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CONCEPTUAL DIGITAL TWIN FRAMEWORK FOR CONSERVING URBAN CULTURAL HERITAGE: A CASE OF SLAVE ISLAND, COLOMBO

W.D.B.J. Jeewananda[1], K.S.K.N.J. Kudasinghe[2] and A.R. Rupasinghe[3]

ABSTRACT

Digital twins have emerged as significant tools within architecture and construction, enabling the creation of precise virtual representations of physical structures and environments. However, no universal digital twin system is applicable across all contexts, as development processes must be tailored according to specific site conditions, project objectives, and user requirements. Within heritage conservation, Building Information Modelling (BIM) and digital twin principles support documentation, performance assessment, behavioural analysis, and preventive maintenance of historic environments. Nevertheless, their implementation remains complex, particularly within developing-country contexts where technological limitations and data constraints exist. In Sri Lanka, research and application of digital twins for urban cultural heritage conservation remain limited. Simultaneously, rapid modernization increasingly threatens colonial-era streetscapes and historically significant urban structures within Colombo. In response, this conceptual study proposes a site-specific digital twin framework for conserving disappearing urban cultural heritage, focusing on the De Soysa building and the surrounding streetscape of Slave Island, Colombo. The study adopts a qualitative exploratory approach combining a literature review, case study analysis, and semi-structured professional interviews to identify suitable framework components, implementation challenges, and future application strategies. The proposed conceptual workflow integrates archival documentation, digital reconstruction approaches, and comparative visualization techniques to support heritage documentation and long-term digital preservation. Findings indicate that heritage-oriented digital twin development within Sri Lanka requires context-sensitive and adaptable implementation strategies due to challenges associated with data acquisition, software accessibility, interoperability, cost, and ethical considerations. The study contributes by establishing an initial conceptual foundation for future digital twin implementation in urban cultural heritage conservation within resource-constrained contexts.

Keywords: *Conservation; Digital Twins; Urban Cultural Heritage.*

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[1] Lecturer (Probationary), Department of Quantity Surveying, Faculty of Built Environment & Spatial Sciences, General Sir John Kotelawala Defence University, Sri Lanka, bimsaraj@kdu.ac.lk

[2] Lecturer (Probationary), Department of Architecture, Faculty of Built Environment & Spatial Sciences, General Sir John Kotelawala Defence University, Sri Lanka, ksknjkudasinghe@kdu.ac.lk

[3] Senior Lecturer (Grade I), Department of Spatial Sciences, Faculty of Built Environment & Spatial Sciences, General Sir John Kotelawala Defence University, Sri Lanka, a.ranjith.r@kdu.ac.lk

1. INTRODUCTION

The "digital twin" phenomenon has seen widespread adoption across sectors such as aerospace, healthcare, and the Architecture, Engineering, and Construction (AEC) industry (Grieves, 2014). Formulated by Grieves in the early 2000s within industrial design, a digital twin serves as a standalone digital mirror of a physical system (Grieves, 2014, 2016). This model archives the physical system's data and maintains a continuous link throughout its lifecycle (Huzzat et al., 2025). Essentially, it acts as a virtual proxy for a tangible object or process.

Over the last ten years, cross-disciplinary efforts have positioned BIM as a primary tool for managing historic landscapes, proving effective for behavioural analysis and preventive upkeep of heritage sites (Jouan & Hallot, 2019). Digital twins enhance this by providing a dynamic method to manage accurate digital representations of structures (Fuller et al., 2020). This technology allows engineers to execute multiscale simulations to detect defects and suggest repairs. It merges diverse survey methods (Martínez et al., 2021) with BIM-centric semantics (Woodward & Heesom, 2019). However, because implementation is technically demanding and time-intensive, establishing a project-specific input framework is vital (Semeraro et al., 2021). No "one-size-fits-all" system exists for digital twins (Huzzat et al., 2025; Pasupuleti, 2025); therefore, the development workflow must be customized for every site.

Digital twin implementation within the built environment is highly context-specific and cannot be standardized through a single universal framework. The selection of suitable algorithms, modelling techniques, and data input flows must be tailored according to project requirements, user objectives, and site conditions (Dembski et al., 2020). Subsequently, development workflows differ significantly from one heritage context to another. Consequently, heritage-oriented digital twin research often adopts phased implementation approaches that integrate HBIM, photogrammetry, archival reconstruction, AR visualization, and structured digital repositories as foundational components for future digitally connected heritage management environments (Dore & Murphy, 2017; Jouan & Hallot, 2019; Massafra et al., 2022). Previous studies have demonstrated that heritage digitization frequently begins with the creation of accurate digital documentation and information models before progressing towards more advanced digital twin functionalities such as real-time monitoring, predictive analysis, and lifecycle management (Murphy et al., 2013; Boje et al., 2020). This staged development approach is particularly common within heritage contexts where data availability, technological infrastructure, and conservation requirements often limit immediate implementation of fully synchronized digital twin systems.

In Sri Lanka, the adoption of these technologies remains sparse compared to global leaders (Opoku et al., 2021), though interest in their transformative potential is rising (Bandara et al., 2023). Despite the volume of literature linking architecture to digital twins, professional consensus on who should operate them and their total utility remains elusive (Attaran & Celik, 2023; Lucchi, 2023; Semeraro et al., 2021). Research regarding their specific application in cultural heritage maintenance is particularly underdeveloped (Jouan & Hallot, 2019; Kudasinghe & Jeewananda, 2024). This is a critical gap, as Sri Lanka's rapid modernization often leads to the neglect of historical significance (Pasupuleti, 2025; Munasinghe et al., 2023).

Within the Sri Lankan context, research on digital twins for heritage conservation remains at an early stage. Existing studies have primarily focused on individual religious or monument-based heritage structures rather than broader urban cultural landscapes. For example, Egodawela et al. (2023) explored the use of 3D photogrammetric modelling and digital twin principles in the restoration process of Rankoth Wehera/Stupa in Sri Lanka. However, applications addressing dynamic urban cultural heritage environments and disappearing historical streetscapes remain largely unexplored. Furthermore, digital twin implementation is inherently context-specific and user-specific, meaning that no universal digital twin system can be applied across all projects (Dembski et al., 2020). The selection of algorithms, modelling approaches, and data input workflows must therefore be tailored according to the specific heritage context and project objectives. Consequently, establishing a conceptual and site-specific framework is a necessary preliminary step toward implementing digital twins for historical urban environments such as Slave Island, Colombo.

The vanishing colonial streetscapes of Slave Island (Kompannaveediya) in Colombo highlight this preservation crisis. Precise restoration is necessary to protect architectural integrity, and digital twins support this by creating intricate virtual models that capture materials and historical contexts (Ćosović & Maksimović, 2022).

This research explores using digital twins to conserve Sri Lankan urban heritage, with a focused case study on the disappearing streetscape of Slave Island, Colombo. The objectives are:

- Objective 01: Identify facilitator areas where digital twins aid heritage preservation via literature synthesis.
- Objective 02: Formulate a site-specific framework for historical landscapes to allow for comparative visualization of urban shifts.
- Objective 03: Pinpoint and address the challenges of implementing these twins in the built environment.

2. LITERATURE REVIEW

A thorough literature review was conducted prior to the study as well as during the study, since the first objective for this study is to identify key facilitator areas where digital twins can enable the preservation of cultural heritage within the built environment through the findings of previously conducted studies. While industrial digital twins commonly rely on continuous real-time synchronization through IoT sensors and automated data exchange, heritage-focused digital twins often evolve through phased development due to limitations in historical data availability, monitoring infrastructure, and conservation constraints. Consequently, early-stage heritage digital twin studies frequently incorporate HBIM, photogrammetry, archival reconstruction, AR visualization, and structured digital repositories as foundational components toward future fully synchronized systems. Therefore, this study adopts a conceptual framework-oriented approach intended to establish the preliminary architecture for future real-time heritage digital twin implementation.

The literature review followed a structured exploratory review approach focused on digital twin applications within architecture, HBIM, urban heritage conservation, and cultural heritage management. Sources were selected based on relevance to digital twin implementation frameworks, heritage applications, and built environment studies.

2.1 DIGITAL TWINS IN ARCHITECTURE

Digital twins permit architects to test designs in virtual spaces, enhancing stakeholder communication and decision-making (Guo et al., 2025). By incorporating sensor data, they optimize building performance and energy use (Sharma et al., 2022). Their role in physical prototyping follows a three-stage logic (Grieves, 2014):

- See: Sensors and tools capture data for visualization.
- Think: Analytics detect issues and propose solutions.
- Do: Algorithms enact optimal remedies.

A digital twin acts as a synchronized, virtual counterpart to a physical asset or system, mirroring both the constituent elements and the operational dynamics of a complex system as it changes over time. Consequently, the architecture of a digital twin is comprised of three fundamental pillars (Hu et al., 2021; Grieves 2014, 2016): physical objects, virtual model, their connection.

The physical objects are indispensable to the twin because they act as the source for vast, heterogeneous datasets originating in the real world (Therias & Rafiee, 2023). These tangible components generate an immense volume of multi-source and diverse data. Currently, the most prevalent techniques for data acquisition include laser scanning and photogrammetry, both of which demonstrate high efficacy in the generation of digital replicas for existing structures (Dagnaw et al., 2026).

Virtual modelling technologies encompass the methodologies used to translate a physical asset into digital formats that are compatible with computer-based analysis, management, and processing (Alam & Saddik, 2017). Modelling is arguably the most critical phase of the digital twin lifecycle. A robust digital twin model incorporates its geometric data (including shape, dimensions, orientation, and assembly logic), physical properties (such as material characteristics, tolerances, and structural information), behavioural patterns (the model's reaction to external environmental stimuli), and governing rules (the constraints and associations utilized to judge, optimize, and forecast the performance of the object) (Alam & Saddik, 2017).

Regarding connection and data transmission, high-fidelity mechanisms are required for the digital twin to offer near-real-time synchronization and accurate state mapping (Grieves 2014, 2016). Various connection protocols facilitate the flow of data between the physical environment and the digital twin, as well as between different software applications within cyberspace (Sun et al., 2025). The execution of a digital twin is a sophisticated and time-intensive undertaking that necessitates the integration of numerous tools and technologies. Therefore, selecting a framework and a sequence of inputs tailored specifically to the project is vital (Dembski, 2020). Because no universal digital twin system exists that can be applied to every context, development processes must be site-specific and flexible.

2.2 DIGITAL TWINS IN THE CULTURAL HERITAGE OF THE BUILT ENVIRONMENT

The digital twin is a highly promising technology for the preservation of cultural heritage, enabling a sophisticated level of interaction between tangible physical objects (such as historical landmarks or archaeological sites) and their virtual counterparts (Pasupuleti, 2025). The framework introduced by Massafra et al. (2022) focuses on the integration of historical building models into a digital twin environment specifically to support heritage conservation. This holistic methodology recognizes that model integration must extend beyond the initial project phase; it emphasizes the automation of simulation and data analytics within the twin, leading to a deeper comprehension of how preservation efforts affect both the heritage sites and the people who interact with them (Massafra et al., 2022).

3. METHODOLOGY

This study adopted a qualitative exploratory research approach to investigate the potential application of conceptual digital twin frameworks for conserving urban cultural heritage within the Sri Lankan context. A qualitative and exploratory methodology was considered appropriate because digital twin implementation for heritage conservation remains an emerging research area with limited established frameworks, particularly within developing-country urban environments (Creswell & Creswell, 2018).

The research methodology consisted of four primary stages;

- Step 01: Structured Literature Review- was conducted to identify key facilitator areas where digital twin technologies could support cultural heritage preservation.
- Step 02: Case Study Selection and Analysis- selecting the streetscape of Salve Island and the historical significant De Zoysa Building.
- Step 03: Development of the Conceptual Digital Twin Framework is created for a heritage-oriented digital twin framework were identified using archival and spatial data sources.
- Step 04: Semi-Structured Expert Interviews were conducted with industry experts to investigate implementation challenges, technological limitations, and future opportunities associated with digital twin applications for heritage conservation.

As illustrated in Figure 1, the methodology follows a logical progression from literature review and case study selection to conceptual framework development and implementation challenge analysis, thereby ensuring a systematic approach toward investigating urban cultural heritage conservation through digital twin principles.

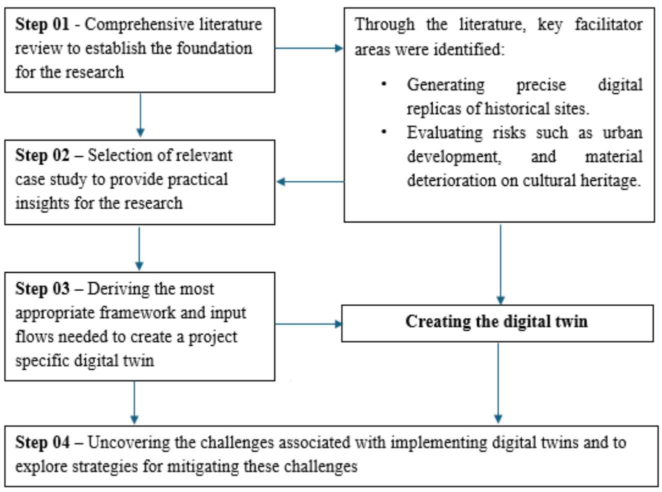

Figure 1: Framework for developing the research.

To begin, an extensive literature review was conducted to establish the theoretical foundation for the research. Literature reviews are widely utilized in exploratory built environment studies to identify existing knowledge gaps, conceptual relationships, and emerging implementation approaches (Snyder, 2019). To establish the theoretical foundation of the study, a structured exploratory literature review was undertaken. Exploratory reviews are particularly suitable for emerging research domains where concepts, applications, and implementation approaches are still evolving (Snyder, 2019). Academic journal articles, conference proceedings, and industry publications published between 2014 and 2025 were reviewed using databases including Scopus, Google Scholar, ScienceDirect, and IEEE Xplore. Search terms included "digital twin", "heritage conservation", "HBIM", "urban heritage", "cultural heritage preservation", and "digital reconstruction". Sources were selected based on their relevance to digital twin implementation frameworks, heritage applications, and built environment studies. The review facilitated the identification of key application areas, implementation challenges, and technological components relevant to the development of a conceptual digital twin framework for urban cultural heritage conservation.

Through the synthesis of existing academic work, the study identified key facilitator areas where digital twins can contribute to the maintenance and preservation of cultural heritage, including:

- the creation of highly precise digital replicas of historical landmarks to support documentation,
- and the assessment of risks such as material deterioration and urban redevelopment pressures affecting heritage assets.

These identified areas were considered particularly relevant to the colonial urban streetscapes of Sri Lanka, where rapid modernization and redevelopment increasingly threaten historically significant structures.

Secondly, a case study strategy was adopted to provide contextual depth and site-specific understanding. Case study approaches are particularly suitable for investigating complex contemporary phenomena within real-world settings where contextual conditions are highly significant (Yin, 2018). The selected case study focused on the disappearing urban landscape of Slave Island, Colombo, with particular emphasis on the De Soysa building.

The Slave Island streetscape and the De Soysa building were selected due to their historical significance and the immediate urban redevelopment pressures threatening their existence. Similar urban transformation has already resulted in the loss of nearby heritage structures such as the Castle Hotel, which was replaced by a modern structure lacking the architectural character of the original building. Therefore, the De Soysa building and the surrounding Slave Island streetscape represent a highly relevant case for investigating conceptual digital twin approaches for urban cultural heritage conservation, documentation, and comparative visualization.

To support the development of the proposed conceptual digital twin framework, semi-structured interviews were conducted with ten industry professionals selected through purposive sampling (Patton, 2015). Since digital twin implementation for cultural heritage remains a highly specialized and emerging field within Sri Lanka, participants were selected based on their professional knowledge and practical experience rather than through probabilistic sampling methods.

Semi-structured interviews were selected because they provide flexibility for participants to elaborate on emerging themes while ensuring consistency across core discussion areas (Kallio et al., 2016). The interviews explored themes relating to digital twin implementation challenges, heritage conservation concerns, and the future applicability of digital twin technologies within Sri Lanka's built environment sector.

The participants as indicated in Table 01 consisted of architects with experience in heritage conservation and urban design, archaeologists specializing in cultural heritage preservation, technical managers from engineering software organizations familiar with BIM and digital modelling technologies, and machine learning engineer with expertise in data integration and intelligent systems. This multidisciplinary composition was intended to capture both technological and conservation-oriented perspectives relevant to digital twin implementation within historical urban environments.

Table 1: Interview participants.

Interviewee Code	Organizational Sector	Experience (Years)
I1	Private architectural practices	5
I2	Private architectural practices	7
I3	Private architectural practices / conservation consultancy	10
I4	Private architectural practices / conservation consultancy	12
I5	Private architectural practices / conservation consultancy	15
I6	Heritage and archaeological institutions	6
I7	Heritage and archaeological institutions	14
I8	Engineering software organizations	5
I9	Engineering software organizations	11
I10	Digital technology sector	9

All participants possessed professional experience relevant to heritage conservation, digital modelling, BIM technologies, or data-driven built environment applications.

The conceptual framework was developed using multiple data sources, including: historical architectural drawings, archival photographs, contemporary site observations, publicly available urban imagery, and historical documentation relating to the De Soysa building and the surrounding Slave Island streetscape.

The study prioritized conceptual workflow development rather than geometric precision validation. Consequently, the generated models should be interpreted as representative heritage visualizations based on available archival data rather than exact metrically verified reconstructions. The accuracy of the model was therefore dependent on the quality and completeness of the historical records and visual references available.

The collected interview data were analysed using qualitative thematic analysis, where recurring implementation issues, technological constraints, and future opportunities were identified and grouped into thematic categories (Braun & Clarke, 2006). The findings from the interviews were subsequently synthesized with the literature review and case study observations to support the development of the proposed conceptual framework.

The proposed framework is intended to function as an evolving digital repository capable of accommodating future updates. Additional spatial, historical, environmental, or monitoring data can be integrated incrementally as new information becomes available, allowing the framework to support long-term urban heritage documentation and comparative analysis.

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4. RESULTS AND DISCUSSION

The data collection was conducted through both primary and secondary data following a mixed method. Gathered data was then carefully analysed for the purpose of achieving the main aim of the study.

4.1 RESULTS FROM THE LITERATURE REVIEW

As noted in the previous chapter, the synthesis of literature pinpointed two essential facilitator zones where digital twins are vital for the protection of cultural identity within the built environment:

1) The generation of high-precision digital replicas for buildings and historical locations.
2) The evaluation of risks, specifically regarding the consequences of urban growth and the natural deterioration of materials on heritage sites.

Guided by these facilitator areas, the disappearing streetscape of Slave Island, Colombo (specifically the De Soysa building) was designated as the focus for applying the digital twin framework.

4.2 RESULTS AND DISCUSSION FROM THE CASE STUDY

4.2.1 The Selection of Case Study

In Sri Lanka, the UDA has determined that the 150-year-old De Soysa building in Slave Island will be demolished. To accommodate road widening, a new structure featuring a replicated facade will be built some distance away (Figures 02, 03). Architect Ismeth Raheem, in a statement published in the Sunday Times, characterized the building as a "century-old gem of colonial street architecture." The demolition is intended to clear land for the Indian-owned Tata Housing Development Company. A similar fate befell the Castle Hotel, which was replaced by a white structure that currently serves as the Tata project office and bears no resemblance to the original hotel.

The De Soysa building was historically significant as the headquarters for H.W. Cave & Co., which became the nation’s premier printing and publishing house starting in 1877. During the 1920s and 1930s, the H.W. Cave & Co. premises were regarded as one of Colombo's most elite addresses. Because the De Soysa building carries such cultural weight, a digital twin is a valuable tool for its promotion and preservation. It offers a way for future generations to engage with and understand the historical importance of the building within the context of Sri Lankan Street architecture. Digital twins enable the development of a highly precise, interactive 3D model that ensures architectural and historical nuances are archived and can be recreated with fidelity.

Even if a physical restoration is not possible, the digital twin serves as a virtual museum, providing a platform for people to explore the building in its original state.

Figure 2 & 3: Demolished state of the De Soysa building.

The findings from the De Soysa case study reinforce broader concerns identified within urban heritage conservation literature regarding the rapid disappearance of culturally significant historical streetscapes due to urban redevelopment pressures. Similar observations have been made in studies examining colonial urban environments in rapidly modernizing Asian cities, where economic development frequently outweighs heritage preservation priorities (Bruno et al., 2010; Jouan & Hallot, 2019). The present case further demonstrates the importance of digital documentation approaches for safeguarding architectural memory in situations where physical conservation may no longer be feasible.

4.2.2 Development of the Framework for its Digital Twin

This section outlines the specific framework and input sequences required to develop a digital twin for the De Soysa building in the Slave Island area. The first step involves gathering historical data on the building. While photogrammetry and laser scanning are excellent methods for digital recreation, such technologies are not widely available in Sri Lanka. As an alternative, this study utilized existing 2D documentation (such as scanned plans, sections, elevations, and old paper drawings) alongside historical site photographs to manually capture details and building updates.

Subsequently, a 3D-printed model would be created to represent the historical streetscape of Slave Island, the De Soysa Building included. This physical model offers a tangible representation of the urban environment of the past, capturing the fine details of the historical landscape. The use of 3D printing ensures that the physical attributes of the buildings and infrastructure are replicated accurately as they once existed.

To create a juxtaposition between the past and the present, a virtual 3D model (the digital twin) of the current streetscape is to be produced using data collected on recent urban developments. By utilizing the Outlier tool in SketchUp, it will facilitate a clear comparison between the original and modern states. Digitizing this information results in a detailed virtual representation of the current streetscape, acting as a dynamic digital twin that offers insights into urban and architectural evolution over time.

To allow for an immersive and interactive comparison, the 3D-printed historical model is to be integrated with a unique QR code which is linked to the digital twin; when scanned via a tablet or smartphone, it initiates an augmented reality (AR) experience.

This feature enables users to see the current digital twin superimposed onto the physical 3D-printed historical streetscape. By overlaying the digital model onto the physical one, users can observe and analyse the transformations that have occurred, creating a site-specific digital twin that can be continuously updated as new changes arise.

In summary, this process (Figure 4) involves the creation of a 3D-printed historical model, the development of a current virtual twin using SketchUp, and the use of QR codes to overlay the two versions via AR. This comparative visualization brings to light the urban planning choices, architectural changes, and cultural shifts that have defined Slave Island. The model functions as a living archive for preservation and monitoring, allowing researchers to track modifications to historical buildings through successive data versions. Thus, the digital twin becomes a robust tool for historians, architects, and the public to better understand the area's historical trajectory.

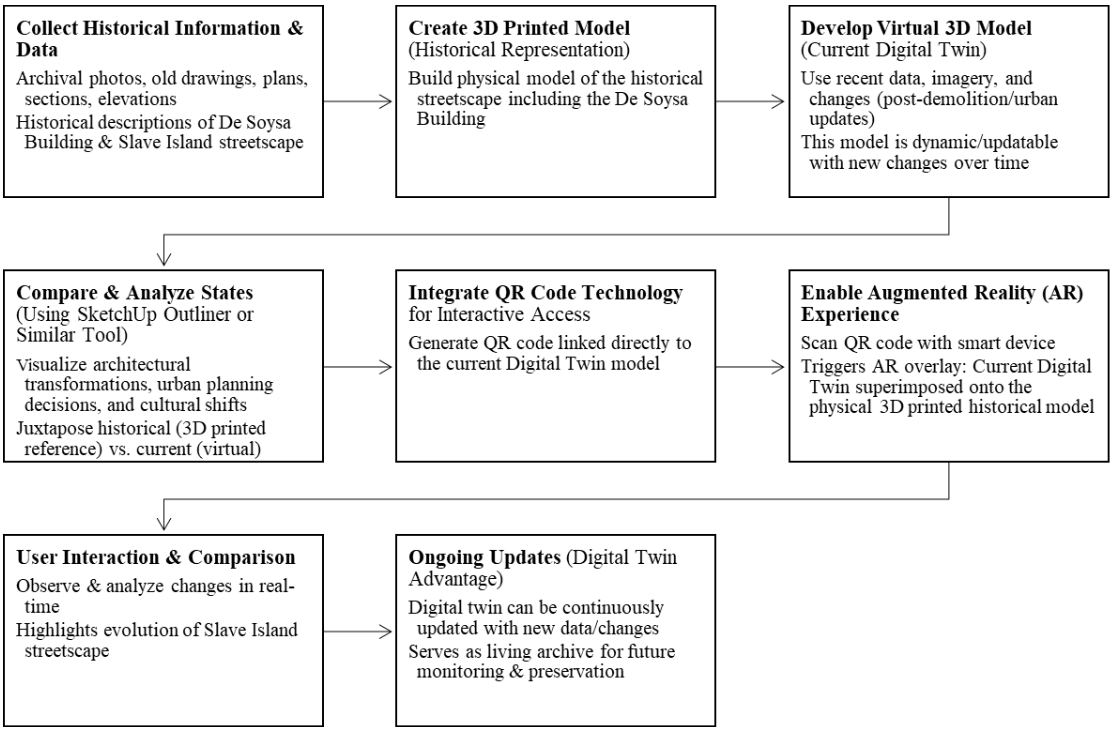

Figure 4: Digital twin creation process

Similar to prior research (Massafra et al., 2022; Dore & Murphy, 2017), the study demonstrates that digital heritage frameworks can function not only as documentation tools but also as interactive platforms for public engagement, comparative visualization, and long-term archival preservation.

Nevertheless, unlike industrial digital twin systems that rely heavily on real-time synchronization through IoT and sensor-based infrastructures, heritage-focused applications often require phased and adaptive implementation strategies due to limitations in historical datasets, technological accessibility, and conservation sensitivity (Dembski et al., 2020). The findings therefore support the argument that digital twin implementation within historical urban environments must remain context-specific and flexible rather than universally standardized.

In the Sri Lankan context, the study also highlights the necessity of adopting low-cost and adaptable workflows. The reliance on archival drawings, historical photographs, SketchUp modelling, and AR-assisted visualization reflects practical constraints commonly faced in developing countries, where access to advanced scanning technologies such as LiDAR and continuous monitoring systems remains limited. Consequently, the proposed framework contributes toward establishing an accessible conceptual foundation for future heritage-oriented digital twin development within resource-constrained urban contexts.

4.2.3 Challenges in Using Digital Twins for Cultural Heritage Preservation in the Built Environment

The concluding portion of the study identified various challenges and mitigation tactics for implementing digital twins in heritage conservation through semi-structured interviews with ten industry experts.

The challenges identified and the relevant mitigation tactics are as outlined below:

1. High-Resolution Data Collection: It can be difficult to capture precise data for heritage sites, particularly for hard-to-reach or complex areas. Furthermore, unavailable historical data can impede the creation of an accurate twin. To mitigate this, advanced tools like LiDAR and photogrammetry should be utilized for high-resolution 3D modelling. Additionally, artificial intelligence can be employed to reconstruct missing historical information by predicting gaps in the data.
2. Software Complexity and High Costs: The expertise and technology required for maintaining digital twins are often expensive, and the necessary software tools can be complex, requiring specialized training. Mitigation strategies include seeking grants and funding from governmental or non-governmental heritage organizations. It is also recommended to implement training programs for stakeholders and utilize open-source software to lower costs.
   The proposed workflow also aligns with previous heritage-oriented digital twin studies that integrate HBIM, photogrammetry, and visualization technologies to support cultural heritage documentation and interpretation (Jouan & Hallot, 2019; Massafra et al., 2022). However, unlike many existing studies conducted within technologically advanced contexts, the present framework adopts a comparatively low-cost and adaptable approach using archival records, SketchUp modelling, and AR-assisted comparative visualization suitable for developing-country contexts.
3. Data Management and Integration: It is challenging to integrate different data types, such as environmental data and 3D models, from multiple sources. Efficiently managing large data volumes while ensuring accessibility and integrity is also difficult. To address this, the industry should adopt standardized data protocols and formats to ensure compatibility, while leveraging cloud-based solutions for more effective data processing and storage.
   The findings support the observations of Dembski et al. (2020) and Semeraro et al. (2021), who emphasize that digital twin systems cannot be universally standardized across all built environment applications. Within the Sri Lankan context, these limitations become more significant due to restricted access to advanced scanning technologies and limited digital heritage infrastructure.
4. Legal and Ethical Concerns: Protecting the security and privacy of data is crucial, particularly regarding culturally sensitive information. Navigating legal regulations for data sharing and collection is also necessary. Mitigation involves creating

transparent data management policies that respect privacy and cultural sensitivities, ensuring all legal guidelines are followed and proper permissions are obtained.
The challenges identified through the professional interviews are consistent with findings reported in prior digital twin literature, particularly regarding data interoperability, software complexity, and high implementation costs (Fuller et al., 2020; Sharma et al., 2022). Ethical concerns relating to the digitization of culturally sensitive heritage assets have also been highlighted in previous cultural heritage studies (Pasupuleti, 2025). The findings therefore reinforce the need for phased and context-sensitive digital twin development strategies for heritage conservation projects.

5. CONCLUSIONS

In summary, the "digital twin" concept has become a significant force in the construction and architecture industries, serving as a vital tool for maintaining up-to-date and accurate digital mirrors of physical assets. Over the last decade, interdisciplinary research has highlighted the effectiveness of historic building information modelling for behaviour analysis, performance modelling, and the preventive maintenance of heritage sites. However, implementing a digital twin remains a complex task that requires a customized approach for every individual project. In the context of Sri Lanka, the adoption of digital twins lags behind more technologically advanced nations. This delay is worsened by a lack of professional consensus regarding their utility and operation, as well as sparse research on their specific role in maintaining cultural heritage. The conservation of historical structures is essential, as modernization threatens the cultural significance of urban areas like Slave Island in Colombo. Digital twins provide a viable solution by generating detailed virtual models that archive historical context and architectural features.

This research utilized a comprehensive literature review, a focused case study on the De Soysa building within the Slave Island streetscape, the development of a site-specific framework, and professional interviews. These steps successfully identified both the challenges and the strategies for successful digital twin implementation. For the De Soysa building, the digital twin offers a means to preserve its legacy amid rapid urban expansion through documentation, virtual reconstruction, and interactive AR tools. Ultimately, project-specific digital twins are vital for managing urban heritage and safeguarding cultural identity, ensuring these structures remain part of our collective history for future generations. The study concludes by emphasizing that while data capture, costs, and ethics present hurdles, the use of advanced technologies like laser scanning, standardized data formats, and strategic funding can significantly enhance how cultural heritage is preserved through digital twins. The development and testing of detailed prototype visualizations and user-interactive models are identified as important directions for future research.

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