ISPRS Annals of the Photogrammetry, Remote Sensing and Spatial Information Sciences, Volume X-M-2-2025
30th CIPA Symposium "Heritage Conservation from Bits:
From Digital Documentation to Data-driven Heritage Conservation", 25–29 August 2025, Seoul, Republic of Korea

Educational Strategies for Digital Documentation in Southeast Asian World Heritage Cities: Implementing the HUL Approach

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Keywords: Historic Urban Landscape (HUL) Recommendation, Digital Documentation, Educational Strategies, Capacity Building, Sustainable Heritage Management, Institutionalization, Southeast Asian Heritage Cities, Community Engagement.

Abstract

This study addresses the gap between rapid digital documentation adoption and inadequate educational and institutional frameworks in Southeast Asian World Heritage cities. Integrating UNESCO's Historic Urban Landscape (HUL) Recommendations with digital documentation technologies, this research analyzes case studies from Huế, Ayutthaya, George Town, and Vigan. Findings reveal disparities in local capacities and institutional maturity primarily due to dependency on external expertise and short-term interventions. Consequently, the study advocates structured educational curricula, robust institutional frameworks, certification systems, dedicated regional training institutions, and international collaboration networks to ensure sustainable, locally driven heritage management. This approach fosters resilience, empowering local communities through comprehensive education, adaptive governance, and sustainable preservation aligned with HUL principles.

1. Introduction

1.1 Research Background and Purpose

World Heritage cities are not merely collections of historic sites but complex urban landscapes characterized by multilayered historical contexts and cultural identities. These urban environments represent "living heritage," intrinsically linked to the daily lives and traditions of local communities. Southeast Asia, in particular, is home to numerous multicultural heritage cities, including Huế, Luang Prabang, and Ayutthaya, all recognized as UNESCO World Heritage Sites due to their integrated historical, architectural, and landscape values. However, rapid urbanization, large-scale tourism developments, climate change, and natural disasters increasingly threaten the sustainability of these heritage cities, highlighting the inadequacy of traditional conservation approaches focused solely on physical preservation.

Responding to these emerging challenges, UNESCO introduced the Historic Urban Landscape (HUL) Recommendation in 2011, proposing a holistic paradigm for understanding and managing urban heritage. This approach moves beyond traditional preservation practices by incorporating broader considerations, outlined as follows:

1) Integrated Approach: Comprehensive consideration of tangible and intangible heritage, natural environments, and urban functionality.
2) Context-based Sustainable Management: Emphasis on preserving regional cultural contexts while fostering sustainable urban development.
3) Community Engagement: Inclusive governance structures that encourage participation from diverse stakeholders.
4) Utilization of Science and Technology: Effective heritage documentation and management through advanced technological tools, including Geographic Information Systems (GIS), digital mapping, and online platforms.

In essence, the HUL approach reframes heritage not as static relics but as dynamic resources capable of evolving within their local contexts. It advocates for sustainable urban heritage management, heavily emphasizing community involvement and technological integration (UNESCO, 2011). Within this framework, digital technologies play a crucial role by facilitating data collection, policy development, and participatory heritage management strategies (Roders & Bandarin, 2019).

Digital documentation supports sustainable preservation and restoration by accurately capturing the form, structure, and changes of heritage assets. It further expands heritage's public value by connecting with diverse fields such as tourism, education, and policy-making. Nevertheless, effective implementation requires more than mere technical training. Currently, digital documentation projects in many heritage cities are heavily dependent on external expertise, a challenge clearly highlighted in ICCROM's report, *The Digital Imperative (ICCROM, 2021)*, which emphasizes the urgent need for building robust local capacities to achieve sustainable digital heritage management. Consequently, establishing a localized educational system emerges as a critical issue for achieving sustainable digital transformation in World Heritage cities. Addressing this imperative, this paper investigates the necessary educational strategies.

1.2 Study Scope and Methodology

This study integrates UNESCO's HUL Recommendations with digital technology and educational strategies, aiming to propose a viable structure for digital documentation education in Southeast Asian World Heritage cities. Specifically, the research comprises the following methodological steps:

This contribution has been peer-reviewed. The double-blind peer-review was conducted on the basis of the full paper.
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First, it examines foundational documents such as the HUL Recommendations and recent reports, notably The Digital Imperative and The Sustainability Test from the International Centre for the Study of the Preservation and Restoration of Cultural Property (ICCROM), to identify intersections between digitally-driven heritage management and educational practices.
Second, it analyzes case studies of digital documentation initiatives in prominent Southeast Asian heritage cities, such as Huế (Vietnam), Ayutthaya (Thailand), and Luang Prabang (Laos), evaluating their technological application and educational integration.
Third, based on these analyses, it proposes a contextualized educational framework for digital documentation, aligning education, policy, and governance.

This paper thus positions digital documentation not merely as a technological adoption but as a strategic educational tool to actualize integrated urban heritage management principles envisioned by UNESCO's HUL Recommendations, exploring its feasibility and practical implementation strategies.

2. Theoretical background: Aligning hul recommendations with digital documentation training

2.1 The HUL Recommendations and the Role of Digital Technologies

UNESCO's Historic Urban Landscape (HUL) Recommendation (2011) conceptualizes World Heritage cities as dynamic, multi-layered urban environments, advocating for an integrated approach that encompasses community identity, social values, urban planning, and the natural environment. This approach departs from traditional conservation methods, which primarily focus on physical preservation, and instead views heritage as an evolving representation of historical layering and local identities. It aims to harmonize conservation with sustainable urban development by emphasizing adaptability and inclusivity (Roders & Bandarin, 2019).

The HUL Recommendation explicitly emphasizes the strategic use of digital technologies. In particular, Article 27 identifies Information and Communication Technologies (ICT) as essential tools for documenting, analyzing, visualizing, and presenting the complex historical layers and urban components to diverse stakeholders:

"Encourage the use of information and communication technology to document, understand, and present the complex layering of urban areas and their constituent components. The collection and analysis of this data is an essential part of the knowledge of urban areas. To communicate with all sectors of society, it is particularly important to reach out to youth and all under-represented groups in order to encourage their participation." (UNESCO, 2011, Article 27)

Accordingly, this study adopts a modular digital documentation framework that systematically combines three core components:
(1) **Data Acquisition Tools:** Utilizing LiDAR scanning, terrestrial photogrammetry, and UAV-based aerial documentation to accurately capture spatial and temporal dimensions of heritage sites.
(2) **Data Management and Preservation Protocols:** Applying structured metadata tagging protocols and standardized data formats to ensure interoperability, long-term preservation, and secure access.
(3) **Community Engagement and Interpretation Tools:** Leveraging GIS-based mapping platforms and interactive VR/AR applications to facilitate participatory heritage management, community education, and stakeholder collaboration.

Such documentation provides essential baseline data necessary for effective scenario planning, strategic urban management, and long-term monitoring. In particular, quantitative documentation and longitudinal analyses underpin the monitoring frameworks recommended by the HUL approach, enabling proactive heritage management practices.

Furthermore, digital technologies significantly enhance community engagement and governance—a core principle of the HUL Recommendations. For example, immersive virtual reality (VR) and augmented reality (AR) experiences can improve public understanding and appreciation of heritage values. Additionally, digital platforms support inclusive stakeholder participation and democratic governance. Consequently, digital documentation initiatives aligned with community participation contribute to realizing the shared vision promoted by the HUL Recommendations.

Digital technologies, therefore, are strategically integrated into the HUL framework as essential tools that operationalize its principles. Specifically, 3D scanning and photogrammetry enable precise documentation aligned with context-based sustainable management, while interactive digital platforms support inclusive community engagement and governance processes advocated by HUL. Challenges such as disparities in technological infrastructure, inadequate long-term data preservation strategies, and the digital divide underscore the need for specialized training and local capacity-building to integrate digital technology effectively into community-based contexts.

2.2 Digital Documentation Training as a Foundation for Sustainable Heritage Management

Southeast Asia hosts numerous UNESCO World Heritage cities characterized by complex histories and rich cultural landscapes. Notable examples include the imperial architecture of Huế (Vietnam), the Buddhist cityscape of Luang Prabang (Laos), and the ancient temple ruins of Ayutthaya (Thailand) (UNESCO Bangkok, 2020). Despite their global significance, these cities are increasingly threatened by rapid urbanization, tourism pressures, climate-related disasters, and urban sprawl. Traditional conservation approaches, primarily focusing on physical restoration, are proving insufficient to manage these multi-dimensional challenges.

In response, digital documentation emerges as a strategic approach capable of performing diverse and critical roles, including precise site documentation, tracking changes and deterioration, assessing risks, and informing restoration and conservation strategies. Advanced methods such as drone-based aerial photography, photogrammetry, LiDAR scanning, and GIS-integrated platforms offer comprehensive data essential for informed urban planning, policy formulation, and effective disaster response. Additionally, digital documentation generates engaging content through simulations, virtual heritage experiences, and immersive metaverse platforms, thereby enhancing public understanding and appreciation of heritage values.

However, digital documentation efforts in Southeast Asian World Heritage cities currently remain predominantly short-term and externally driven. This dependency results in limited sustainable local capacity to manage, maintain, and effectively utilize digital heritage data. The principal challenge is not a lack of

technological resources but rather the insufficient local expertise and inadequate institutional structures required for long-term sustainability. Therefore, establishing robust, locally-driven training programs in digital documentation is imperative for realizing the sustainable heritage management envisaged by the HUL Recommendations.

Recognizing this necessity, the HUL Recommendations explicitly underline capacity-building and educational institutionalization as fundamental prerequisites. Specifically, Article 27 emphasizes integrating science and technology training with active participation from local communities and professionals. Complementing this stance, ICCROM's 2023 report, The Digital Imperative: Envisioning the Path to Sustaining our Collective Digital Heritage, identifies critical competencies required for digital sustainability, including strategic content collection, metadata infrastructure, interoperability, ethical data management, adaptive responses to technological evolution, and interdisciplinary collaboration (ICCROM, 2021). Likewise, ICCROM's Sustainability Test provides a structured self-assessment framework focused on service orientation, operational scalability, value creation, and impact measurement, directly informing comprehensive digital heritage training curricula(ICCROM, 2023).

Consequently, digital documentation education in Southeast Asia should extend beyond technical training and strategically incorporate three key dimensions:

Firstly, it should enhance digital literacy among local stakeholders, reducing dependency on external projects and empowering local actors to independently manage heritage data collection, processing, and utilization.
Secondly, training programs must embed cultural context awareness and foster skills in community collaboration, aligning digital documentation practices with the integrated heritage management philosophy outlined in the HUL Recommendations.
Finally, educational initiatives should be systematically integrated into local governance frameworks, ensuring that digital documentation education becomes a sustainable component rather than a transient intervention within heritage management practices.

In summary, digital documentation training represents a strategic mechanism to operationalize the integrated heritage management advocated by the HUL Recommendations. By aligning technology, policy, and education within a coherent and localized educational framework, this study aims to establish a robust institutional foundation for sustainable digital heritage management tailored specifically to Southeast Asian World Heritage contexts.

3. Digital documentation and institutionalized education in southeast asian world heritage cities: Current status and case studies

Digital documentation is not only essential for heritage preservation but also a fundamental component of sustainable heritage management and policy-making in World Heritage cities. Advanced technologies such as 3D scanning, UAV (drone)-based documentation, LiDAR, photogrammetry, and GIS-based mapping significantly contribute to monitoring structural integrity and landscape conditions, enabling effective long-term comparison and restoration efforts. However, the level of technology adoption and local human capacity varies widely across Southeast Asia, and educational and training frameworks for digital documenation remain at a nascent stage. Below are recent examples of digital documentation and institutionalized educational efforts in World Heritage cities in Southeast Asia.

3.1 Vietnam - Huế (Complex of Huế Monuments)

In Southeast Asia, Huế has emerged as a frontrunner in digital documentation and public engagement. The Hue Monuments Conservation Centre (HMCC) has partnered with South Korea's UALS Co., Ltd. to conduct extensive 3D scanning and digital photography of the Thai Hòa Palace—restored at a cost of VND 129 billion—with the goal of completing a comprehensive, Vietnamese and international standard-compliant digital archive by mid-2026. To maintain public engagement during restoration, HMCC deployed QR-code and virtual reality (VR)-based virtual tours, enabling remote visitor access to the palace.

Figure 1. Digital documentation at Thai Hoa Palace

In May 2024, HMCC collaborated with Phygital Labs and HueCIT to digitize ten Nguyen Dynasty artifacts, unveiling Vietnam's first metaverse cultural exhibition. This platform—available at museehue.vn—utilizes NFC tags (Nomion technolo-gy) and blockchain to provide encrypted, interactive, Apple Vision Pro compatible experiences for users.

These advanced technological initiatives have been complemented by structured efforts to institutionalize local digital heritage education. This marks a shift from the previous NGO-driven, ad hoc training prevalent from 2018 to 2020, toward an institutionalized, sustainable educational framework. In 2024, HMCC was awarded the Vietnam Digital Transformation Award and launched a comprehensive digital ecosystem—including e-ticketing, digital archives, and 360° VR tours—embedded directly into heritage site management Vietnam+ (VietnamPlus, 2024).

Figure 2. Vietnam's First Metaverse Cultural Exhibition Space

Education and capacity-building have been central to Huế's strategy. Since late 2023, HMCC has worked with Thừa Thiên–Huế University, HueCIT, and the Vietnam Computer Society to deliver biannual modular workshops on photogrammetry, XR content

production, and digital asset management. These locally led programs reflect ICCROM’s recommendations for strength-ening digital heritage skills (ICCROM, 2021). Through integrating advanced technologies (3D imaging, VR/XR, metaverse, NFC/blockchain) with structured local education and institutional support, Huế has fostered a self-sustaining digital heritage ecosystem. This model closely aligns with the principles of community engagement, accessibility, and participatory heritage governance emphasized in UNESCO's HUL framework.

3.2 Thailand - Ayutthaya (Historic City of Ayutthaya)

In Ayutthaya, digital documentation initiatives are led by collaborative international projects, including UNESCO Bangkok, the Fine Arts Department of Thailand (FAD), and CyArk, which conducted **laser scanning and photogrammetry of key sites like Wat Phra Si Sanphet** to create accurate 3D models for public use and heritage monitoring. While these initiatives significantly contribute to data acquisition and raise public awareness, the **reliance on international expertise** creates challenges in maintaining local technical capacity and continuity after project completion.

To strengthen regional capacity, the FAD, UNESCO, and regional partners have organized workshops for site managers and archivists from ASEAN heritage cities, focusing on emergency record-saving techniques, metadata organization, and cataloguing practices. These activities produced the Ayutthaya Records Preservation Facility, built under UNESCO guidance in 2025 **to protect and manage heritage records more effectively, especially in emergency situations such as flooding,** and to centralize architectural plans, archaeological notes, AutoCAD files, and archival images, ensuring alignment with international archival standards.

However, to sustain these archival and documentation capacities over the long-term, it is essential to integrate digital documentation systematically into local educational institutions and professional practices. The FAD has embedded digital documentation into formal education systems—local universities now include hands-on 3D scanning in fieldwork, and ASEAN professional networks have emerged from workshop participants. Further steps, such as developing standardized curricula and establishing regular professional training programs at local universities and cultural institutions, remain essential objectives.

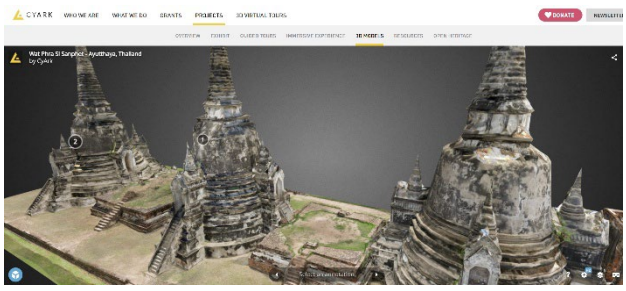

Figure 3. 3D models of Wat Phra Si Sanphet (Cyark) (https://www.cyark.org/projects/ayutthaya/3D-Explorer)

3.3 Malaysia - George Town (Melaka and George Town, Historic Cities of the Straits of Malacca)

In George Town, digital documentation has significantly advanced under a UNESCO Heritage regeneration program led by Think City, an urban placemaking institute founded in 2009 under Khazanah Nasional, with support from international partners including the Aga Khan Trust and the Getty Conservation Institute. One key initiative was the comprehensive 3D scanning of the restored Syed Al-Attas Mansion, conducted by Maitree and Cahaya XR using Matterport Pro technology. The resulting digital twin and interactive virtual tour effectively broaden public access and enhance heritage interpretation. To communicate the city’s multicultural identity more effectively, Think City and George Town World Heritage Incorporated (GTWHI)—a state-created heritage management body since 2010—have digitized archival collections and developed interactive AR/VR exhibitions. These initiatives harnessed immersive media to enhance visitor experience and promote deeper engagement with the city’s cultural narratives.

Community-based education plays a central role in sustaining these innovations. Regular workshops in photogrammetry, digital storytelling, and heritage documentation techniques are offered to youth and volunteers, supported through initiatives like Cahaya XR’s XR mentorship linked to the George Town Festival since 2022. Plans are underway to establish a Digital Heritage Hub in George Town, intended to foster ongoing collaboration between tech practitioners and heritage professionals and to institutionalize capacity-building. Despite strong local engagement and technological progress, challenges remain. Formal educational structures and policy integration are necessary to ensure long-term sustainability and scalability. Additionally, given the region’s susceptibility to natural disasters, robust and resilient documentation systems capable of rapid response are crucial for safeguarding heritage assets.

Overall, George Town exemplifies a successful transition from externally driven digital heritage initiatives toward locally led documentation efforts and educational institutionalization. However, further integration of these initiatives into formal academic curricula and city heritage policies remains essential for ensuring long-term sustainability and resilience.

Figure 4. 3D models of Syed Al-Attas Mansion (Think City) (https://my.matterport.com/show/?m=Ko4Y1vYMChr)

3.4 Philippines - Vigan (Historic City of Vigan)

In Vigan, the local government has proactively invested in digital documentation and educational infrastructure to con-serve its well-preserved Spanish colonial heritage. As high-lighted by UNESCO, the city recently acquired its own 3D laser scanner for built-environment documentation, specifically to enhance disaster risk reduction and heritage preser-vation capabilities.

Following a major earthquake in 2023, Vigan initiated a digital documentation project supported by the UNESCO–ICOMOS

Heritage Emergency Fund in October–November 2023. Led by Digiscript, the project prioritized damage assessment and capacity-building, conducting 3D laser scanning of heritage structures, including Syquia Mansion and the Cabildo Old House, to generate precise as-built documentation. The accompanying training workshop engaged 11 local stakeholders representing the University of Northern Philippines, Vigan City government, and the United Architects of the Philippines–Ilocos Chapter (UAP-ICF), equipping them with practical laser-scanning skills using Leica RTC360 and essential digital documentation techniques for future restoration and disaster recovery efforts.

Figure 5. Using RTC360 for 3D documentation of the Syquia Mansion (Digiscript) (https://philippines.icomos.org/2023/12/06/)

This collaborative initiative, overseen by UNESCO Jakarta and ICOMOS Philippines, underscores a significant shift from externally driven interventions toward locally empowered heritage practices, embedding technical expertise within university, municipal, and professional planning frameworks. The provision of equipment and targeted training has not only improved Vigan’s heritage documentation capabilities but also fostered a nascent local expertise network capable of independently maintaining and expanding digital heritage practices. For instance, the skills and documentation produced through the project are now systematically integrated into municipal heritage management practices and are being utilized by local academic curricula to ensure sustained institutional capacity. This initiative was critical for immediate post-disaster assessment and recovery planning and underscored the necessity of pre-existing, institutionalized local capacity in digital documentation for both emergency response and routine heritage management.

Challenges in Digital Documentation: Towards Educational Institutionalization

From the analysis above, it is evident that digital documentation efforts across Southeast Asian World Heritage cities display diverse levels of technological adoption and institutional maturity. While Huế and George Town have successfully transitioned towards sustainable and institutionalized local frameworks, Ayutthaya and Vigan still face considerable challenges due to their ongoing dependency on external expertise and short-term project cycles. These differences highlight critical gaps that must be addressed to achieve long-term sustainability in digital heritage management.

Commonly identified challenges across these cases include:
1) Insufficient local expertise for managing and utilizing digital heritage data sustainably.
2) Operational discontinuity upon completion of externally-funded projects.
3) Lack of institutionalized frameworks integrating digital documentation into formal curricula.
4) Inadequate standards and strategies for long-term data preservation and security.

These challenges underscore the urgent need for institutionalizing and localizing digital documentation education as a prerequisite for effectively implementing UNESCO’s HUL Recommendations. Addressing these gaps is critical for transitioning toward sustainable heritage management driven by empowered local actors.

These identified gaps in local capacity and institutional sustainability clearly resonate with UNESCO’s HUL Recommendations, particularly Articles 25 and 26, which directly advocate for robust educational infrastructure and sustained research initiatives as core elements of heritage management.

Article 25 emphasizes integrating capacity-building into all aspects of heritage planning and management, highlighting the essential role of local and national institutions:
"Capacity-building should be integrated into all planning and implementation processes in order to provide all stakeholders—community members, policy makers, decision makers, professionals, and managers—with the necessary values, skills, and knowledge to support the implementation of the historic urban landscape approach. Particular emphasis should be placed on capacity-building for local and national institutions in order to ensure long-term sustainability and effective implementation of the proposed actions." (UNESCO, 2011)
Article 26 highlights the importance of academic research to deeply understand and comprehensively manage urban heritage:
"Research should target the complex layering of urban settlements to identify values, understand their meanings for communities, and present them comprehensively to visitors. Academic and research institutions should be encouraged to develop scientific research on aspects of the historic urban landscape approach and to cooperate at local, national, regional, and international levels." (UNESCO, 2011)

In summary, UNESCO’s HUL Recommendations explicitly prioritize sustainable growth through educational institutionalization and capacity-building rather than technology adoption alone. Therefore, prioritizing digital documentation education as a foundational strategy not only addresses immediate operational challenges but also ensures a resilient and self-sustaining heritage management system, firmly rooted in local expertise and aligned with international best practices.

4. Recommendations for sustainable digital heritage management

Building upon the conclusions drawn in Chapter 3 regarding the critical challenges facing sustainable digital heritage management in Southeast Asian World Heritage cities, this chapter presents concrete recommendations. These recommendations outline specific strategies for enhancing digital documentation education and establishing the necessary institutional and operational frameworks to ensure long-term sustainability. Grounded in the

principles of UNESCO's Historic Urban Landscape (HUL) Recommendations, these proposals aim to foster locally-driven, integrated heritage management practices that address the identified gaps in local expertise, institutional capacity, and governance structures.

4.1 Educational Strategies and Training Action Plan

To address the identified gaps in local expertise and training frameworks, this section outlines a strategic action plan focused on the content and approach of digital documentation education. The HUL Recommendations explicitly emphasize leveraging science and technology, community participation, and capacity building as essential components for the sustainable management of heritage cities. Aligned with these core principles, digital documentation training is proposed as a strategic tool for effective HUL implementation through the following specific action steps:

First, training should extend beyond basic technical instruction, cultivating strategic competencies in contextual heritage understanding, data management, and long-term planning. This approach ensures that practitioners can apply digital tools effectively within the complex urban landscape context, understanding the 'why' behind the 'how'.

Second, it is imperative to reduce dependency on external experts by establishing localized training programs that empower local stakeholders, including curators, heritage professionals, institutional staff, and students, to independently manage digital documentation processes. This fosters local ownership, builds indigenous capacity, and enhances the resilience of heritage management efforts.

Third, transition from short-term, project-based training to comprehensive educational frameworks that address the entire lifecycle of digital heritage data—from collection and preservation to utilization—and align closely with local policy and governance frameworks. This ensures continuity, allows for proactive management, and integrates digital documentation into the broader urban development process.

Fourth, develop and implement a practical curriculum incorporating UNESCO’s HUL Recommendations, ICCROM’s digital training guidelines, and relevant tools such as the Evaluation of Heritage (EoH) Toolkit, ensuring integration and field applicability. This structured approach operationalizes the "institutionalization and localization of training" emphasized in Article 27 of the HUL Recommendations, laying a critical foundation for sustainable digital heritage governance by bridging theoretical knowledge with practical application tailored to local needs.

4.2 Institutional and Operational Framework for Sustainability

Beyond the training content, establishing robust institutional and operational measures is crucial for the long-term success and sustainability of digital documentation initiatives. The following recommendations provide a framework for embedding these practices within existing or new structures, ensuring that trained personnel can operate effectively within a supportive ecosystem:

Firstly, introduce specialized digital heritage curricula into formal education programs at universities and vocational schools, effectively integrating cultural heritage management, urban planning, and digital technology disciplines. This formal integration ensures a steady supply of qualified professionals grounded in interdisciplinary knowledge.

Secondly, establish clear educational quality assurance measures by implementing certification systems for digital documentation competencies at national and local government levels. Additionally, securing an independent budget line for digital heritage education ensures sustained investment and quality control, moving beyond reliance on unpredictable project-specific funding and signaling government commitment.

Thirdly, create dedicated digital documentation institutions or regional hubs. Alternatively, expand existing heritage institutions’ functions to encompass specialized digital training and documentation services, reinforcing regional capacity-building and knowledge sharing among cities facing similar challenges and fostering economies of scale.

Fourthly, foster cooperative networks among Southeast Asian countries by collaborating with international organizations such as KOICA, UNESCO, and ICCROM. Joint training programs, knowledge exchange platforms, and sustained partnerships will ensure continuity, consistency, and international alignment in digital heritage practices, facilitating the transfer of best practices and access to resources.

Finally, present digital documentation education not merely as technical training but as an strategic, integrated development model encompassing educational, technological, and policy dimensions. Such a comprehensive approach significantly contributes to establishing robust, locally-driven heritage management systems aligned with UNESCO’s HUL Recommendations. Article 25 and 26 of the HUL Recommendations explicitly underscore the importance of capacity-building, research targeting urban layers, and the essential role of local and national institutions and academic bodies in ensuring sustainability and comprehensive understanding, which these institutional measures directly support.

4.3 Future Research Directions: Focusing on Sustainable Curriculum Design and Implementation

This study has defined a strategic direction and structural framework for digital documentation education aligned with the HUL Recommendations, emphasizing the critical need for localization and institutionalization based on challenges observed in Southeast Asian World Heritage cities. Building upon this foundation, future research should delve specifically into the detailed design, content, and effective implementation strategies for educational curricula that foster sustainable digital documentation practices tailored to the Southeast Asian context.

Key areas for future investigation include:

Firstly, in-depth analysis of the core competencies required for sustainable digital documentation practitioners. This necessitates research to identify and define the blend of technical skills (e.g., specific software/hardware proficiency), strategic thinking, data management expertise, long-term preservation knowledge, ethical considerations, legal awareness, and crucially, abilities in community engagement and contextual understanding within diverse HUL settings.

Secondly, designing and evaluating pedagogical approaches and curriculum content that effectively integrate technical training with cultural heritage values, community engagement principles,

and HUL concepts. Research is needed on developing curricula that utilize active learning methods, problem-based or project-based fieldwork in real heritage sites, participatory approaches involving local communities, and the effective use of digital platforms for both learning and practice.

Thirdly, developing tailored and flexible curriculum models adaptable for different educational levels and target audiences across Southeast Asia. This involves investigating how to best structure learning for formal university programs (undergraduate/postgraduate), vocational training centers, professional development courses for existing practitioners, and informal community-based workshops, ensuring pathways for progression and recognition.

Fourthly, examining the practical challenges and enablers for implementing and sustaining such curricula within the diverse educational and institutional landscapes of Southeast Asian countries. This requires granular, country-specific studies to understand varying levels of technological infrastructure accessibility, educator capacity, policy support frameworks, funding mechanisms, and institutional readiness, in order to develop contextually appropriate implementation strategies.

Finally, developing robust methodologies for evaluating the long-term effectiveness and impact of these educational programs. Research should focus on assessing not just immediate learning outcomes, but how well graduates and trained individuals are subsequently able to initiate, manage, and sustain digital documentation initiatives, contribute to the adaptive management of urban heritage, and facilitate meaningful community participation aligned with the HUL approach in practice.

By focusing on these critical aspects of curriculum design, implementation, and evaluation, future research can provide the essential practical knowledge base required to translate the strategic importance of digital documentation education into actionable, effective, and truly sustainable training programs that empower local actors and contribute significantly to the preservation and management of Southeast Asian World Heritage cities within the dynamic HUL framework.

5. Conclusions

Reflecting on the educational frameworks and institutional recommendations outlined in the preceding chapter, it is clear that common limitations identified across the Southeast Asian cases converge on a central structural issue: current digital documentation practices prioritize short-term outcomes and lack foundational educational frameworks and long-term operational sustainability. Specifically, prevalent barriers include insufficient local expertise, absence of institutionalized training infrastructure, fragmented technology transfer, and inadequate strategies for long-term data preservation.

This study highlights the critical challenge faced by Southeast Asian World Heritage cities, where digital technologies are actively employed yet fail to achieve sustainable heritage management due to inadequate educational frameworks and governance structures. To address these challenges, this research proposes that digital documentation education must serve as a strategic mechanism to implement the integrated heritage management principles outlined in UNESCO's Historic Urban Landscape (HUL) Recommendations. The case studies clearly indicate that despite short-term technological achievements, long-term sustainability remains compromised due to gaps in local capacity, institutional education infrastructure, and integrated governance frameworks. This study, therefore, provides a foundational argument for shifting the paradigm from technology adoption alone to prioritizing the institutionalization and localization of digital documentation education as a cornerstone for achieving sustainable heritage management aligned with the HUL framework in Southeast Asia.

Thus, the recommendations provided—such as establishing specialized digital heritage curricula, implementing certification systems, developing dedicated institutional frameworks, and fostering regional cooperation networks—form essential steps toward resolving these challenges and ensuring the sustainable preservation of Southeast Asian World Heritage cities.

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