CONNECTING EMBEDDED HISTORY OF THE URBAN INFRASTRUCTURE TO THE CONTEMPORARY CITY: A CASE STUDY OF GWANGHWAMUN WOLDAE RESTORATION

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ABSTRACT:

The captured 3D digital record of the excavation site represents a momentary state of the city, but also conveys rich evidence and stories as an urban environment created by the interaction of actors, artifacts, and institutions surrounding the place. These digital records combine multiple temporal layers of complex urban scenes and require interpretation by multiple stakeholders for comprehensive decision-making. This study revealed that in the context of Seoul, the Cultural Heritage Administration and the City of Seoul have made significant use of digital records in cultural heritage restoration from the perspective of preservation and utilization. The two organizations collaborated on the Gwanghwamun Woldae excavation survey recently. The site has been dealing with the multi-layered time and space of complex urban sites for over 40 years while carrying out urban planning and cultural heritage preservation. Through a case study of the Gwanghwamun Woldae excavation site, we articulate the nature of governance in digital documentation to extend its application. The goal is to highlight the urban cross-section and historical layers of urban infrastructure captured digitally - LiDAR and photogrammetric scanning - at the Gwanghwamun Woldae excavation site. This involves describing the chronological layers of tram lines, streets and buildings from different eras and linking them to the current urban context of Seoul through analog historical records such as maps and plan diagrams. Ultimately, we discuss the value of digital restoration of technologies, events and landscapes as a record of the process valuing modern urban heritage.

1. INTRODUCTION

1.1 Background and Purpose

This study addresses the new role of the 3D digital documentation focused on the Gwanghwamun Woldae restoration project, as not just a byproduct of cultural heritage excavation but a live record that testifies to the successive historical layers of modern urban space transformation. Gwanghwamun is the main gate of Gyeongbokgung Palace, one of the most important royal palaces of Seoul built in 1395. Woldae is the primary podium structure of this gateway, which was destroyed arguably during the Japanese occupation period in early 20C, then recently restored. Situated at the heart of Seoul, it also serves a monumental public space that symbolizes the modern history of the country.

The research purpose is twofold. First, it aims to illuminate the urban cross-section and historical layers of urban infrastructure captured in a digital manner - LiDAR & Photogrammetry scanning - at the Gwanghwamun Woldae excavation site. This involves explaining the chronological layers of tram lines, streets, and buildings from different eras, and connecting them to the current urban context of Seoul with analogue historical records such as maps and planning diagrams. Second, it intends to propose a digital twin approach that combines multiple time layers of complex urban site for the comprehensive decision making. Ultimately, we aim to discuss the value of digital restoration as a record of the process valuing the contemporary urban heritage.

1.2 Related Narratives

Urban cultural heritage inherently involves conflicts and clashes between urban planning and cultural heritage preservation. Therefore, collaborative and communicative processes among archaeologists, architects, researchers, and technicians are crucial. In recent times, digital records have played a central role in this communication process (A. Respaldiza et el., 2012; L. Mateus et el., 2020; A. Stmnas et al., 2021; G. Sanfilippo et al., 2021). Through various examples, digital records have been used to propose and manage the necessary technologies for scientific monitoring of cultural heritage restoration in the face of climate and natural or human-made threats. In the context of cultural heritage documentation, the technology of archaeology has been used as a tool to record excavation results as facts. In contrast, records in the field of architectural conservation and restoration should serve as a means to show changes in the urban environment over time (T. Georgios, 2019; F. Raco, 2022). To ensure continuous use of digital records, methodologies such as the integration of analog records and 3D reproduction technologies centered around GIS applications by experts have been discussed (Danilo Marco Campanaro et al., 2016; A. Stmnas et al., 2021). Additionally, the inclusion of 3D models on platforms like Sketchfab with historical technical information and 2D drawings as part of educational programs has also been considered (G. Sanfilippo et al., 2021).

1.3 Problems and Research Questions

This research begins with the problem that the cultural heritage restoration has been reduced within the site and disconnected

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from a wider urban context. Urban infrastructure exists in the hidden spaces under the streets but it is essential for the fundamental functioning of the city, serving as public services that facilitate the flow of materials, people, energy, and information in the city. While the Gwanghwamun restoration aimed to reproduce the past original, the excavation process and its digital documentation raised the issue of co-existing historical layers and multiple decision-making processes. The research question lays whether the digital documentation of the Gwanghwamun excavation site can be utilized as a record archive of the urban infrastructure space that embraces the past and present, and as a novel alternative to the methods of cultural heritage restoration.

2. THE SEOUL CONTEXT: DIGITAL RECORDS AT CULTURAL HERITAGE EXCAVATION SITES

The Cultural Heritage Administration of Federal Government and the Metropolitan Government of Seoul are significant institutions that have been involved in the digital recording of cultural heritage excavation sites in Seoul. These two institutions have used digital records from different perspectives. The Cultural Heritage Administration considers excavation site records as essential evidence and foundational data for the restoration of cultural heritage to its original state. In contrast, the city of Seoul intends to use the excavation site records as conditions for designing the historical urban environment and as educational and promotional programs for citizens.

2.1 Restoration of Gyeongbokgung Palace by the Cultural Heritage Administration

In response to the Korean government's information technology initiative in the 1990s, the Cultural Heritage Administration established organizations related to digital cultural heritage and began conducting three-dimensional surveys of cultural heritage and building a 3D cultural heritage database from the 2000s (CHA, 2020a). The recreation of cultural heritage that no longer exists physically is referred to as "digital restoration," which primarily started visualizing it based on historical research and verification in the field of archaeology. The main objectives of digital restoration include 3D modeling for pre-verification of physical restoration, simulation of the reconstruction and repair process, and recent integration of VR and AR technologies for expanded use in recording and restoration (NRICH and KAAH, 2022).

The first phase of the Gyeongbokgung Palace restoration project by the Cultural Heritage Administration marked a turning point, which was initiated by the Gwanghwamun Square excavation survey (2006-2009). According to the first Gyeongbokgung Palace restoration plan (1994), the Japanese General Government Building (1916-1996) and the concrete Gwanghwamun (1968-2005) were demolished, leading to detailed planning and excavation surveys in the Gwanghwamun area. The excavation survey was based on maps, photographs, and documentary records of the Joseon Dynasty (Figure 1), and it revealed the remains of the Joseon era buried beneath the asphalt road surface at a depth of 30-70 cm. It identified the exact location of the historical Gwanghwamun gate from the late Joseon Dynasty (Figure 2), providing the basis for the restoration of the wooden structure of Gwanghwamun (CHA, 2011).

Figure 1. Old photo of the Gwanghwamun
(source: https://portal.nrich.go.kr/)

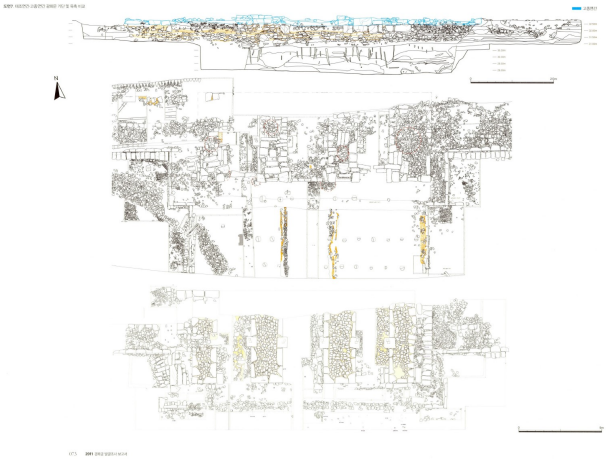

Figure 2. Joseon Dynasty Historical Map (source:CHA, 2011)

Through the excavation survey, the Cultural Heritage Administration also gained insight into the current state of the Gwanghwamun Square and its missing components, contributing to the establishment of a comprehensive restoration plan. Furthermore, the Cultural Heritage Administration has revised the second phase of the Gyeongbokgung Palace restoration basic plan (2008, 2011, 2015, 2017, 2018) multiple times for the complete restoration of Gwanghwamun Square. The Cultural Heritage Administration also entered into an agreement with the city of Seoul for the "Enhancement of Cultural Heritage Conservation and Utilization," leading to long-term coordination of the Gwanghwamun Square plan.

Currently, the Cultural Heritage Administration has been publicly disclosing digital records of existing cultural heritage within Hanyangdoseong on the South Korean e-Government's data portal since 2020. This is a result of cumulative field surveys and spatial measurement technologies, which have been ongoing since the 1990s as part of the Gyeongbokgung Palace restoration project.

2.2 Historical Urban Design by the City of Seoul

Since the 1990s, the city of Seoul has initiated plans to highlight the historical significance of Sejong-ro (Gwanghwamun Square) as the central area of the nation for over 600 years by creating pedestrian spaces (SDI and SMG, 1994). Seoul established the Citizen's Square in 2002, and the Cultural Heritage Administration created the Gwanghwamun History Square Plan in 2005, both separately planning for the same location. When the Cultural Heritage Administration decided to restore Gwanghwamun to its original location, the historical landscape axis connecting Gwanghwamun Square, Gyeongbokgung Palace, and Mount Bukak became an important design theme for the city of Seoul.

Seoul and the Cultural Heritage Administration collaborated, aligning the Gwanghwamun Square plan with the restoration of Gwanghwamun, and planned the transformation of Gwanghwamun Square into a fully pedestrianized area and the undergrounding of roads beyond 2030. The winning design proposal for the redevelopment of Gwanghwamun Square led by Seoul aimed to extend the natural flow from Mount Bukak to Gyeongbokgung Palace and reflect the historical landscape for restoring the axis of historical and natural significance (Figure 3).

Figure 3. Winning proposal and contest poster for New Gwanghwamun Square (source: https://project.seoul.go.kr/)

Before the Gwanghwamun Square redevelopment project commenced, Seoul conducted seven precise archaeological excavations (Figure 4). The city of Seoul decided to revise the redevelopment plan after the original Joseon-era remains were excavated at the former *Sahoenbu*(Office of the Inspector-General), with the intention of exhibiting them to the public on-site (Figure 5). This led to a revaluation of the underground plaza, emphasizing the importance of maintaining the identity of this site as a symbolic public space of history from the Joseon Dynasty to the present (SMG, 2022). In the Gwanghwamun Square Improvement and Development Plan (2021), historical design for Seoul refers not only to the restoration of the Gwanghwamun Square but also to design strategies that include the preservation of burial cultural heritage and the representation of the shapes of historical roads and walls. It includes a minimal planting strategy to protect the exposed remains, instead of a large-scale tree planting plan that could impact burial cultural heritage.

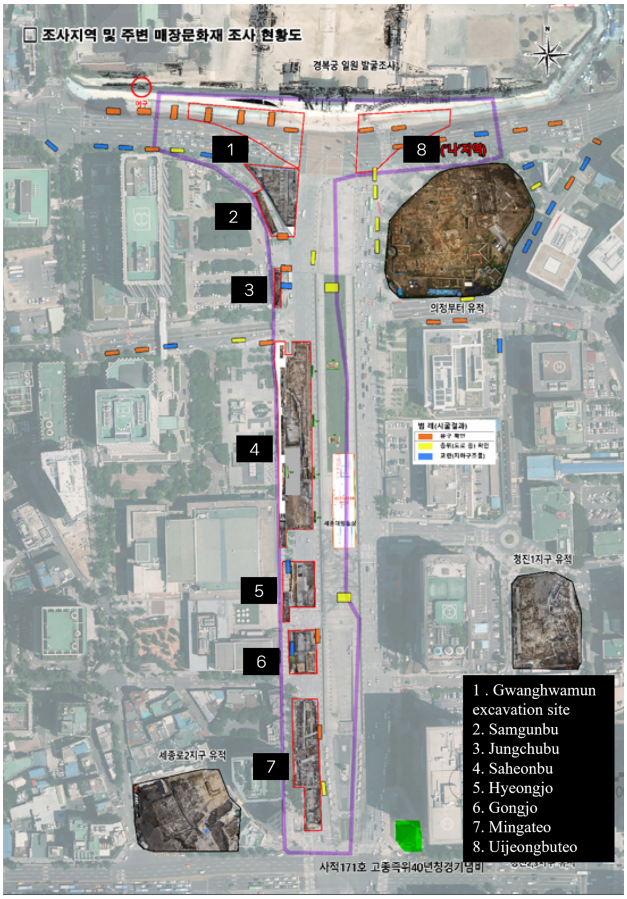

Figure 4. Excavation Survey Map of Development Site (source: https://gwanghwamun.seoul.go.kr/)

Figure 5. Exhibition Space for the Excavation Remains of the former Sahoenbu (source: https://gwanghwamun.seoul.go.kr/)

2.3 Case Study: Gwanghwamun Square Excavation Site

The complete restoration of Gwanghwamun Square became a significant justification for both the Cultural Heritage Administration, responsible for the cultural heritage zone, and the city of Seoul, responsible for the urban planning zone, and they jointly managed the excavation site (Figure 6).

Figure 6. Cultural Heritage Administration and Seoul City Management Boundary
(source: https://gwanghwamun.seoul.go.kr)

This project has yielded various pieces of evidence that allow us to trace the history of modern urban infrastructure. These findings span from the tram routes of the Joseon Dynasty era (operating from 1917 to 1966) to the construction of Samgunbu (19th century), and even include water and sewage systems from the Joseon era to the present day (CHA, 2023). Public institutions along with historians and architectural researchers, have engaged in discussions that go beyond the scope of traditional restoration during the restoration process. The Cultural Heritage Administration primarily focused on analyzing the traces of Joseon Dynasty-era pedestrian roads to verify Joseon-era ground structures. They categorized the excavation results into four distinct periods and also emphasized a significant discovery from the excavation research, which was a substantial area measuring 48.7 meters in length from north to south and 29.7 meters in width from east to west, extending in the direction of Sejong-daero. This area was linked to Gwanghwamun's central gate and the adjacent area known as Eodoji(the former King’s road), and it was considered crucial by researchers advocating for the original restoration (Figure 2).

However, architectural archaeologists argued that modern layers coexisted with Joseon-era layers. They confirmed the presence of tram tracks and sleepers from the old Seoul tram system, which was established in 1928 and dismantled in 1968. These artifacts were classified as significant relics, not only shedding light on Seoul's industrialization and urbanization but also serving as historical artifacts (See Figure 9). Eventually, the tram tracks were relocated to the Railway Museum, and other infrastructure facilities underwent similar relocation.

The joint excavation project of Gwanghwamun Square highlights the divergent perspectives on the conservation and utilization of cultural heritage, underscoring the need to consider the sense of place as a boundary between cultural heritage management and urban planning. It also raises questions about the value of urban infrastructure heritage within the modern urban context and the significance of addressing the temporal layers spanning different eras.

3. REPRESENTING EVIDENT VALUES OF THE EXCAVATION SITE FOR THE CONTEMPORARY CITY

The captured 3D data of the excavation site represents a momentary state of the city, however it conveys rich evidence and stories that penetrate then history of the contemporary urban environment. Could digital records become a sustainable heritage for designing a better urban environment? Could we compile datasets from different sources encompassing the historical layers of infrastructure, roads, buildings, and people in the spacetime?

Data related to the Gwanghwamun Square restoration project are currently managed in a fragmented manner, even though they are accessible by request. While the Cultural Heritage Administration documented 3D scanning records of restored Gwanghwamun for the data archiving purpose, Seoul Metropolitan Government pursued the 3D scanning to capture the site surveying and managing urban infrastructure relics in excavation process along with the urban planning (Figure 7). The 3D model for executing Woldae restoration is also served in different 3D formats. On the other hand, in S-MAP, a digital twin platform managed by Seoul Metropolitan Government, we witness the moment of Woldae reconstruction (Figure 8).

In this section, we rewrite the evidence of Gwanghwamun excavation site as urban infrastructure by compiling historical analog sources. The value of urban infrastructure is to adapt the urban space according to traditional topography, to create the flow of materials, people, energy, and information. These layers provide valuable insights into the historical evolution of Gwanghwamun Square, encompassing infrastructure, roads, buildings, and urban development, and raise questions about

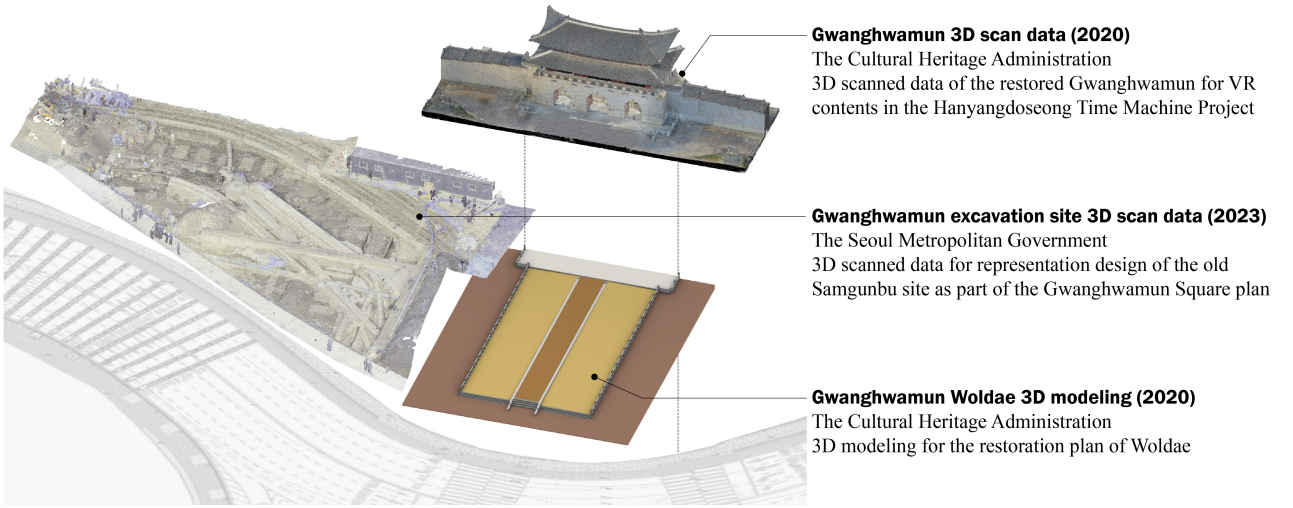

Figure 7. Fragmented Datasets of Gwanghwamun Excavation Sites

how to preserve and utilize this rich cultural heritage in the context of contemporary urban design for a sustainable and better city environment.

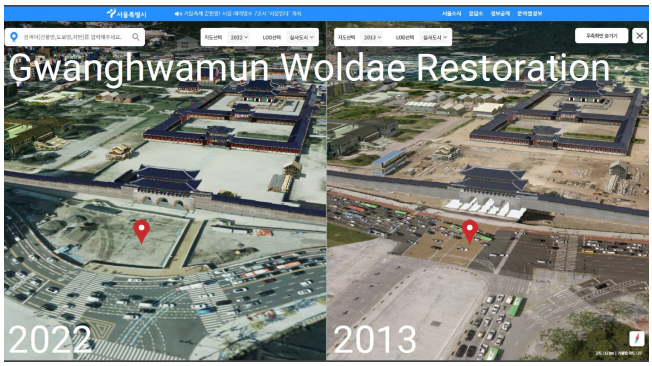

Figure 8. The Gwanghwamun Woldae Site on S-Map (source: https://smap.seoul.go.kr/smap/)

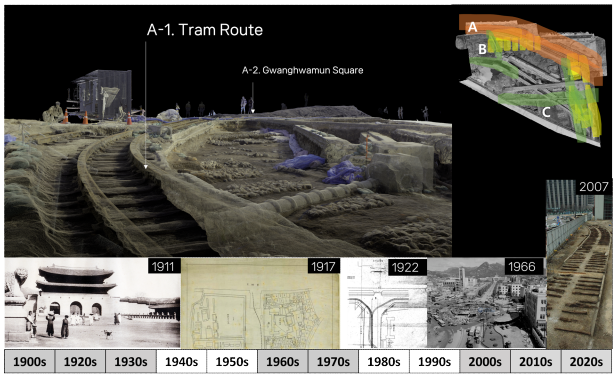

Figure 9. Tram Route from Landscape A of 3D scan data of Gwanghwamun Woldae excavation site

The Tram Route A-1 at the excavation site was a branch line established in 1917. It originated from the Jongno line. This Jongno line was a newly inaugurated tram line in 1899, which spanned from Donuimun(western gate) to Dongdaemun(estern great gate), the key east-west thoroughfare within Hanyangdoseong. During the process of converting the tram route into a double track, it overlapped with Gwanghwamun Square A-2, and the square was filled in. The tram tracks, which are no longer in use, were preserved even after their official operation ended in 1966. In preparation for President Johnson's visit to discuss special funds for the Vietnam War, the tram tracks, weighing 350 tons, and sleepers were hastily removed, and road paving was carried out. Landscape A of the excavation site reveals rich layers related to the establishment and double-tracking of the tram route (1917-1927), the termination of its operation and removal (1966), and the restoration process of Gwanghwamun and the excavation research of Gwanghwamun Square (2007, 2003). (Figure 9)

Excavation site Building Remnants B-1 preserves the foundation of the Joseon Dynasty's Samgunbu (regional offices) and a part of the front gate, which was dismantled due to the double-tracking of the tram route in 1927, and the establishment of the Library of the ministry of commucations(1945) after liberation. Until the western expansion by 30 meters due to road widening projects in the 1960s and 1970s, this area was used for public architecture. The misalignment between Road B-2 and Building Remnants B-1 demonstrates the difference in urban planning standards between the Joseon Dynasty's pedestrian road and Sejong-ro. Landscape B of the excavation site represents the urban space that underwent significant transformation from a road (Sejong-ro) to a square (Gwanghwamun Square). It displays traces of buildings from the Joseon Dynasty, 1920s, and 1940s that were developed along the horizontal axis. (Figure 10)

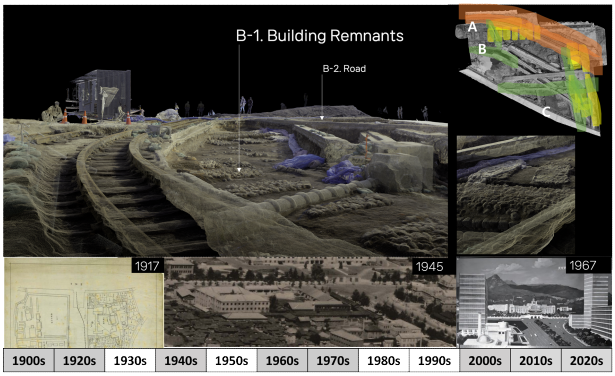

Figure 10. Building Remnants from Landscape B of 3D scan data of Gwanghwamun Woldae excavation site

Drainage System Remnants C-1 serve as the side boundary between the roads, as seen in their relationship with Building Remnants C-3, which were part of the Joseon Dynasty's pedestrian road and *Samgunbu*. Drainage system Remnants C-2 intersect below the tram route, showcasing the construction of a new water and sewage dam below the road during the double-tracking of the tram route and the expansion of the Gyeongseong administrative district in 1936. (Figure 11)

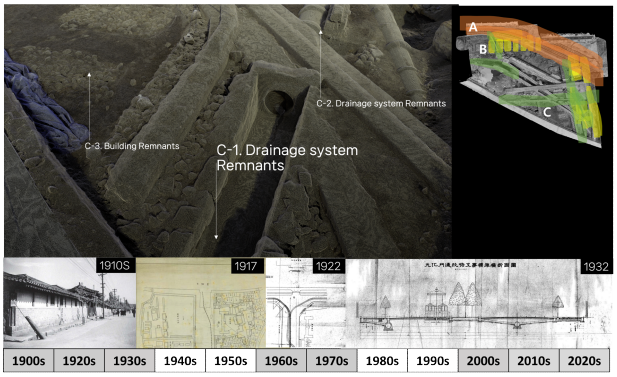

Figure 11. Drainage System from Landscape C of 3D scan data of Gwanghwamun Woldae excavation site

We showcased the Gwanghwamun excavation site to represent embedded history of urban infrastructure by connecting historical reference materials to the 3D captured model of. This preliminary study will open up tangible opportunity to develop a comprehensive digital twin as extensive digital heritage.

4. CONCLUSION

The fragmented use of digital records from urban cultural heritage excavation sites is a concern not just in Korea, but potentially in other regions as well. When we examine the urban architectural planning processes in surrounding areas, it becomes evident that the perception of cultural heritage goes beyond restoring specific structures at a certain time. It also involves discussions about various potential uses.

This research has highlighted the importance of distinguishing and presenting records from different time periods and sites to ensure the sustainability of digital record utilization. Through methodologies aimed at respecting the historical layers of sites and records, we ultimately discussed the new role of 3D digital documentation in a broader decision-making process.

As a follow-up to this research, we will prototype a digital twin of the Gwanghwamun excavation site, which is intricately overlaid on the contemporary urban space. By customizing Cesium and public digital twin platforms, we aim to reveal the complex urban terrain embedded in the site, expanding its influence on the current urban infrastructure. Leveraging point cloud data manipulation for geometric representation, we anticipate that historical reference materials for tram route development and modern urban planning data can be presented on the digital twin platform.

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