

Heritage as a Driver for Resilience: A Four-Dimensional Historic Urban Landscape (HUL) Approach to Cultural Heritage in Urban Development

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Abstract

This study presents a systematically constructed four-dimensional theoretical framework that operationalizes the Historic Urban Landscape (HUL) approach in urban heritage documentation, ultimately fostering urban resilience through cultural heritage preservation. Through rigorous analysis of HUL's theoretical foundations and contemporary urban heritage complexities, we have identified four fundamental characteristics inherent in HUL theory: physical integrity, temporal layering, spatial connectivity, and social participation. These characteristics directly inform the development of our four-dimensional framework comprising individual building, area, time, and perception dimensions, and it offers a systematic, mass-oriented way to capturing and analysing these values. With the help of geographic information System (GIS) and digital information technology, this theoretical framework has been transformed into a practical documentation tool, and on the basis of integrating spatial and non-spatial data resources, dynamic updated cultural heritage information management has been realized. The effectiveness of the framework was then substantially validated through an in-depth case study in Singapore. In general, this research approach can be seen not only as a theoretical support for the historical urban landscape (HUL) approach, but also as a structured approach to urban heritage records. Through a heritage-based development strategy, more efficient, dynamic and comprehensive solutions are provided to further enhance the sustainability and resilience of cities.

Keywords

Urban Heritage, Historic Urban Landscape (HUL) approach, Four-dimensional Heritage Map

1. Introduction

In the contemporary context, the rapid pace of urbanization presents novel challenges and opportunities for the conservation and utilization of urban heritage. As the bearer of urban history and culture, urban heritage plays an increasingly crucial role in fostering urban resilience (Bahrami & Samani, 2015; Ginzarly et al., 2019). However, influenced by the context of rapid urban development and the digital age, the

delicate relationship between heritage and its surrounding environment has also changed. (Rey-Perez & Siguencia Ávila, 2017), which necessitates the implementation of new methods. Traditional conservation methods have primarily focused on the protection of individual historical buildings, but experience has shown that this simplistic approach does not work when attempting to integrate heritage into modern cities. These methods often fail to capture the broader urban context and social dimensions, which are increasingly recognized as important components of heritage value (Bandarin & Oers, 2015). For example, in some urban renewal projects, only focus on the restoration of individual buildings, while ignoring the interaction with surrounding communities and the coordination of the overall environment, resulting in poor protection effects, or has lost its heritage value due to excessive commercialization, and community life has disappeared and become a "theme park" (Lowenthal, 2005; Urry, 1996). The Beijing Dashilar Historic District (Tong et al., 2023), the transformation of Xintiandi in Shanghai (Luo et al., 2022; Zhou et al., 2020), Venice in Italy (Bertocchi & Visentin, 2019; Russo, 2002), and the Old town of Prague (Liu et al., 2022; Soukopová, 2019) all exemplify the aforementioned issues.

In the face of this challenge, the emergence of the Historic Urban Landscape (HUL) approach marks an important turning point in the field of urban heritage conservation. The HUL approach regards heritage as "the result of the historical stratification of cultural and natural values and attributes" (UNESCO 2011, Article 8), thereby expanding the scope of conservation from the traditional concepts of "historic centers" or "wholes" to broader urban areas and their geographical settings. This approach no longer views heritage as a constraint on urban development, but rather as a potential driving force for a sustainable urban future. However, in practical application—especially in systematically documenting and assessing the complex values of urban heritage—the HUL approach still faces challenges, despite its theoretical framework being widely recognized in academia. To support this conceptual evolution, there is a call for the implementation of "document, understand and present the complex layering of urban areas" (UNESCO 2011, Article 27). However, existing documentation methods often address heritage dimensions in an isolation way: Physical documentation focuses primarily on architectural features, spatial analysis remains limited to defined conservation zones, and social values are frequently treated as supplementary rather than integral components (Jones & Leech, 2015). This fragmented approach fails to adequately capture the interconnected nature of urban heritage highlighted by the Historic Urban Landscape (HUL) approach. Although in recent years, some digital technologies have demonstrated their potential in the field of heritage research (Fortenberry, 2019; Karadag, 2023), but there are still significant gaps: The existing research has not been able to fully construct a theory that conforms to the principle of historical urban landscape (HUL) and at the same time can realize the in-depth excavation and record of the multi-dimensional value of urban heritage, and more importantly, promote the sustainable development of heritage imperceptibly. The central challenge from this perspective is how to develop a documentation approach that captures the physical characteristics, spatial relationships, temporal evolution, and social perception of urban heritage, while at the same time, Maintain theoretical coherence with urban heritage principles (physical integrity, temporal stratification, spatial connectivity, and social engagement) (Bandarin & Oers, 2015).

To bridge the gap between theory and practice, this study constructs a four-dimensional documentation framework. Rooted in the Historic Urban Landscape (HUL) approach, this framework systematically records the tangible and intangible values of urban heritage through four dimensions—individual architecture, regional environment, temporal evolution, and social perception. From the construction characteristics of every brick and tile to the spatial texture of community alleys, from the marks of time's passage to the living memories of ordinary people, we anticipate that this theoretical framework will offer a practical and feasible methodological guide for the comprehensive documentation of heritage sites.

The significance of this framework lies in its ability to:

1. Systematically transform HUL theoretical principles into practical documentation methods, providing a new practical path for urban heritage conservation.
2. Integrate multiple dimensions of heritage value within a unified analytical structure, thereby achieving a comprehensive assessment and effective protection of urban heritage value.
3. Achieve comprehensive documentation through digital technology, improving the efficiency and accuracy of documentation.
4. Support evidence-based heritage management decisions, providing a scientific basis for the sustainable development of urban heritage.

Through this research, we hope to provide a new perspective and practical method for the field of urban heritage conservation, to cope with the challenges brought by rapid urbanization and to achieve harmonious integration of urban heritage with modern urban life. (Figure 1)

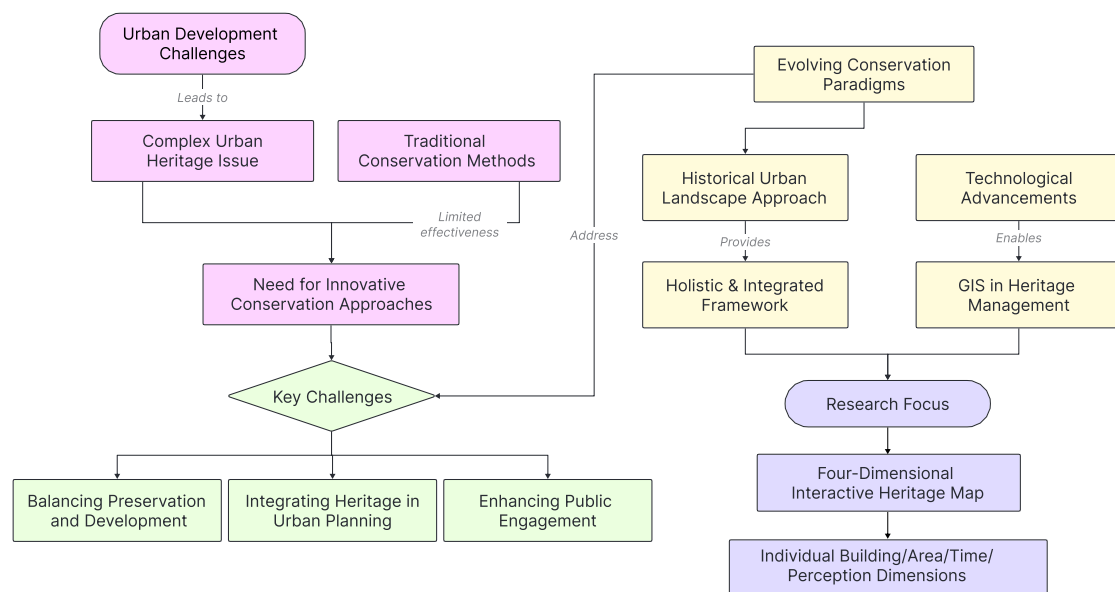


Figure 1. Research Motivation and Methodology Diagram. Source: Authors' own compilation.

2. Theoretical Framework

2.1 Historic Urban Landscape (HUL) approach

The Historic Urban Landscape (HUL) approach recognizes heritage as a potential driver for sustainable urban futures. In November 2011, UNESCO's General Conference adopted the Recommendation on the Historic Urban Landscape (HUL), the first such instrument on the historic environment issued by UNESCO

in 35 years (Figure 2). HUL is defined as "the urban area understood as the result of a historic layering of cultural and natural values and attributes, extending beyond the notion of 'historic centre' or 'ensemble' to include the broader urban context and its geographical setting" (UNESCO, 2011). Rather than replacing existing conservation approaches, the HUL Recommendation serves as an additional tool to integrate heritage conservation into broader urban development goals while respecting diverse cultural contexts. Through the analysis of HUL theory and evolution of heritage regulations, four key characteristics can be identified that guide the development of our four-dimensional heritage mapping framework---Physical Integrity; Temporal Layering; Spatial Connectivity; Social Participation.

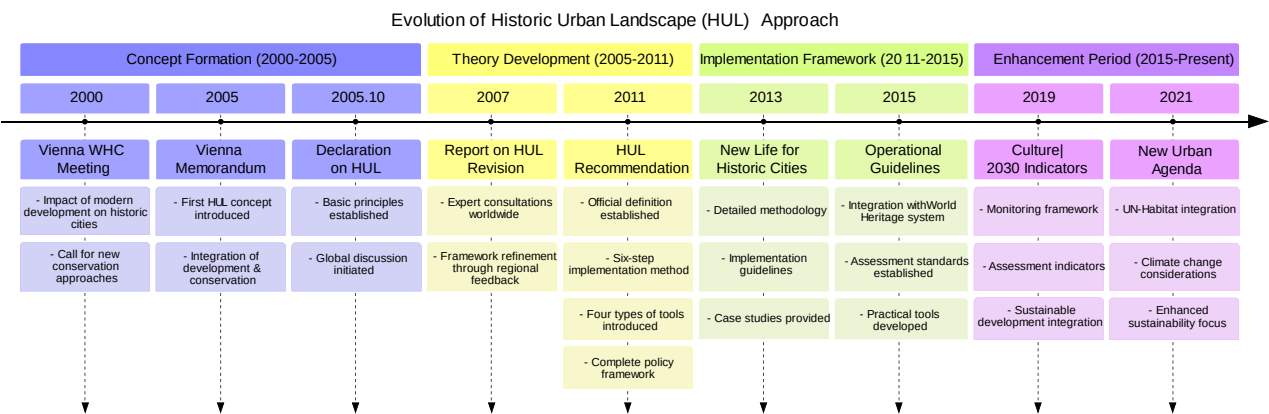


Figure 2. Evolution of Historic Urban Landscape (HUL) Approach. Source: Synthesized from UNESCO's official documents and recommendations. Visualization: Authors.

2.2 Four Key Characteristics of Historic Urban Landscape (HUL) Approach

2.2.1 Physical Integrity

The principle of physical integrity represents a fundamental cornerstone in heritage conservation. This recognition can be traced from the 1931 Athens Charter's initial concern for heritage environments, through Article 6 of the 1964 Venice Charter's clarification of the relationship between heritage and its setting (ICOMOS, 1964), to the 1972 World Heritage Convention's establishment of "integrity" as a core evaluation criterion for World Heritage (UNESCO, 1972), marking the systematization of holistic protection cognition for heritage entities and their environments.

HUL theory inherits and deepens this understanding, specifically emphasizing the holistic characteristics comprising "topography, geomorphology, hydrology and natural features; its built environment... its open spaces and gardens" (UNESCO, 2011). This theoretical development reveals two critical dimensions of physical integrity: first, the protection of authenticity in heritage entities, reflected in the complete preservation of historical information and value carriers; second, the holistic maintenance of environmental elements, emphasizing the inseparability of heritage from its immediate environment. This recognition reflects a basic professional consensus: effective transmission of heritage values must be based on complete physical carriers and their environmental context (Poulios, 2010, 2014).

2.2.2 Temporal Layering

"Temporal layering" emerges as a key characteristic of HUL theory, derived from its fundamental definition of historic urban landscapes as "the result of historic layering." This concept has profound theoretical origins: from the 1964 Venice Charter's emphasis on single-period authenticity, through the 1994 Nara Document's expansion of authenticity understanding, to the 2005 Operational Guidelines' introduction of "cultural continuity," culminating in the 2011 HUL Recommendation's establishment of "historic layering" as a core principle.

"Temporal layering" precisely summarizes this theoretical development, breaking through traditional conservation theory's fixed cognition of specific historical periods and emphasizing cities as organisms continuously accumulating across temporal dimensions. This perspective has gained widespread scholarly support: Bandarin and Van Oers define cities as "continuously evolving organisms" (Bandarin & Oers, 2015) Worthing and Bond emphasize the evolutionary nature of heritage values (Bond & Worthing, 2016), while Poullos's "living heritage" concept further confirms the continuous nature of culture (Poullos, 2010). This profound understanding of historical cities' temporal dimension not only provides new perspectives for evaluating urban historical and cultural values but also establishes theoretical foundations for contemporary historic city conservation and development, enabling us to support reasonable urban evolution while protecting historical values (Ginzarly et al., 2019).

2.2.3 Spatial Connectivity

Spatial connectivity represents a significant breakthrough in HUL theory. The 2011 Recommendation explicitly extends heritage consideration to include the "broader urban context" and "geographical setting," (UNESCO, 2011) expanding conservation vision to larger regional scales. HUL emphasizes that historic urban landscapes constitute spatial systems comprising natural and cultural elements, tangible and intangible components, requiring understanding beyond the limitations of historic centers.

From a spatial dimension, HUL particularly emphasizes the connectivity between heritage and its regional cultural background, social and natural environment (Panjabi & Winter 2009; Bandarin 2015; Taylor 2015). This connectivity manifests in two aspects: first, the organic connections among heritage elements internally; second, the functional connections between heritage and broader urban systems. This regional perspective necessitates attention to heritage sites' cultural position and function within larger spatial contexts, promoting the expansion of conservation concepts from microscopic places to macroscopic regions. As Jones and Leech emphasize, this multi-scalar understanding necessitates comprehending heritage within broader spatial contexts, grasping the network of spatial relationships from individual sites to regional scales (Jones & Leech, 2015).

2.2.4 Social Participation

The principle of social participation stems from HUL's fundamental recognition that heritage values are socially constructed and maintained rather than predetermined professional judgments. This recognition essentially reflects HUL's emphasis on "public common values." Smith's reinterpretation of heritage nature has profound significance: defining heritage as "a social process" where it is "something that people create and use actively to maintain the connections between themselves and other places." (Smith, 2006)

This definition reveals two fundamental characteristics: first, heritage is no longer static physical carriers but a dynamic process embedded in people's daily life practices (Rey-Perez & Siguencia Ávila, 2017); second, heritage protection objects have broken through traditional limitations of special sites to expand to place environments carrying ordinary people's daily life memories. These two characteristics essentially point to a core transformation: since heritage is defined by daily life practices and carried by ordinary environments, heritage value assessment should naturally be centered on ordinary people who actually use and perceive these places, rather than relying solely on expert academic judgments. This recognition inevitably leads to a fundamental shift in value assessment systems from expert-led to public participation.

2.3 From Theory to Practice: Four-Dimensional Framework

2.3.1 Framework Conceptualization

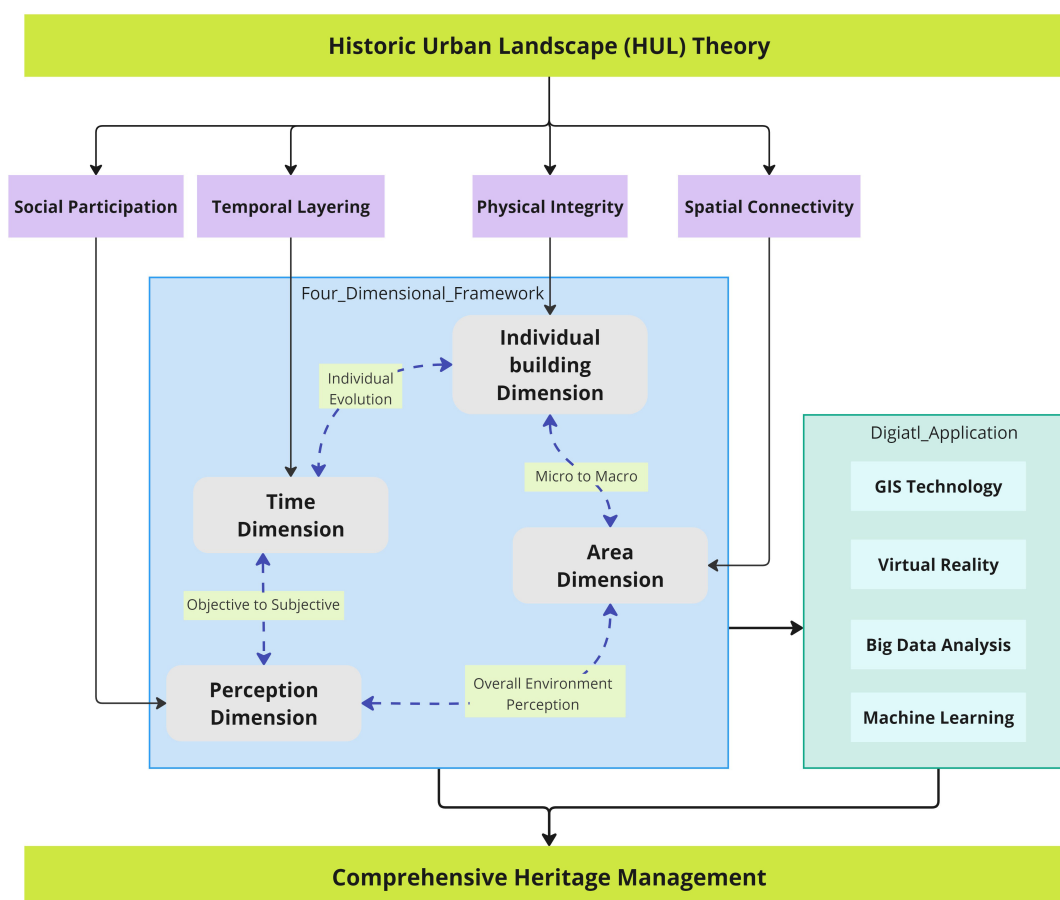


Figure 3. Research Framework Diagram. Source: Authors' own compilation.

The four key characteristics identified from HUL theory provide the theoretical foundation for developing a systematic documentation framework (Figure 3). This framework translates HUL's conceptual principles into operational dimensions while addressing contemporary conservation challenges.

The Individual Building Dimension, derived from “physical integrity” requirements, enables systematic documentation of architectural attributes and material conditions, responding to HUL's requirement of extending “beyond the notion of ‘historic centre’ or ‘ensemble’ to include the broader urban context and its geographical setting”. The Area Dimension reflects “spatial connectivity” principles by capturing broader

urban contexts and environmental relationships, aligning with what Jones and Leech describe as the necessity to understand heritage within its wider spatial context. The Time Dimension embodies the concept of "temporal layering" by documenting historical evolution processes and cultural continuity, which are "the result of a historic layering of cultural and natural values and attributes" (UNESCO 2011, Article 8). The Perception Dimension implements social participation principles through the integration of stakeholder perspectives and community values, addressing what Waterton identify as the need to democratize heritage practice (Waterton et al., 2006) and aligning with HUL's recognition of the "dynamic character" of urban heritage and its promotion of "social and functional diversity" (UNESCO 2011, Article 11).

While each dimension addresses specific aspects of HUL requirements, their integration creates a comprehensive framework that enables systematic heritage documentation and analysis. This framework provides:

- Systematic recording of physical heritage attributes
- Documentation of spatial-temporal relationships
- Integration of social values and perceptions
- Support for evidence-based conservation decisions

Through this structured yet flexible approach, the framework establishes a methodological bridge between HUL's theoretical principles and practical heritage conservation requirements.

2.3.2 Digital Implementation Strategy

While the HUL Recommendation explicitly encourages the use of information and communication technologies (UNESCO 2011, Article 27), comprehensive digital implementation frameworks remain limited. Smith advocates for digital interactive mapping as a tool for urban heritage conservation, emphasizing its ability to document how "different subcultures may exist in the same physical space in different ways," while Haskins highlights maps' capacity to integrate fragmented heritage content dynamically (Haskins, 2015).

Recent technological advances have significantly enhanced heritage documentation capabilities. Web 3.0 and semantic web technologies have improved historical building interpretation (Amoruso and Manti 2016; Bolici et al. 2017), while digital platforms have democratized heritage documentation through enhanced public participation (Murphy et al. 2016; Widodo et al. 2017). GIS-based modeling and remote sensing technologies provide essential tools for spatial analysis (Agapiou et al., 2015; Robinson et al., 2010; Williams, 2014), and social media integration enables participatory heritage practice (Giaccardi 2012; Liew 2014).

However, most existing studies focus on single aspects of heritage documentation, primarily serving as electronic records rather than integrated analytical tools. The potential for multi-dimensional analysis through the integration of Geographic Information Systems (GIS), Virtual Reality Applications, Big Data Analytics and Machine Learning remains largely unexplored. This research addresses this gap by developing a comprehensive digital platform that leverages these technologies to implement our four-dimensional framework, enabling systematic documentation and analysis of urban heritage values across multiple dimensions.

GIS Technology	Virtual Reality Applications	Big Data Analytics	Machine Learning
Serves as primary platform for spatial data integration	Provides immersive visualization of heritage environments	Processes large-scale perception data from multiple sources	Processes collective perception data through natural language processing
Facilitates temporal data analysis through historical map overlays	Enables detailed documentation of architectural features	Enables pattern recognition in social value assessment	Identifies social value trends from community feedback
Supports creation of interactive heritage mapping interfaces	Supports spatial relationship analysis	Supports temporal trend and multi-modal analysis	Enables systematic analysis of public sentiment and cultural significance
Enables multi-scale documentation from individual buildings to urban contexts	Facilitates stakeholder engagement through interactive experiences	Integrates diverse data types for comprehensive analysis	Analyzes patterns in stakeholder engagement responses

Figure 4. Overview of Digital Heritage Technology Framework. Source: Authors' own compilation.

3. Case Study: Development of Interactive Heritage Mapping Platform Using Four-Dimensional Framework

3.1. Study Area Selection

The research focuses on the northern bank of Singapore River, encompassing significant heritage precincts including Clarke Quay, Fort Canning Park, and Queen's Square. This district, formerly designated as one of six historic conservation districts by the Singapore government in 1986, presents multiple layers of heritage significance through its waterfront landscapes, historic architecture, and evolving urban fabric (Figure 5). Although its conservation status was subsequently modified due to policy changes, the area's rich combination of built heritage, natural elements, and cultural significance provides an ideal testing ground for developing comprehensive digital documentation methodologies.

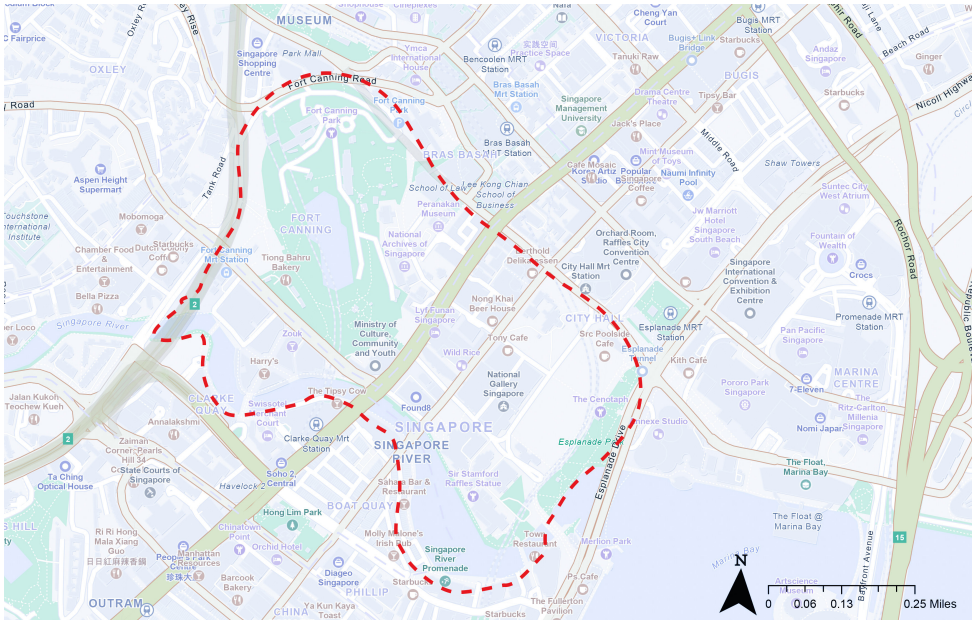


Figure 5. Scope of the research. Source: Authors' own compilation.

3.2 Framework Operationalization

The framework is operationalized through ArcGIS Online and ArcGIS Pro, integrated with Virtual Reality technology, machine learning applications and big data analytics. These platforms are chosen for their capabilities in handling complex spatial-temporal data and supporting multi-dimensional heritage documentation (Figure 6,7). The technical implementation specifically addresses our four dimensions: Individual Building Documentation; Area Documentation; Time Documentation; Perception Documentation.

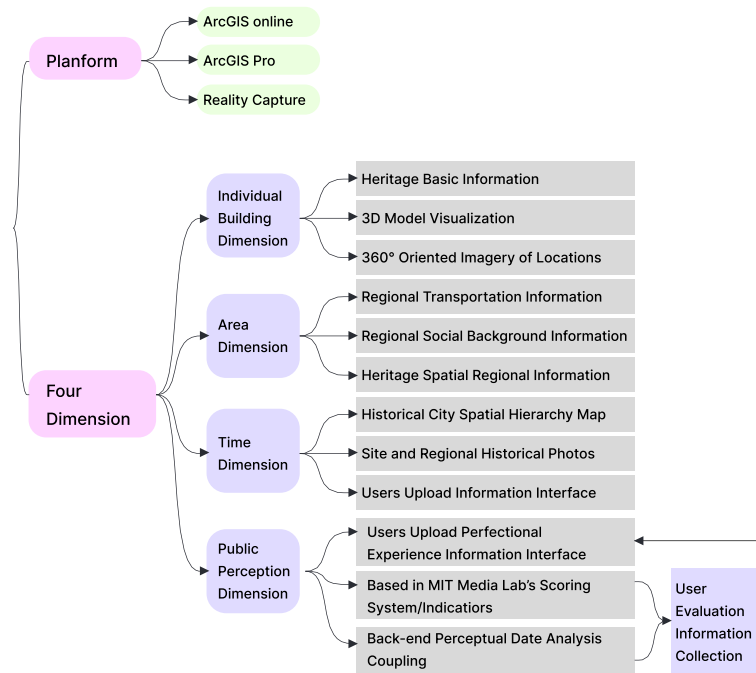


Figure 8. Construction of a Four-Dimensional Framework Interactive Map Using HUL Theory and GIS. Source: Authors' own compilation.

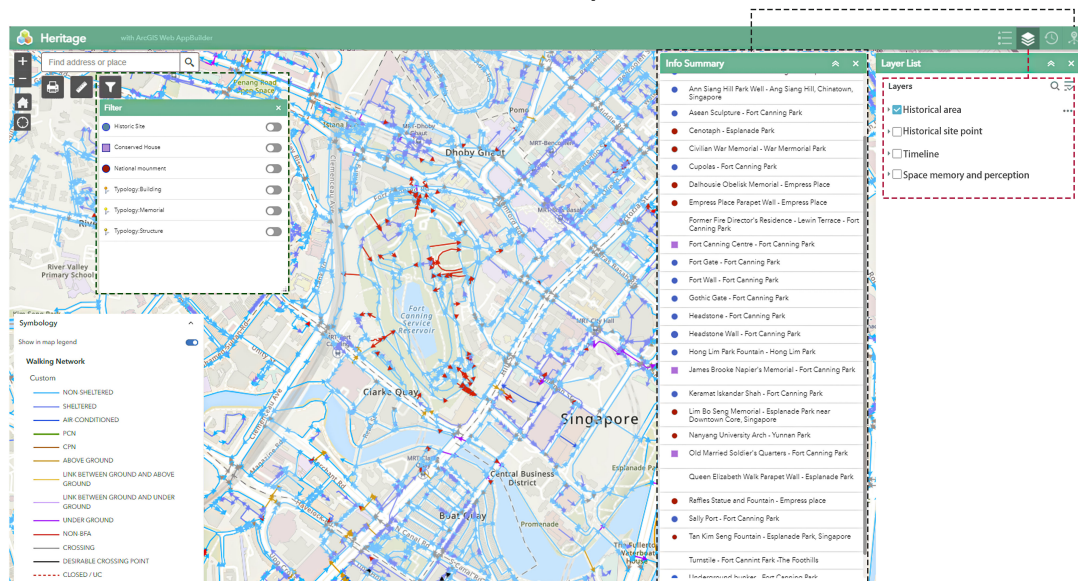


Figure 9. Digital heritage mapping platform of Singapore River North Bank: interface screenshots demonstrating. Source: Authors' own development.

3.2.1 Individual Building Dimension: Establishing Digital Archives of Heritage Sites

The individual building dimension represents the fundamental unit of analysis in implementing the HUL approach, serving as both physical carriers of heritage values and focal points for social meaning construction. While HUL emphasizes comprehensive urban landscape management, the documentation and analysis of individual structures form the cornerstone for understanding layered urban heritage values.

This dimension employs a two-tier documentation methodology that integrates traditional archival research with advanced digital technologies. The foundational tier systematically digitizes conventional documentation, including historical records and basic site information, while the advanced tier utilizes unmanned aerial vehicles (UAVs) and photogrammetry techniques to create precise digital representations. Through specialized photogrammetry software such as Reality Capture and Agisoft Metashape, high-resolution aerial photographs are processed into detailed point clouds and textured three-dimensional models. These models undergo rigorous georeferencing within ArcGIS environment, followed by conversion to SLPK format for integration with ArcGIS Online platform, enabling interactive heritage mapping and three-dimensional visualization capabilities that extend beyond traditional documentation approaches. (Figure 10)

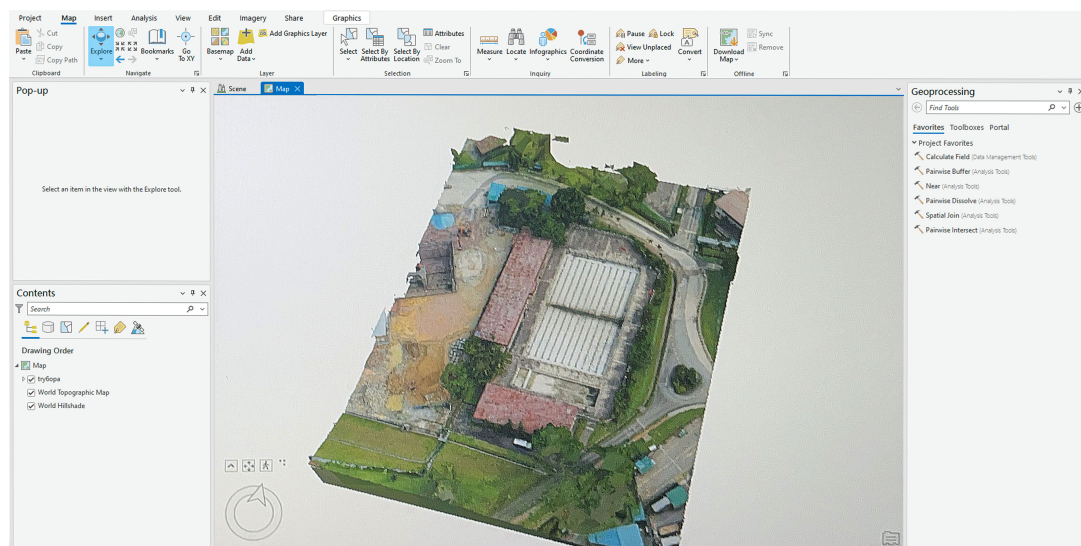


Figure 10. Implementation of heritage 3D documentation: ArcGIS-based visualization interface of Singapore OPA heritage site showing detailed architectural modeling and spatial context. Source: Authors' own development.

The documentation framework is further enhanced through oriented imagery catalogs, implemented via ArcGIS Pro, which systematically capture the contextual relationships of heritage structures. This advanced visualization approach creates interactive 360-degree panoramic views at strategic positions surrounding each heritage site, enabling detailed analysis of visual relationships and spatial patterns. The integration of oriented imagery with the broader digital documentation framework provides an essential layer of contextual information that bridges individual building documentation and area-level analysis, supporting both detailed architectural investigation and broader urban studies. (Figure 10)



Figure 11. Oriented imagery documentation system: 360-degree interactive visualization of heritage sites implemented through ArcGIS platform, enabling comprehensive spatial context analysis. Source: Authors' own development.

3.2.2 Area Dimension: Integrated Spatial-Cultural Documentation

The area dimension operationalizes HUL's holistic conservation principles by establishing a systematic documentation framework that examines heritage preservation from a macro-regional perspective. Through ArcGIS Online's multi-layered visualization capabilities, we developed an integrated platform that extends beyond individual sites and buffer zones to capture comprehensive urban contexts. The platform incorporates multiple data layers including street infrastructure, cultural landscapes, and social patterns. An interactive interface enables users to access contextual information through strategically designed data layers, while embedded linking mechanisms allow stakeholders to contribute cultural narratives, historical photographs, and social memory documentation, enriching the cultural-spatial database through community participation. (Figure 12)

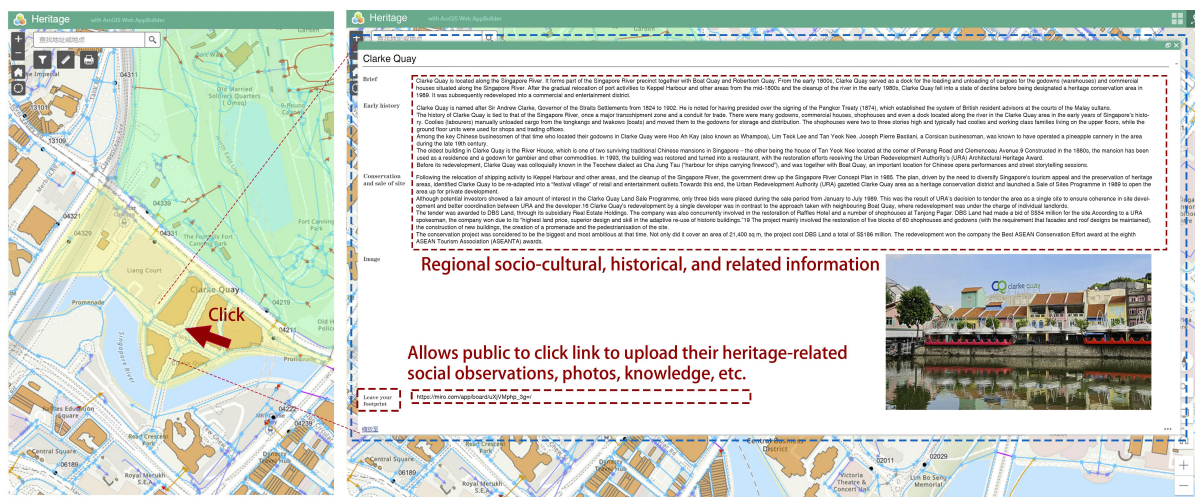


Figure 12. Implementation of the digital heritage documentation framework: interface screenshots showing area-dimensional data integration and visualization. Source: Authors' own development.

3.2.3 Time Dimension: Dynamic Heritage Evolution Analysis

The time dimension systematically documents urban transformation processes, drawing significant methodological inspiration from the Singapore Historical Geographic Information System (SHGIS). The implementation integrates historical maps dating from 1822, providing comprehensive documentation of Singapore's urban evolution over nearly two centuries. At the precinct level, we established detailed chronological documentation capturing the transformation of heritage sites and streetscapes, including records of establishment, restoration, and environmental changes. The temporal database structure enables systematic analysis of both physical evolution and associated social transformations, creating a dynamic framework for understanding heritage sites within their historical contexts.

The establishment of a multi-dimensional framework follows a progressive logic from surface to deep structures. While the individual building and area dimensions represent the fundamental physical layers, the temporal and perception dimensions capture deeper layers of heritage significance. This hierarchical structure enables systematic documentation from tangible attributes to intangible values, reflecting HUL's comprehensive approach to heritage understanding. (Figure 13)

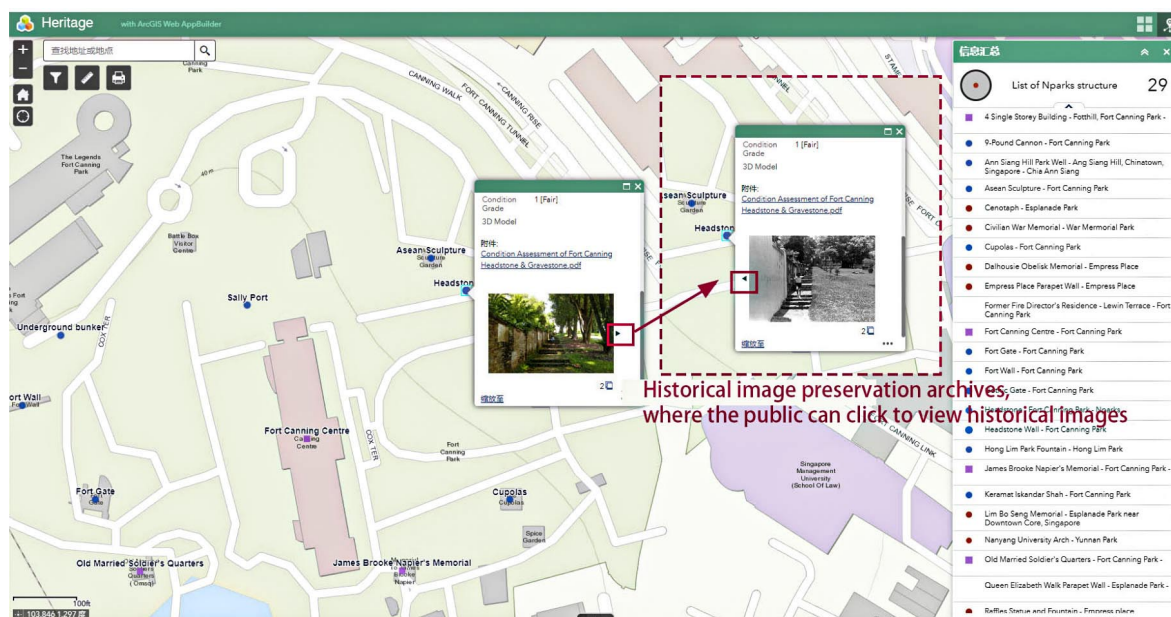


Figure 13. Implementation of the digital heritage documentation framework: interface screenshots showing time-dimensional data integration and visualization. Source: Authors' own development.

3.2.4 Perception Dimension: Quantifying Heritage Experience

The perception dimension advances the public value perspective emphasized by HUL theory through systematic documentation of spatial experience. The implementation methodology involves three key components (Zhang et al., 2023). First, we collected street-view imagery through strategic sampling points identified via OpenStreetMap and accessed through Google Street View API, resulting in a filtered dataset of 1,251 samples. Second, building upon MIT Media Lab's "Place Pulse" framework (Ito et al., 2024), we developed a machine learning-based evaluation system that extends beyond traditional metrics of safety, liveliness, beauty, wealth, depression, and boredom to incorporate heritage-specific indicators. Third, we

integrated an interactive questionnaire system within the digital platform, enabling users to contribute their spatial perceptions and value orientations for locations within the study area. This user-generated data continuously refines our understanding of heritage district perception, aligning with HUL's objective of enhancing public awareness of urban heritage's socio-cultural significance across generations.

In fact, encouraging users to upload and record their own perceptions is consistent with HUL's goal of increasing people's awareness of the social and cultural significance of urban heritage for past, present and future generations. As mentioned by Van der Hoeven in his work, "The storytelling and perceptions on social media are highly relevant to fostering public engagement in heritage conservation, as they reveal residents' emotional and social values associated with the city." (van der Hoeven, 2020) This also indirectly reflects Article 21 of the UNESCO 2011 document, where the HUL theory calls for providing participatory tools to facilitate public dialogue on the core values of urban areas.

4. Discussion

The four-dimensional framework established in this investigation presents a comprehensive paradigm for urban heritage documentation that seamlessly aligns with Historic Urban Landscape (HUL) principles. By integrating physical, spatial, time, and perception dimensions, the framework captures the complexity of urban heritage values and offers a systematic method for their documentation and analysis. In other words, urban heritage values, in their inherent complexity, are captured within this structured approach. The case study of Singapore validates the framework's applicability in urban heritage management.

However, the implementation of the proposed framework encounters several significant challenges, including data collection, stakeholder collaboration, capacity building, and the optimization of visual page presentation. For example, in the terms of data collection, the current integration method combines the recording and uploading of information not only rely on relevant departments but also by the audience themselves. The advantage is that it provides the public with a medium for uploading and greatly enhances the sense of participation. However, at the same time, it also brings certain disadvantages, which may be of uneven quality, resulting in the risk of invalidity. In addition, information from different channels requires a lot of time and energy to clean, organize and verify the data, which also increases the complexity of data management. In terms of Visual Interface, the current platform construction mainly relies on ArcGIS Online. The advantage is that it reduces the technical difficulty and facilitates rapid deployment and use. However, the disadvantage of ArcGIS Online is also evident. As a SaaS (Software as a Service) product, it inherently restricts users' ability to customize and control the system, which, importantly, poses a significant barrier to maximizing the expansion or stimulation of audience interest and engagement. Finally, urban renewal and heritage management involve multiple stakeholders, including government agencies, community residents, experts and scholars, non-governmental organizations and so on. The goals and needs of different stakeholders may be different, and how to maximize the interests of all parties is a complex process, which is also one of the main limitations of existing platforms at the methodological level - the efficiency of theory and practice transformation.

Future research may be approached from two perspectives. First, the expansion of technological support should be considered. On the backend deployment side, the rationalization of data collection and management methods is essential. Additionally, on the frontend web interface, human-centered design principles should be employed to maximize audience engagement and participation. Second, efforts should be focused on refining the methodology. By establishing a connection between theoretical foundations and practical applications, this approach offers a structured methodology for urban heritage

documentation. Through this systematic framework, urban development strategies can maintain a balance between heritage preservation and contemporary urban requirements.

5. Conclusion

The four-dimensional framework developed in this study is highly compatible with the Historical Urban Landscape (HUL) approach and provides a framework with a solid methodological foundation for the field of urban heritage research. The framework comprehensively captures the complexity and multi-dimensional nature of urban heritage values by integrating physical, spatial, temporal and social dimensions. Its practical application in Singapore shows that the framework can effectively support evidence-based decision-making and promote inclusive estate management practices.

The core value of the framework is to transform the theoretical principles of HUL into practical tools, achieving a close combination of theory and practice: The first level, the four perspectives distilled from the four-dimensional framework, is the fulfillment and validation of the historical urban landscape (HUL) approach. It is based on digital technology, arcgis as the platform media, based on the four-dimensional perspective, based on the establishment of a profound interpretation of the historical urban landscape (HUL) approach, but also practice the theory, for the urban heritage record and sustainable protection to create a new perspective, a multidimensional four-dimensional perspective. The second level, this multidimensional perspective not only integrates the four dimensions of physical, spatial, temporal and social, but also comprehensively captures the complex levels of urban heritage values. It provides a platform to showcase the rich diversity of the city's heritage, further promoting voluntary public heritage knowledge and promoting heritage conservation from the "bottom up". This in turn can further promote the development and implementation of HUL theory.

Overall, the four-dimensional framework based on digital technology is not only a powerful tool for urban heritage experts and planners, but also a powerful medium for the public to actively participate in the sustainable conservation and renewal of urban heritage. Its framework is not only an efficient and comprehensive record of urban heritage changes, its application is also expected to revolutionize urban heritage management practices, promote a comprehensive and inclusive approach to safeguarding our common urban heritage, and enable it to move towards a more efficient and sustainable development model.

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