The Symbiosis of Tradition and Modernity: A Study on Culturally Driven Urban Regeneration in the Context of Digitalization- A Comparative Analysis of the "Cloud Tour Suzhou" Metaverse Service and Projection Mapping with Media Art on Barcelona's Heritage Facades

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Abstract: In recent years, digital technologies such as the metaverse, virtual reality, and digital twins have rapidly entered the public sphere. As a key strategy of digitalization, gamification-by incorporating game-design elements-has significantly enhanced both engagement and user participation, providing new technical means and expressive modes for the preservation, dissemination, and innovation of traditional culture. These developments have exerted profound influence on urban regeneration, the activation of public spaces, and the growth of cultural tourism. Although scholars and practitioners increasingly examine the integration of digitalization with traditional culture and urban renewal, systematic comparative research on how different digital pathways differentially affect cultural transmission and urban development remains limited. To address this gap, this study analyzes two representative cases: the "Cloud Touring Suzhou" metaverse service and the projection-mapping and media-art practices on the façades of Barcelona's heritage architecture, comparing their technological applications, modes of audience participation, mechanisms of cultural value transmission, and outcomes in urban transformation.

Keywords: Digital Technology; Metaverse; Urban Renewal; Culture-Driven

1. Research Object

As the development of digital technologies accelerates, digitalization has increasingly become a crucial force in driving urban regeneration and cultural heritage preservation. Traditional cultural resources are being revitalized within this digital context, and the convergence of culture and digital technologies is gradually shaping a culture-driven paradigm of urban renewal. Consumers of the "net generation," raised in an environment dominated by internet technologies and social networks, are inclined to seek enjoyment, challenge, and interaction, often placing entertainment at the forefront of their daily activities. (Zichermann,2010) [1] Against the backdrop of ongoing digital transformation and the integration of cultural heritage protection, Suzhou and Barcelona have each explored distinct pathways in employing digital technologies to advance culture-driven urban regeneration.

The rise of the "Virtual Suzhou" Metaverse service emerged as a response to the restrictions on offline cultural tourism during the pandemic and represents a product of urban digital transformation. The Metaverse can be conceptualized as a persistent, multi-user environment that integrates physical reality with digital virtuality. Leveraging immersive technologies such as Virtual Reality and Augmented Reality, it enables multi-sensory interactions between users, virtual environments, and digital objects. Through interconnected immersive platforms, it supports real-time, dynamic interactions among user avatars and facilitates socialized communication. (Mystakidis, 2022) [2] The "Virtual Suzhou" service leverages Metaverse technologies to construct an immersive virtual space, with its core focus on the integration of digital representations of cultural heritage and interactive immersive experiences. This approach enables users to explore and engage with the virtual environment through active participation. By adopting this model, "Virtual Suzhou" not only expands the channels for the dissemination of traditional culture and enhances public cultural engagement and identification,

but also opens new pathways for the development of the urban cultural tourism industry, simultaneously promoting cultural value transmission, updating the city's image, and advancing the digital economy.

In the course of Barcelona's digital exploration, Refik Anadol's projection mapping and media art practice centered on Antoni Gaudí's architectural heritage, particularly Casa Batlló, represents a significant manifestation of the city's cultural innovation and digital transformation. This approach transforms building façades into dynamic visual narrative spaces through the use of light and projection technologies, endowing static heritage with new sensory vitality and dimensions, and enabling the public to experience esthetic appreciation and emotional resonance through collective participation. By integrating artistic light projections with interactive media art, this practice facilitates a dialog between historical architecture and contemporary art while promoting the recreation of cultural memory. Through the organic fusion of digital media and physical structures, it effectively enhances the city's cultural appeal and tourism attractiveness, further advancing Barcelona's cultural identity construction and urban branding in a globalized context.

2. Cultural Interpretation Enabled by Technology

2.1 Virtual Technologies and the Metaverse

In recent decades, digital twins have emerged as a toolkit for collecting, processing, and utilizing graphical, spatial, and other attribute data of cultural heritage, and have been widely applied to China's world cultural heritage sites. Based on digital twin technology, the "Virtual Suzhou" Metaverse app enables a high-fidelity reconstruction of urban spaces and cultural landscapes within a virtual environment. The virtual construction encompasses three aspects: space, objects, and characters. In terms of spatial representation, "Virtual Suzhou" employs three-dimensional data acquisition and simplification of the real environment to achieve the construction of 3D spaces. As shown in Figure 1, urban elements such as buildings, roads, and rivers are comprehensively reconstructed in the virtual environment. Unlike traditional two-dimensional images or video displays, this digital twin-based spatial reproduction allows for 360° panoramic scene browsing and can be augmented with additional layers of information, such as virtual tour guide narration, introductions to events, and other relevant information, while also permitting users to freely switch between scenes.

Figure 1. Lake Tour Scene in the Suzhou Metaverse App

In terms of object construction, virtual items are created through three-dimensional reconstruction and high-precision modeling, complemented by real-world imagery to enhance visual fidelity. From the perspective of characters, the technology allows users to select and edit virtual avatars or to "travel in companionship" with others, as illustrated in Figures 2 and 3. In many respects, the application incorporates gamification mechanisms. Studies have shown that gamification can cultivate and stimulate learning motivation. (Dang, 2023) [3] The integrated application of these technologies enables the "Virtual Suzhou" app to construct a digital representation of the ancient city that is "viewable, perceivable, and understandable." Without physically visiting the site, users can experience Suzhou's unique urban culture and historical heritage from home across multiple terminal devices.

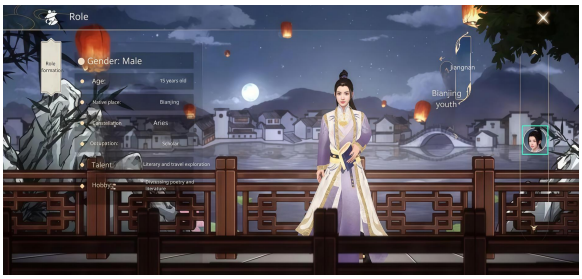

Figure 2. Character Information Editing

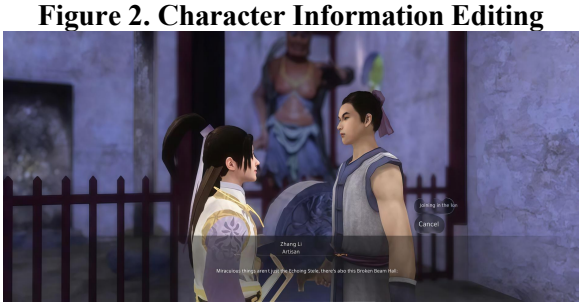

Figure 3. Character Interaction

However, the three-dimensional reconstruction of architectural heritage within Metaverse platforms is highly dependent on data acquisition and modeling technologies. The management of data integrity and the complexity of resource structures highlight the resource-intensive nature of such endeavors, particularly in terms of capital investment and the allocation of technical expertise. (Bai, 2020)[4] The "Virtual Suzhou" Metaverse app still exhibits shortcomings in modeling accuracy and the fidelity of detail reproduction. User evaluations have become polarized, as shown in the figure 4, with concerns raised regarding the precision of task- and scene-related modeling as well as the operational workflow. In addition, the app suffers from a lack of interactive features, long scene loading times, and insufficient richness of application elements, resulting in limited user engagement and overall appeal.

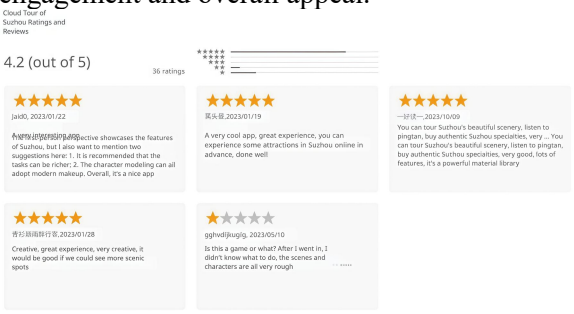

Figure 4. Rating and Review

2.2 Projection Mapping and Media Art

Barcelona's architectural heritage projects employ projection mapping and media art to transform historical sites, such as Gaudí's buildings, into dynamic visual carriers through the artistic interplay of light, shadow, and space. Projection mapping technology utilizes building façades as natural screens, creating multidimensional narrative spaces through digital light and shadow, thereby transcending the limitations of traditional static viewing and enabling regenerative expressions of culture and art. To ensure color fidelity and alignment precision on complex architectural surfaces, the project employs high-luminance laser projection equipment, maintaining continuity of projection effects and correcting geometric distortions across curves, planes, and relief surfaces. Large-scale static images are integrated with real-time environmental data via customized machine learning models. In Figure 5, designer Refik Anadol further combines AI-driven data sculptures and painting, live audiovisual performances, and installations to produce an immersive on-site experience.

Unlike immersive experiences in virtual spaces based on digital twins, this form of media art is highly dependent on the specific physical heritage site. Its effects can only be fully realized within the real environment, leveraging architectural textures and ambient atmosphere. Consequently, a number of uncertainties exist. Since climate data participates in image generation in real time, the system must be sensitive to environmental changes and maintain visual fidelity under unstable conditions such as nocturnal lighting variations and weather fluctuations (e.g., cloud cover, wind speed, temperature, and humidity). On-site operations also require long-term maintenance of equipment and resources to ensure consistent exhibition quality.

Figure 5. Meteorological Technical Data

3. Cultural Heritage Reconstruction and User Experience

Technological experiences must evoke emotional responses in order to gain public acceptance and encourage repeated engagement and dissemination. (Wang, 2024) [5] To deepen the public's appreciation of Suzhou's cultural heritage, the Suzhou Metaverse project vividly recreates the idealized "bridges, streams, and riverside dwellings" of traditional life. To preserve this historical memory, the project has completed a three-dimensional model covering approximately 420 square kilometers within the city's central ring. This virtual world allows visitors to experience the ancient city's culture, intangible cultural heritage, museum collections, and human stories online, while also providing multifunctional experiences such as cloud-based shopping and community sharing.

The "Virtual Suzhou" Metaverse app, built on highly immersive virtual technologies, demonstrates dual value in cultural heritage preservation and creative innovation. The application reconstructs areas such as Pingjiang Road, the historic canal network, and garden

streets in an integrated 3D model, faithfully restoring the historical appearance and daily life of the ancient city, thereby enabling users to obtain near-authentic sensory experiences in a virtual space. For instance, high-precision surveying and 3D modeling have been conducted for Suzhou's classical gardens, capturing detailed elements such as architecture, rockeries, and vegetation, and reproducing overall color schemes, spatial orientation, and material textures. This digital reproduction of the physical environment not only preserves the esthetic value, traditional Jiangnan architectural patterns, and cultural memory, but also provides a sustainable digital archive of the city's historical legacy.

The platform further reinforces the "living" transmission of culture through narrative-driven characters and the embedding of local contexts. Digital characters such as the 18-year-old classical-style youth "Jiangnan," a shoulder-pole vendor, and Gu Xiaoman, combined with the continuous introduction of Wu-speaking NPCs, allow regional language, folk customs, and local character representations to be regenerated through interaction. Players can engage in dialogs with these characters or undertake tasks, creating a form of participatory cultural learning. This virtual interaction, mediated through local language, transcends the limitations of traditional one-way communication, enabling the intergenerational continuation of intangible cultural heritage such as the Suzhou dialect and Pingtan storytelling. Within the Pingtan Hall, audiences can explore the development history of Pingtan, learn about renowned performers across generations, access historical and cultural materials, and even select specific Suzhou performing arts pieces. The app also incorporates interactive modules such as digital weddings and virtual photo-taking, blending the traditional garden's romantic imagery with contemporary user experiences to create cultural scenes that combine classical esthetics with modern engagement.

In terms of digital presentation, the app demonstrates a strategy of creative re-interpretation. The Digital Crafts Market module integrates intangible cultural heritage products such as Suzhou embroidery, walnut carving, and Taohuawu woodblock New Year prints, and enables online display and commerce through the "Virtual Travel Post." This converts cultural resources into sustainable cultural productivity, broadening the audience for traditional crafts while opening new pathways for the cultural economy.

Through spatial reconstruction, linguistic interaction, and commercialized operations, the "Virtual Suzhou" app achieves the digital re-creation of cultural heritage, preserving the historical memory of the Jiangnan ancient city and imbuing traditional culture with new vitality. It provides a replicable technological approach and developmental paradigm for local cultural heritage transmission within the Metaverse environment.

Casa Batlló is located on Passeig de Gràcia in central Barcelona, Spain. Antoni Gaudí's renovation of the building was inscribed on the UNESCO World Heritage List in 2005. (Wang, 2025)[6] Drawing inspiration from nature, Gaudí integrated spectacular natural motifs-such as rivers, waves, clouds, and fish scales-into the architecture, with graceful design curves creating a mysterious, underwater-like world. To revitalize this iconic building, designers Refik Anadol and Sofia Crespo employed digital art through artificial intelligence and augmented reality, reintroducing Casa Batlló to public attention.

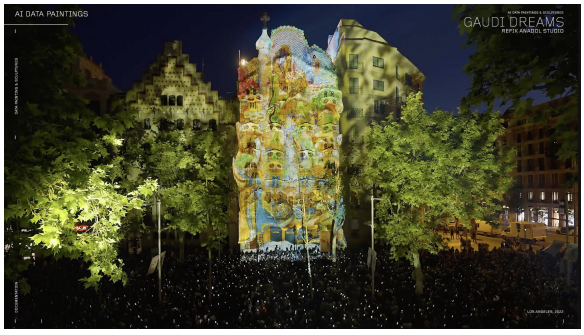

Figure 6. Living Architecture

Anadol compiled a dataset of approximately one billion images, including Gaudí's sketches, historical visual archives, academic records, and publicly available photographs of Casa Batlló from various Internet and social media platforms. (Yang, 2023) [7] These data were then processed through custom algorithms that incorporated Barcelona's climate data to generate images projected onto the building as shown in Figure 6. The projections were not mere surface textures but interacted dynamically with the architectural forms. The curves of the exterior walls, tiles, balconies, and windows served as a "canvas" for light and shadow, with these structural features often guiding the patterns and movements within the projected imagery.

Anadol extended Gaudí's design philosophy-emphasizing natural curves, fluidity, and organic structures-by integrating AI, data visualization, and sound design. This approach respects the historical heritage while transforming the building into an active participant and medium of dynamic art. At media art festivals such as "Llum BCN," projection mapping further incorporates contemporary artistic elements, including abstract geometry and digital particle effects, fostering a dialog between tradition and modernity. This method not only enhances the visual appeal of the building as cultural heritage but also endows it with renewed artistic vitality [8].

Casa Batlló represents the first UNESCO World Heritage site presented in the form of dynamic NFTs, which, in combination with external projection mapping, are also displayed within the interior rooms. The work was sold on May 10 at Christie's 21st Century Evening Auction, with 10% of the proceeds donated to organizations supporting neurodiverse adults and children. This initiative demonstrates a synergistic effect between artistic value and social impact, generating economic value while simultaneously fulfilling a public mission of promoting social inclusion and diversity [9].

4. Impacts on Urban Renewal and Culture-Driven Development

This paper conducts a comprehensive analysis from the perspectives of research background, technological implementation, cultural heritage reconstruction, and user experience. By comparing the "Cloud Tour Suzhou" Metaverse project and the media art practice at Casa Batlló in Barcelona, it explores the role of digital technology in cultural inheritance and urban regeneration. The study reveals that although the two cases differ in their technical approaches and expressive forms, both share the common goal of revitalizing cultural connotations through digital means, enhancing public engagement and cultural identity, and providing a valuable model for future culture-driven urban renewal.

Both the Suzhou Metaverse project and Casa Batlló in Barcelona aim to engage audiences as active co-creators. Users can experience local culture through mobile interactions, on-site participation, or digital collections, enabling multi-sensory engagement. From the perspectives of participation methods, narrative strategies, and public involvement, the "Virtual Suzhou" platform demonstrates a strong educational function. The project emphasizes accessibility and universality, faithfully reproducing the city's original appearance, allowing global online users to intuitively experience Jiangnan landscapes and understand local culture. In contrast, Casa Batlló focuses on regeneration, creating unique artistic experiences and cultural consumption. Through nighttime light shows, media art festivals, and cross-disciplinary exhibitions combined with NFTs, the project activates heritage sites for night-time use and tourism, promoting the adaptive reuse of historic streets and architectural spaces.

Although both initiatives place "culture-driven" approaches at the core of urban renewal, the Suzhou Metaverse app emphasizes the digital extension and soft enhancement of cultural dissemination, leveraging technology to achieve long-term and widely accessible international outreach. Barcelona, by contrast, prioritizes cultural regeneration of urban spaces and immediate experiential engagement, using on-site artistic practices to activate spaces and drive economic growth. In the digital era, urban renewal can expand cultural influence through virtual means while simultaneously enhancing the tangible appeal of heritage sites through artistic interventions, presenting a multidimensional pathway for culture-driven development.

5. Conclusion

This study comparatively examines the digital practices of culture-driven urban renewal through the cases of Suzhou's "Virtual Suzhou" Metaverse project and Barcelona's Casa Batlló digital art projections. The Suzhou Metaverse app utilizes virtual technologies and the Metaverse to document and preserve gardens, architecture, and folk landscapes, ensuring the continuation of intangible cultural heritage through immersive experiences. It also expands the online cloud commerce market, promoting the digital commercial operation of cultural resources, injecting new vitality into the city, and enhancing cultural influence. In contrast, Barcelona's digital practice transforms architecture into a real-time, dynamic "living" artwork, activating urban spaces and integrating contemporary algorithmic art with traditional architectural language through naturalistic visual narratives. By positioning the heritage site as a cultural event within the global art market, and

through auctions and art festivals, the project extends the international influence and economic value of the architectural heritage while simultaneously enhancing its social responsibility through charitable contributions.

While technology serves as a powerful driver, the success of cultural heritage transmission ultimately depends on whether the core cultural values are effectively activated and embraced. Suzhou offers a long-term strategy emphasizing "cultural authenticity and universal accessibility," whereas Barcelona demonstrates the "expressive power and international marketability" of contemporary interventions. Multi-level urban renewal, combining online and offline experiences, may provide greater momentum for cultural dissemination and urban regeneration. Cities can adopt a dual-track approach of "digital archiving + artistic regeneration," preserving the full integrity of heritage while revitalizing historic areas through contemporary art, thereby establishing a tripartite collaboration among cultural heritage conservation, technology enterprises, and the creative industry, and forming an integrated paradigm of preservation–innovation–dissemination.

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