city adapted the platforms for wartime crisis management, including damage assessment, registration of displaced persons serving over 60,000 evacuees, prioritisation of utility restoration, and emergency communication during bombardment.

Post-war planning through 2028 maintains the centrality of digital infrastructure while recalibrating towards recovery priorities, mitigating the effects of hostilities, and improving quality of life (Tkachenko & Sevastyanov, 2023). The Vision 2030 framework, developed with Ro3kvit Urban Coalition, involves intersectoral working groups examining how digital technologies can support cultural preservation through georeferenced archives mapping historical content to urban locations, virtual reconstructions of destroyed architecture, interactive memory-sharing platforms, and the integration of heritage data with planning tools to inform reconstruction decisions (Ro3kvit, 2024). This convergence positions digital heritage not as separate from, but as integral to, smart city development, potentially establishing 'memory-centric smart city' models in which technological infrastructure serves both functional and commemorative purposes, applicable to other Ukrainian cities and post-conflict contexts globally.

## Methodology

In examining the role of digital archives in preserving cultural memory during the reconstruction of Zaporizhzhia, we employed a mixed-methods research design integrating both quantitative and qualitative approaches. This design was chosen to capture the extensive scope of public

engagement, assessed through a survey, alongside the in-depth insights of experts gathered via interviews, thereby providing a comprehensive understanding of the subject. All research activities were conducted between January and April 2025.

We conducted a survey among Zaporizhzhia residents to assess perceptions, concerns, and behaviours related to cultural memory, loss, and digital engagement. The survey was administered online through social media groups and city channels, with paper formats available at two libraries and a community centre for those with limited internet access. Of the 326 responses, 312 were valid after removing duplicates and incomplete submissions. The sample comprised 54% female and 46% male respondents aged 18–75 (median 34); 82% had a tertiary education, and 20% were internally displaced persons from nearby conflict areas, reflecting Zaporizhzhia's role in hosting evacuees.

IP addresses were limited to one survey submission, and the initial page encouraged participation regardless of prior experience with digital archives to mitigate self-selection bias. Although the sample is not strictly random, the age and gender profiles align with 2024 municipal statistics within ± 4 percentage points, indicating acceptable coverage and minimal non-response bias. The demographic distribution of the validated sample (n = 312) is summarised in Table 1.

**Table 1.** Demographic profile of survey respondents (n = 312)*

| Variable | Category | N | % |
|---|---|---|---|
| Gender | Female | 169 | 54% |
| | Male | 143 | 46% |
| Age group | 18–29 | 86 | 28% |
| | 30–49 | 127 | 41% |
| | 50+ | 99 | 32% |
| Residence status | Permanent residents | 250 | 80% |
| | Internally displaced persons (IDPs) | 62 | 20% |

* Note. Percentages may not total exactly 100% due to rounding.
Source: Authors' elaboration.

The survey comprised 20 questions addressing (1) perceived cultural loss due to war ('Do you feel that important aspects of your city's heritage have been lost?' – with Likert scale responses); (2) attitudes towards preservation (importance of rebuilding monuments, support for memorials); (3) digital engagement with cultural content (use of digital archives, virtual tours, apps); and (4) willingness to participate in digital initiatives (contributing photos, stories, volunteering). Questions included Likert statements, multiple-choice items, and an open-ended question about 'how Zaporizhzhia should remember its past while rebuilding'. Data were analysed using descriptive statistics and cross-tabulations. Open-ended responses were coded thematically to identify common sentiments. Quantitative data were processed in SPSS 29, and qualitative coding was conducted in NVivo 14. Internal consistency of the four-item 'digital engagement' scale was acceptable (Cronbach's $\alpha = 0.78$).

To complement the public survey, we conducted semi-structured interviews with experts in urban planning, cultural heritage preservation, digital technology, and community activism. Using purposive sampling, we selected 10 interviewees: three urban planners/architects (two from local government, one from an academic urbanism institute); three cultural heritage professionals (a museum director, a heritage protection official, and an archivist); two digital technologists (one from a civic tech NGO, the other an IT consultant for smart city solutions); and two community organisers (leading NGOs focused on history and veterans' commemorations). Interviews were conducted either in person in Zaporizhzhia or via video call.

Interviews lasted 60–90 minutes and were conducted in Ukrainian (or English when preferred; Ukrainian interviews were translated). Using a semi-structured guide, we asked questions about the role of cultural memory in reconstruction, digital tools for memorialisation, challenges of digital archives, current commemoration projects in Zaporizhzhia, and policies needed to integrate

cultural memory into urban planning. We encouraged interviewees to provide examples and followed up on their responses.

The qualitative interview data underwent thematic analysis. After transcription, we coded the transcripts to identify themes. Three thematic categories emerged, aligned with the research questions: (A) memory preservation significance, covering its importance and aspects to preserve; (B) methods and practices, detailing preservation approaches, including both digital and traditional methods; and (C) challenges and recommendations, addressing obstacles and potential solutions. Sub-themes emerged inductively; within methods, 'interactive digital experiences' appeared as a sub-theme, with experts citing AR/VR applications. Within challenges, sub-themes included the 'digital divide' and 'data security'. We observed convergence among interviewees, such as consensus between technologists and heritage professionals. Representative quotations exemplified the themes, with attribution to expert types for anonymity, for example, 'Urban planner #1'.

Mixed methods enabled triangulation through surveys and interviews. Participants provided consent anonymously. For interviews, experts signed consent forms while maintaining anonymity. Ethics approval accounted for war-related sensitivities. We avoided compelling participants to recall traumatic experiences and allowed them to skip questions. In the results, identifying details were generalised. Given the politically charged nature of heritage, we maintained balance by acknowledging Ukrainian perspectives. While focusing on Ukrainian cultural memory, we also recognise Zaporizhzhia's multiethnic heritage and support inclusive memory initiatives.

The study protocol (Ref. № 2025-03/27) received approval from Taras Shevchenko National University of Kyiv's Research Ethics Committee on 27 March 2025. All respondents provided informed consent electronically after receiving an online information sheet. Anonymity was maintained throughout data collection, analysis, and publication.

## Results

Survey results indicate a community that is aware of the importance of preserving cultural memory during reconstruction, with broad consensus on this issue. The findings reveal moderate engagement with digital archives, suggesting opportunities for increased participation. Key quantitative findings are summarised in Figure 1, showing respondents who agreed with statements on cultural heritage and digital engagement.

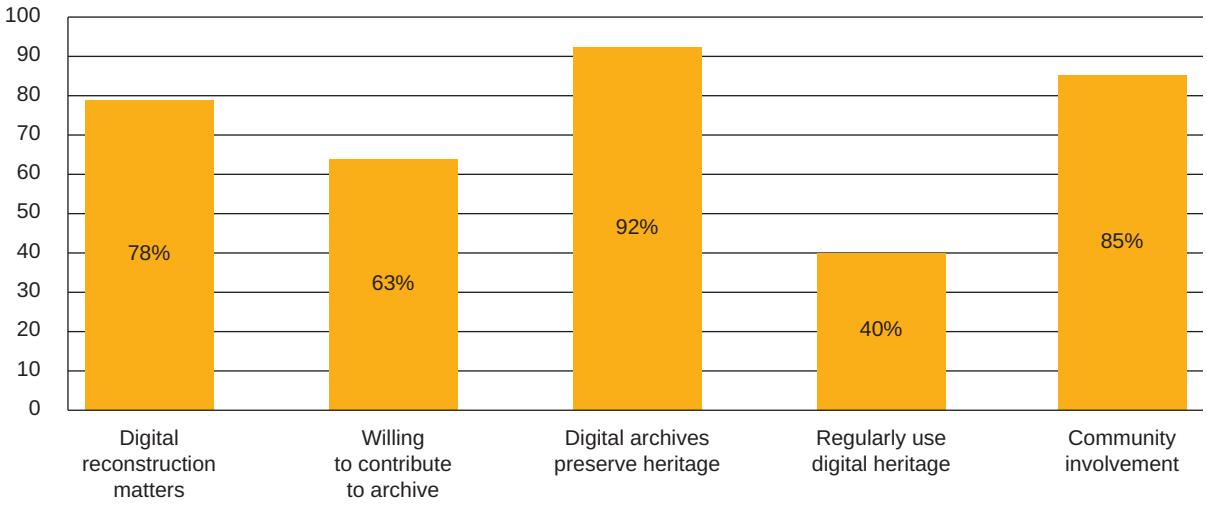


**Figure 1**. Perception of Cultural Memory and Digital Engagement (n = 312)

Source: Authors' elaboration.

Ninety-two per cent of respondents agreed that digital archives are vital for preserving the city's heritage (Statement A). During the war, buildings and monuments were destroyed, and digital records provided solace that 'they won't be forgotten even if gone'. Eighty-five per cent agreed that

community involvement is important in memorial efforts (Statement B). This shows strong support for participatory approaches: people want to shape how their city remembers rather than leaving it to authorities. Comments included ‘Every family has a story from this war – we should share those on some platform’ and ‘Volunteering for a heritage project would help me feel connected to the rebuild’.

The attitude–behaviour gap is visualised in Figure 2.

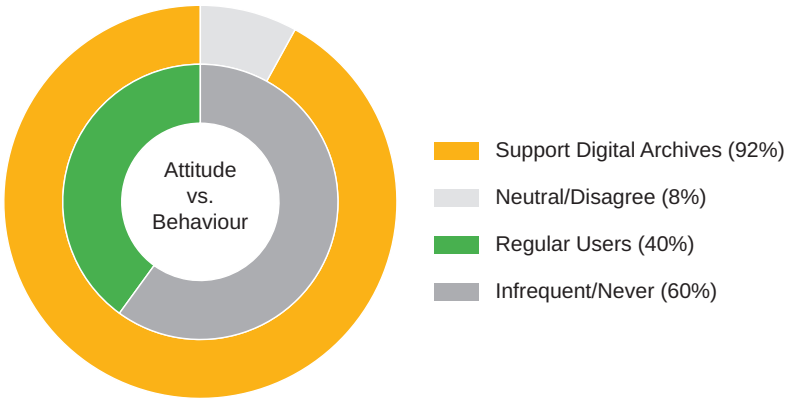


**Figure 2.** Attitude–Behaviour Gap in Digital Heritage Engagement (n = 312)

Source: Authors’ elaboration.

Regarding current personal engagement (Statement C), 40% of respondents reported using digital resources to learn about local history, while one-third rarely engage with such resources. Despite recognising the importance of preserving digital heritage, many do not access this content due to a lack of awareness, time, or engaging material. Those under 30 are more likely to use digital media (55%) compared to those over 50 (25%), showing a generational gap. A $\chi^2$ test confirmed the association between age group and digital-archive use ($\chi^2 = 18.4$, df = 1, $p < 0.001$; younger = 86/156 vs older = 29/156). Interest in digital reconstruction (Statement D) is high, with 78% of respondents supporting it. This shows demand for virtual reality reconstructions and 3D walkthroughs of historic sites. Respondents expressed interest in viewing the historic central square and pre-war buildings, with older participants supporting these initiatives for the benefit of future generations.

Sixty-three per cent agreed to share memories or archives. About half have photographs of the city before its destruction, and 70% possess local history stories that have not been recorded. Over 80 respondents provided contact details for future digital projects. Those hesitant cited a lack of trust in how the material would be used or insufficient digital skills. When asked about the greatest losses to Zaporizhzhia’s cultural identity, 45% chose ‘historic buildings and sites’, 30% ‘community traditions’, 15% ‘archives and museums’, and 10% ‘family histories’. Damage to the built environment ranked highest. Physical memorials (70%) and digital ones (65%) received strong support. Half of the respondents had visited online war-related or Ukrainian history resources recently.

Respondents’ ranking of perceived cultural losses is shown in Figure 3.

Scholars agree that integrating cultural memory into the urban fabric is essential for Zaporizhzhia’s reconstruction. Urban planners, museum directors, and technologists envision a Culture and Memory module in the city’s smart-services portal, combining digitised museum records, evacuee documents, and photo maps. This would enable residents to access AR overlays of lost facades and veterans’ narratives. The digital hub relies on citizen participation through ‘Memories Drive’ workshops, oral-history projects, and mobile digitisation units, transforming personal artefacts into public resources while helping communities heal.

Four structural risks exist. First, damaged power grids require open-standard hosting and dedicated maintenance budgets to prevent digital deterioration (Dinh, 2024; Oliver, 2016). Second, hybrid warfare makes the repository vulnerable, requiring strong cybersecurity measures to guard against hacking (Neglia, 2024). Third, in a bilingual, multi-ethnic city, memory is contested, necessitating diverse narratives and trauma warnings. As one curator noted, ‘history is complex – our

archive should mirror that complexity'. Finally, the digital divide affecting older or rural populations needs complementary outreach through exhibitions, photobooks, and storytelling circles.

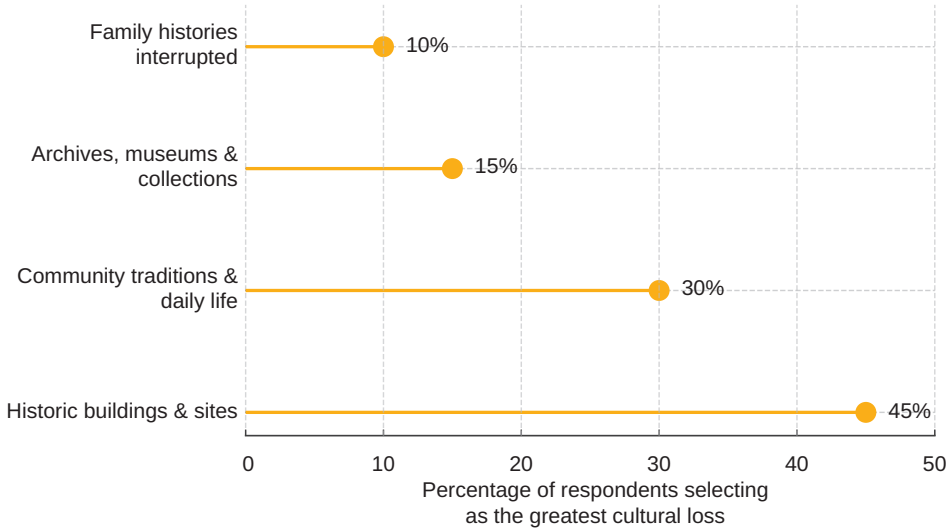


**Figure 3.** Perceived Cultural Losses in Zaporizhzhia

Source: Authors' elaboration.

To implement visionary concepts, experts recommend heritage clauses in reconstruction legislation, a Digital Heritage Unit, and blended funding from municipal budgets, donors, and technology partners. An AI firm has offered cloud capacity and analytics (Culverwell, 2024). They emphasise collaboration with UNESCO, ICOMOS, and university digital-humanities labs to adhere to global standards (Neglia, 2024). The national 'Culture 2025–2030' forum, including Zaporizhzhia officials, serves as a platform where planners, IT teams, and archivists incorporate memory checkpoints into permits and maintain digital records of historically significant sites (Onysko, 2025).

## Discussion

The empirical findings illuminate how communities conceptualise cultural memory preservation through digital infrastructure during active conflict, while highlighting practical constraints that limit generalisation beyond Zaporizhzhia's specific context.

Survey results demonstrate that 92% of Zaporizhzhia residents consider digital archives vital for heritage preservation, aligning with cultural memory theory's emphasis on deliberate preservation when living memory faces erasure threats (Assmann, 2008; Nora, 1989). Russian bombardment destroys both physical structures and the spatial frameworks through which collective memory operates, supporting Halbwachs' (1992) theory that memory requires material anchors in urban landscapes. Digital archives can provide alternative frameworks when these anchors disappear due to destruction or occupation.

War compresses the typical generational transition from communicative memory (eyewitness accounts) to cultural memory (institutionalised records). Survey respondents' willingness to contribute materials (63% agreeing to share photographs and oral histories) suggests recognition that immediate digital preservation is necessary before witnesses are displaced or lost (ICA, 2024). However, current engagement levels remain modest, with only 40% actively using digital historical resources, revealing significant attitude–behaviour gaps. This indicates that cultural memory preservation requires institutional design that actively addresses barriers – including lack of awareness, time constraints, security concerns, and insufficient digital literacy among older populations – rather than relying on intrinsic motivation alone (Cameron & Kenderdine, 2007).

The integration of digital heritage within smart city infrastructure represents a distinctive theoretical intersection. Kitchin's (2014) critical framework emphasises how urban datafication creates

power dynamics requiring attention to data sovereignty, concerns that intensify in wartime contexts. Expert interviews revealed substantial cybersecurity anxieties, with municipal IT consultants explaining that 'any system we build becomes a potential target – not just from hackers but from state-level cyber warfare capabilities'. Hollands' (2008) distinction between entrepreneurial smart cities prioritising economic growth and progressive approaches emphasising social equity proves particularly relevant. Zaporizhzhia's approach integrates cultural memory into smart city planning rather than treating heritage as secondary, suggesting movement towards 'memory-centric smart city' models, although this integration remains aspirational rather than fully implemented, given funding constraints and wartime disruptions.

Comparative post-conflict cases reveal both parallels and divergences with Zaporizhzhia's experience. Warsaw's post-World War II reconstruction achieved cultural continuity through meticulous research and community participation (Murzyn-Kupisz, 2013) but occurred after the conflict had ended and with substantial state investment, contrasting sharply with Zaporizhzhia's need to plan during ongoing bombardment. Beirut and Sarajevo's experiences demonstrate tensions between rapid commercial reconstruction and commemoration (Bevan, 2006; Macdonald, 2013), with expert interviews showing Zaporizhzhia professionals' awareness of these dynamics. However, Zaporizhzhia's digital-first preservation approach has no direct precedent in these historical cases, limiting comparative applicability while potentially establishing new models.

Several empirical limitations constrain generalisability. First, online survey distribution likely underrepresents digitally excluded populations, potentially overestimating engagement levels; the 40% current engagement figure may therefore represent an upper bound rather than an accurate population-wide estimate. Second, a cross-sectional design captures attitudes during ongoing conflict but cannot determine whether patterns will persist after the war. Third, the sample of 312 residents and ten experts provides valuable insights but cannot comprehensively represent the full spectrum of community perspectives. Fourth, research was conducted while reconstruction planning remains aspirational; whether Zaporizhzhia will successfully execute its digital heritage vision cannot be determined from the current data.

Despite limitations, the research provides empirical documentation of community attitudes towards digital heritage preservation during conflict rather than after it, an understudied temporal phase. Mixed-methods triangulation reveals convergence between public attitudes and expert recommendations around participatory approaches, while highlighting divergences between community engagement desires and institutional capacity realities. The theoretical integration of cultural memory studies, digital heritage scholarship, and smart city theory within a single analytical framework demonstrates how these often-separated domains intersect in reconstruction planning, potentially informing future post-conflict urbanism research. Integration with Ukrainian national frameworks shows that, although Zaporizhzhia officials participate in 'Culture 2025–2030' forums, translating national frameworks into operational city-level systems remains challenging.

The proposed National Digital Museum initiative offers potential integration pathways, but interoperability standards and governance structures remain incompletely specified (Onysko, 2025). Future research should track Zaporizhzhia's implementation longitudinally, examine digital heritage approaches across multiple Ukrainian cities, and measure actual effectiveness on identity formation, remembrance practices, and knowledge transfer. These are questions that our methodology could not address but which require validation.

## Conclusion

This study examined the role of digital archives in preserving cultural memory during Zaporizhzhia's wartime reconstruction through mixed-methods research combining surveys of 312 residents with interviews of ten experts. Rather than demonstrating successful implementation, our research documents planning processes, community attitudes, and institutional aspirations during active conflict, when reconstruction remains prospective. Survey results show strong conceptual support – 92% of respondents consider digital archives vital for heritage preservation – alongside modest actual engagement, with only 40% currently using digital resources.

This attitude–behaviour gap indicates that translating conceptual support into active participation requires institutional design that addresses awareness gaps, time constraints, security concerns, and digital literacy barriers. Expert interviews converged on integrating cultural memory into urban planning frameworks through Culture and Memory modules within smart city platforms, but also identified structural challenges, including damaged infrastructure, cybersecurity vulnerabilities, contested memory dynamics in multi-ethnic contexts, and digital divides affecting older populations. Our empirical contributions include documenting public attitudes towards digital heritage during active conflict – an understudied temporal phase – demonstrating through triangulation both convergence and divergences between community desires and institutional capacities, and theoretically integrating cultural memory studies, digital heritage scholarship, and smart city theory to propose 'memory-centric smart city' models where infrastructure serves both functional and commemorative purposes.

However, limitations constrain generalisability. Online recruitment may overrepresent digitally engaged populations; a cross-sectional design cannot predict behavioural persistence beyond wartime urgency; and the research focuses on a single Ukrainian city with specific characteristics, limiting transferability. Based on empirical findings, we recommend specific immediate actions implementable during ongoing conflict, including establishing a Municipal Digital Heritage Unit with dedicated staff (digital archivist, community coordinator, technical administrator); launching pilot digitisation workshops at three locations to address digital divide concerns; developing minimal viable product platforms with georeferenced maps and simple upload portals; and securing short-term funding through UNESCO emergency programs and EU grants (approximately 50,000–100,000 US dollars for initial pilots).

Medium-term post-war actions should integrate heritage infrastructure into existing smart city platforms developed through the 2021 International Finance Corporation investment; implement governance frameworks that balance archival standards with community participation (advisory boards with historians, archivists, community representatives); develop complementary physical memorialisation using QR codes and AR markers; and align with Ukraine's National Digital Museum framework while preserving municipal autonomy. These recommendations go beyond what our data definitively validate and require iterative refinement during implementation. Transferability to other Ukrainian cities and post-conflict contexts requires adaptation, given contextual differences such as damage severity, heritage profiles, technological foundations, and displacement patterns. The ultimate assessment of whether digital archives effectively preserve cultural memory during smart city reconstruction awaits future research evaluating implemented systems and measuring long-term impacts that current conditions prevent determining.

This study provides foundational documentation of possibilities and challenges, rather than demonstrated successes or validated models, establishing a baseline for future longitudinal research tracking implementation fidelity, outcome achievement, and contextual factors affecting success as Ukraine rebuilds.

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