A LIVING LAB APPROACH FOR CONCURRENT 3D DOCUMENTATION OF AN ARCHITECTURAL RENOVATION PROJECT - A SHOWCASE OF GUNSAN CIVIC CULTURAL CENTER

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ABSTRACT:

This paper explores the integration of 3D documentation within a living lab framework for the renovation of the Gunsan Civic Cultural Center. The study emphasizes the importance of architectural renovation in contemporary sustainability and social resilience, highlighting the unique challenges of adapting existing structures. Our approach combines advanced 3D scanning techniques, such as drone filming, photogrammetry, LiDAR scanning, and hybrid modeling, with the living lab methodology, enabling real-world experimentation and stakeholder engagement. Our showcase on the Gunsan Civic Cultural Center illustrates the practical application of these techniques in material reuse and cultural performance planning, emphasizing community participation and collaborative decision-making. The living lab approach, central to our methodology, fosters dynamic interaction among architects, builders, community members, and local authorities, enhancing communication and project outcomes. This study contributes to the field by showcasing how concurrent 3D documentation in a living lab setting can revitalize heritage sites, ensuring their sustainable future while actively involving the community. The lessons and discussions drawn from this project highlight the potential of this approach in broader architectural and urban development contexts.

1. INTRODUCTION

1.1 Background

Architectural renovation is a crucial agenda in our time, addressing sustainability concerns within a circular supply system of materials and enhancing social resilience through the reuse of familiar spaces. It often requires more consideration than new construction, as it involves adapting to the existing structural condition and accommodating new spatial configurations based on new demand. 3D scanning and digital documentation of the existing structure are gradually being applied for measurements and engineering analysis in the planning and construction stages.

This study proposes a living lab approach for 3D documentation in architectural renovation projects. A living lab employs research methods in real-world settings with active participation from users, stakeholders, or the community in experimentation. Our premise is that 3D documentation throughout the entire renovation project cycle can greatly enhance communication and decision-making among diverse participants. Focused on the Gunsan Civic Cultural Center renovation project, we showcase how concurrent 3D documentation can provide valuable support for the project's foundational aspects.

1.2 Modern Heritage City Gunsan

Gunsan, located in the mid-western part of South Korea, is a port city with a significant role in the nation's history. Opened as a port in 1899 during the Japanese occupation period, the city thrived as a planned settlement by Japanese. After Korea's liberation and the Korean War, following the era of industrialization, old downtown Gunsan gradually declined and hollowed out. However, this period of neglect inadvertently led to the preservation of a rich collection of modern historical heritage.

Entering the 2000s, the city government of Gunsan began actively utilizing its modern cultural heritage in urban regeneration projects. The city started to create a historical and cultural landscape by emphasizing its identity as a modern cultural city. Public projects were initiated to preserve and restore the downtown area to its appearance in the 1920s and 1930s. This transformation aimed to attract tourists by exhibiting Gunsan's historical identity. Ironically, the cityscapes from the post-1980s, more closely connected to the daily lives of local residents, received less attention in these efforts. This oversight has led to a growing recognition of the need for urban regeneration that also encompasses more recent periods of the city's history. The renovation of the Gunsan Civic Cultural Center, therefore, represents a new direction in urban regeneration, acknowledging the importance of both preserving historical heritage and revitalizing more contemporary urban landscapes.

1.3 Gunsan Civic Cultural Center Regeneration

The Gunsan Civic Cultural Center, originally constructed in 1989, was once a prominent public theater in Gunsan. It closed after struggling in operation with the opening of the Gunsan Art Center nearby in 2013. Although its period of prosperity was short-lived, it still holds the status of a significant modern architectural monument. The building is the last built project by architect Chung-up Kim, one of the most respectful architects in the post-War modernism era in Korea. It also remains an essential repository of collective memories for the local citizens

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of Gunsan. After extensive discussions, the city government of Gunsan developed a renovation strategy through a private-public partnership. In 2021, they selected a consortium composed of an architect, a cultural program director, local business partners, and artists to devise the Center's ultimate future plan.

2. RELATED WORKS

Utilizing advanced 3D documentation technologies on cultural heritage for the purpose of preservation is a popular research topic as archiving and assetizing specific parts of buildings or highlighting them through web platforms (Potenziani et al., 2015; Ubik et al., 2022; Radanovic et al., 2021; Vieira et al., 2023; Sorin et al., 2023). 3D documentation plays an increasingly crucial role in restoring buildings lost due to natural disaster (Willot et al., 2022; Kevin and Renato, 2023). While preservation and documentation of cultural heritage are important, the adaptive reuse of these buildings through renovation has also become economically and environmentally significant (Foster, G., 2020). As this study address the living lab approach to record the entire process from the state of the building transformation following the construction phase, the participatory nature of information sharing will allow 3D documentation data to be utilized in various ways for renovation projects. It deals with a timely issue of social impact to foster the sense of community.

3. 3D DOCUMENTATION PROCESS

3.1 Recording the Construction Process

Since the inception of the construction, we have engaged in 3D documentation utilizing various techniques, including drone filming, photogrammetry, and LiDAR scanning. We provided these data to the architect and operational director's team in real-time, fostering close collaboration and facilitating design decisions for the living lab experiment.

3.1.1 The Main Concept of Architectural Renovation

The primary principle of renovation is to attentively preserve the original façade while reimagining the spatial dynamics. This innovative endeavor is rooted in a philosophy that harmonizes conservation with sophisticated social transformation. The centerpiece of this renovation is a daring architectural intervention that redefines the interaction between the building and its urban context. The original design of this brutalist building required visitors to ascend a series of four staircases of a height equivalent to two stories above street level to access the main entrance hall. The new design introduces a subterranean tunnel beneath the existing external staircases, which provides an unobstructed, ground-level passage leading directly to the auditorium's stage and the exhibition hall. It is not just a structural alteration but revisioning spatial experience. By facilitating direct and seamless entry from the urban streetscape into the heart of the cultural space, the design metaphorically and physically merges the city with the stage. This creates a cohesive and immersive cultural experience, symbolically dissolving the traditional barriers between the performers and the audience, and between the cultural monument and the city it inhabits. This transformative approach not only respects the historical integrity of the structure but also repositions it as a dynamic, interactive hub in the cultural tapestry of Gunsan.

3.1.2 The Scope and Coverage

In this paper, we describe the 3D documentation process focused on construction of new entrance pathway for the sake of clarity. To effectively capture the rapidly progressing construction work, we made strategic decisions for recording during the phases of greatest change. Thus, the documentation aligned with the construction phases (Figure 1). The data acquisition was segmented into four distinct phases: the initial stage, formwork, concrete structure, and completion. Each of these stages was chosen for their significance in the construction process, ensuring a comprehensive capture of the project's progression. This project is expected to complete in mid-2024.

3.2 Documentation Methodology

3.2.1 Drone Photogrammetry

We applied drone photogrammetry technique to cover the entire site. For the drone imaging process, we initially conducted a survey of ground control points. Following the completion of

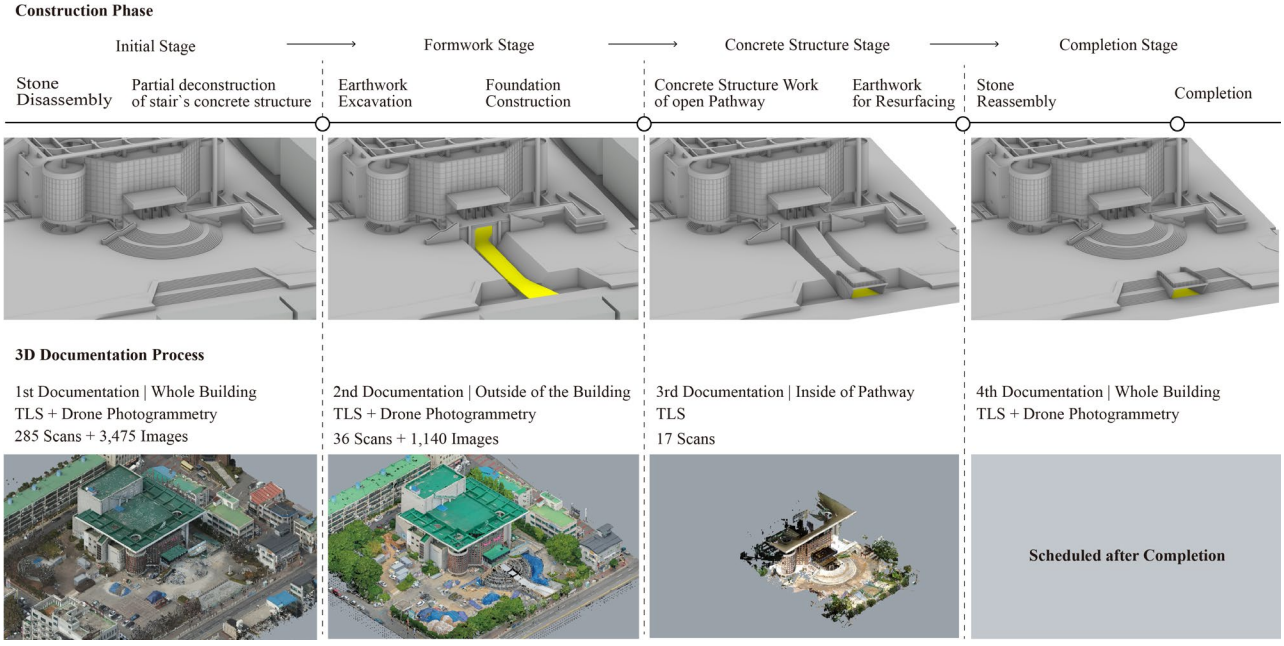

Figure 1 Construction Phases and the Scope of 3D Documentation

this survey, we executed a planned drone flight, capturing approximately 3,475 images. Considering that the rooftop of the building was situated about 20 meters above ground level, we utilized manual operation for close-up photography of areas beneath the eaves.

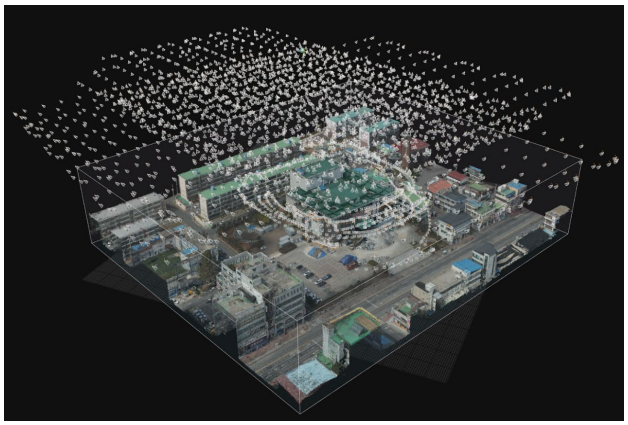

Figure 2. Drone flight path of the 1st documentation

3.2.2 Terrestrial LiDAR Scan

On the ground, we employed TLS to scan both the interior and exterior of the building for precise fidelity of data. This is the more essential method to record the status of architecture at each stage of construction. It included approximately 250 scans of the interior.

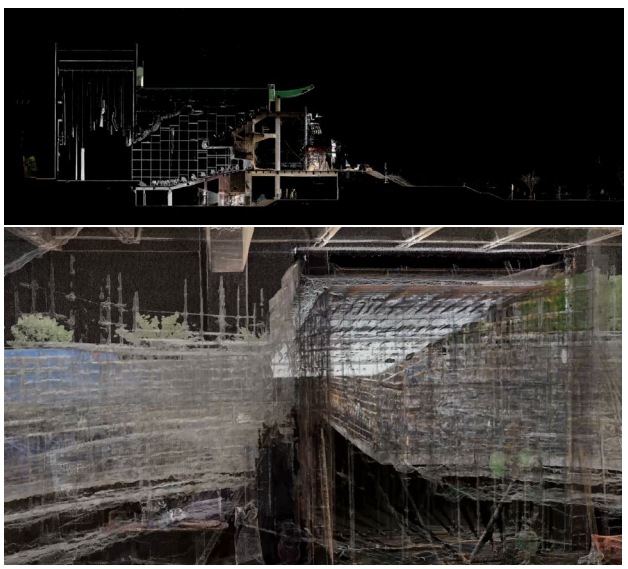

Figure 3. Orthometric image of the section of the building from the 1st documentation (above); Point cloud rendering of pathway formworks from the 2nd documentation (below)

3.2.3 Data Registration and 3D Reconstruction

To complement the ground data with aerial data, it was necessary to integrate both datasets through a process of alignment. We utilized Faro Scene to import and align the extracted ordered e57 files into Reality Capture. Subsequently, we identified several overlapping points between the drone photographs and the point cloud generated using TLS in order to merge two data sources. We manipulated the merged point cloud data into 3D reconstruction in diverse formats for a comprehensive digital representation, encompassing both the interior and exterior of the building.

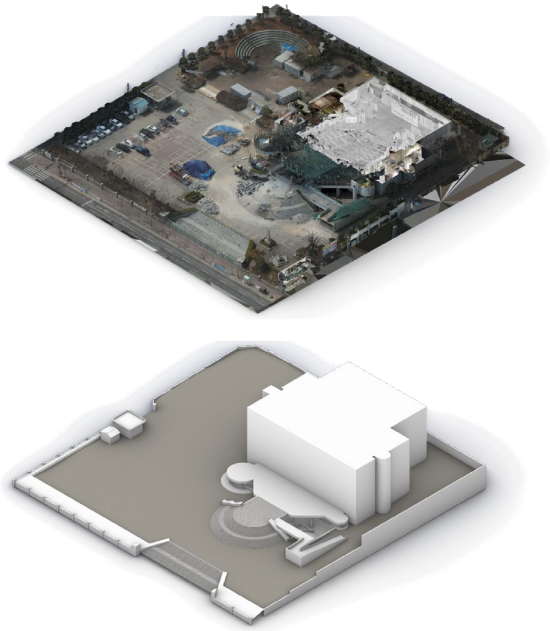

Figure 4. Data processing procedure.

3.3 The Living Lab Approach

In this study, we experiment with 3D documentation as a living lab approach. Typically, 3D scanning techniques are applied in the realm of heritage preservation for ensuring stringent fidelity to original forms and precision in restoration efforts. Similarly, in the case of construction projects, these techniques are predominantly leveraged in detailed surveying and accurate measurement.

During the renovation process of the Gunsan Civic Cultural Center, we define our experiment as a unique reinterpretation of history and modernity. In this context, 3D documentation transcends its conventional roles. We aim to complementarily record the various actions put forth by both the architect and the operation manager. Since this project is propelled under a public-private partnership, we explore how digital records can strategically be utilized in the realization of the architect's design intentions and in the cultural planning aspects from the operator's perspective by offering new insights.

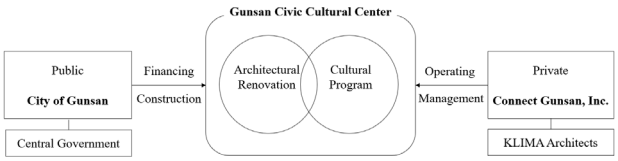

Figure 5. Public-private partnership of the project

This exploration is not just a technical assessment; it is a narrative of blending technology with creativity and strategy. It showcases how digital tools can bridge the gap between architectural imagination and operational pragmatism, ultimately contributing to a cohesive and culturally rich architectural project.

4. SHOWCASE

4.1 Transformative Architecture with Digital Records

4.1.1 Digital Restoration for Reuse of Materials

As described in Chapter 3, we focus on construction of entrance in this study. In a bold architectural move, the architect designed an open pathway connecting the street entrance directly to the theater stage, penetrating the auditorium space. To this end, the main concentric circular staircase at the building front was disassembled during the construction of the entrance tunnel structure underneath and subsequently reassembled in its original position.

We conducted the first LiDAR scanning when the original stonework only partially removed. Digital restoration was employed, starting from the initial state of the record, to analyze and replicate the original alignments as well as the locations of the stone pieces (Figure 6). The architect insisted on reuse of all the stone materials, but due to miscommunication with the builders, partial disassembly occurred prematurely. This accident can be caused universally on the renovation construction site, especially in the case that the building original is considered not yet privileged enough. With this digital restoration process, it could be beneficial in communication between the architect, the builder, stone manufacturers, and the public city inspector for decision making.

Figure 6. The initial stage of the record (above left); Digital restoration of the stonework from the initial stage (above right); Support decision making of stonework of concentric circular staircase (below)

4.1.2 The Evident Subtlety of the Original

The Gunsan Civic Cultural Center embodies a delicate balance in valuation, straddling the line between the cherished modernity of the 1980s and the risk of being perceived as mundane. Although it is a posthumous work of the great master architect Chung-up Kim, applying preservation standards can be a noncommittal matter preserving it as a heritage. Renovation architect Kwonwoong Lim approached this project with a philosophy focused on aesthetical and environmental continuity from the past in a broader sense. While maintaining the Center's distinct architectural language from the 1980s, special attention was given to preserving subtle façade features, including the window frame system and exterior materials, which are often overlooked and easily replaced with contemporary tectonics. This approach was evident in redesign of the main gate, where the thoughtful integration of the original and new elements was facilitated by utilizing 3D digital records (Figure 7).

Figure 7. LiDAR point cloud data overlays to planning model for revising main gate design as reference of the original (left, source: KLIMA architects); The construction site (right)

Our documentation experiment is ongoing in parallel with the construction. It supports real-time decision making and refines the new value of this practice.

4.2 Active Digital Archive for Cultural Planning

4.2.1 A Participatory Night Tour on the Construction Site

Throughout the project's progression, the cultural programmers in the operation manager team have actively engaged in conducting innovative events aimed at fostering community involvement. They organized a special night tour program at the construction site featuring artist performances (Figure 8). This unique initiative provided potential users of the space with an intuitive and realistic glimpse into the Center's future ambiance. To effectively communicate the purpose of this bold undertaking to city inspectors, fieldworkers, and staffs of the event, we utilized a 3D photogrammetry and LiDAR hybrid model of up-to-date construction site on the Web for planning the tour route (Figure 9).

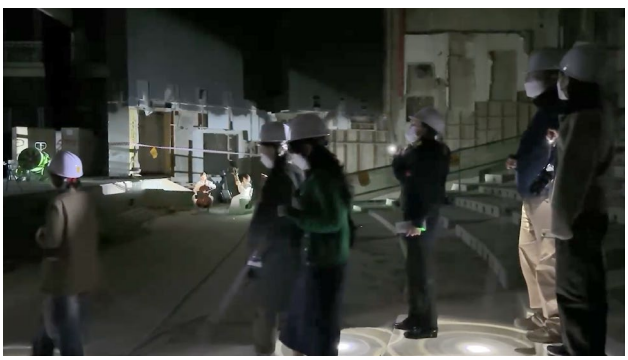

Figure 8. Participatory night tour program in action

The utilization of digital records as media artworks significantly enhanced the event's immersion (Figure 10). This approach not only showcased the renovation progress in an engaging manner but also demonstrated the potential of digital tools in enhancing cultural experiences. The transformation of technical data into artistic expressions bridged the gap between construction and creativity, making the renovation process more accessible and appealing to the community.

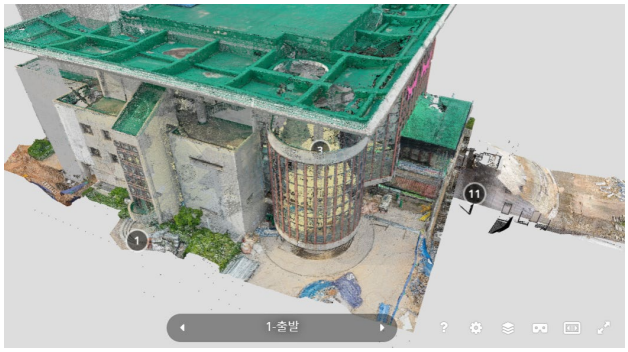

Figure 9. Collaborative tour route planning on 3D WebVR generated from point cloud hybrid model

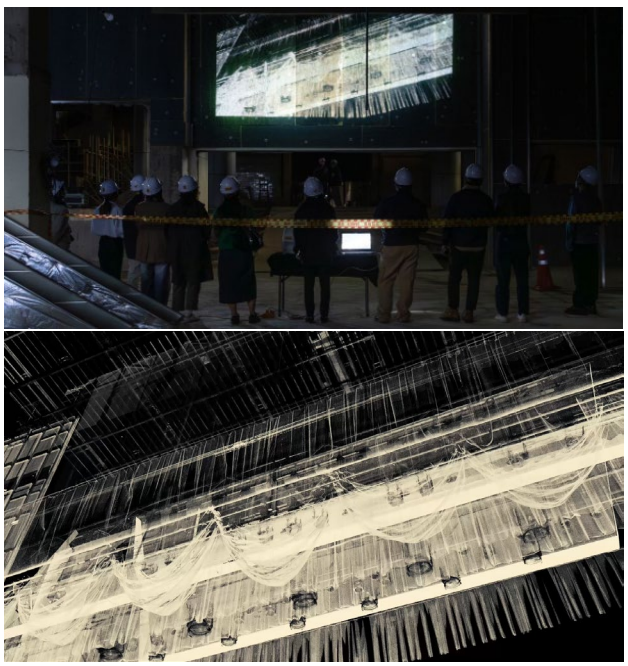

Figure 10. Media artwork using point cloud data at the night tour (above source: Connect Gunsan)

The active digital archive, as envisioned in this project, opens new avenues for imminent cultural planning. It represents a shift towards a more interactive, community-focused approach in urban development. This concept goes beyond traditional archival methods, proposing a dynamic, evolving digital repository that actively contributes to cultural activities and public engagement. The success of this event hints at a future where cultural planning is not just about preservation and presentation, but about active participation and co-creation with the community.

4.2.2 Devising the Spatial Experience with Media Canvas

We propose a concept of the media canvas as an innovative extension of the active digital archive idea. It's not just a static display but a dynamic interaction layer between the building and its visitors, redefining the architectural space. The element of media canvas will be a trigger that motivates producing digital contents as part of Center's cultural identity.

Ambient Canvas: Imagine this canvas as a living, breathing digital skin of the building. It can adapt to environmental factors like weather, time of day, or cultural events, creating a responsive and engaging virtual facade. This virtual universe could employ a mix of sensory elements like ambient lighting, subtle motion graphics, and interactive elements, which together weave an ever-changing tapestry that reflects the rhythms of the city and the cultural pulse of the community around it. This canvas is not just visual; it could incorporate elements of sound and tactile feedback, making the Center space an interactive experience that reacts and evolves, creating a harmonious connection between the structure and its environment.

Entrance Canvas: This canvas transforms the entrance into a storytelling gateway, where digital displays could narrate the history of the building, showcase art, or provide interactive experiences. It's a fusion of the physical journey into the building with a digital journey through time, culture, and art.

Roof Canvas: Utilizing the roof as a canvas adds a vertical dimension to the media experience. This could be a platform for aerial displays, visible from a distance, contributing to the city's nightscape as landmark. It might include artistic interpretations of cultural events or digital exhibitions that reflect the Center's activities.

Each of these canvases contributes to a layered, enriched spatial experience, making the building itself an interactive participant in cultural storytelling and visitor engagement. This approach not only transforms the building's facade but reimagines how people interact with and perceive architectural spaces. It opens up possibilities for future buildings to become active elements in the cultural fabric of the city, engaging with their audiences in profound and innovative ways.

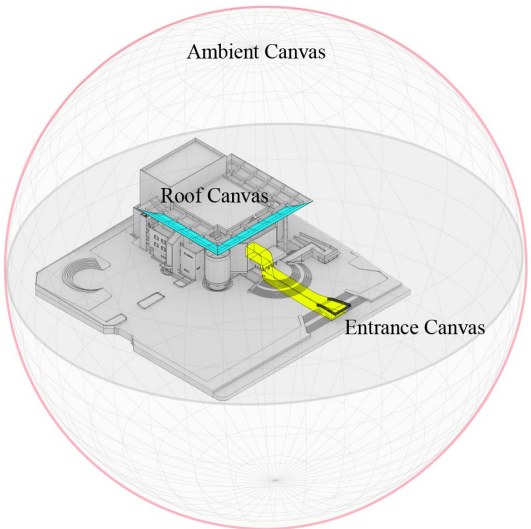

Figure 11. The concept of media canvas

5. LESSONS AND DISCUSSIONS

As we continue this ongoing project with an expected completion date in mid-2024, it's clear that the multifaceted nature of renovation demands more than just engineering solutions. The adoption of concurrent documentation process serves as a live platform that integrates diverse perspectives and fosters effective communication. We utilize it not just as a technical tool, but as a dynamic medium to record, in a

complementary fashion, the myriad of plans, ideas, and actions put forth by both the architect and the operation manager. This approach allows us to capture the essence of their vision and operational strategies, transforming abstract concepts into tangible realities.

The living lab approach, a dynamic and inclusive methodology represents a significant contribution enabled by cutting-edge 3D documentation techniques. It has not only reshaped the physical aspects of the Center but has also revitalized community engagement, providing the foundation for a sustainable and vibrant future for the Center and its users.

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APPENDIX

Persepctive rendering for the renovation project (source: KLIMA Architects)

Project Overview

Client	City government of Gunsan		
Architect	Kwonwoong Lim (KLIM-Associates)		
Operation	Connect Gunsan Inc.		
Site area	7,897.7 ㎡	Building area	2,641.04 ㎡
Gross floor area	4,649.54 ㎡	Height	26.4m
Building size	Basement 1, Ground floor 3		
Structure	Reinforced Concrete		