

Sustainable Development Practices in Architectural Design for Cultural Inheritance in Chinese Cities

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ABSTRACT

Cultural heritage plays a crucial role in urban regeneration and sustainable development. In recent years, Chinese cities have encountered mounting challenges in architectural sustainability, particularly in reconciling the demands of modernisation with the preservation of cultural heritage. This study aims to explore architectural design pathways that integrate sustainability with urban cultural inheritance to bridge this critical gap. Based on a systematic literature review and a multi-case study methodology, it develops an integrative framework that combines critical regionalism—as a value orientation that responds to local culture and social identity—with urban catalyst theory as an operational pathway for revitalising public life and cultural vitality. Case data were coded and thematically analysed using ATLAS.ti 9 to test the framework's applicability and extract transferrable insights. Findings indicate that the sustainable development of Chinese cities benefits from a culture-oriented design approach. Within this paradigm, architecture can achieve a dynamic balance between cultural continuity and modernity through four key strategies: employing materials to sustain heritage, leveraging technology for cultural integration, reinforcing identity and belonging, and optimising spatial structures and organisation. Collectively, these strategies promote the living transmission of urban culture and provide theoretical as well as practical guidance for developing culture-prioritised urban design policies.

Keywords: urban China, architectural design, cultural heritage, sustainable development

INTRODUCTION

Over the past two decades, China has undergone rapid urbanisation. However, the pursuit of short-term economic growth has disrupted the existing urban architectural landscape and, to some extent, neglected the long-term global goals of sustainable development (Zhang et al. 2023). As tensions between urban renewal and cultural heritage preservation have intensified (Diao and Lu 2022), the General Office of the Central Committee of the Communist Party of China issued

the “Opinions on Continuously Advancing Urban Renewal” (The Central People’s Government of the People’s Republic of China 2025), emphasising the need to strengthen cultural inheritance in renewal processes and to promote the deep integration of sustainable architecture with heritage protection. This policy shift indicates that, after a phase of development driven by speed and scale, Chinese cities have entered a new stage of high-quality development centred on cultural value enhancement (Ye et al. 2021). As Naheed and Shooshtarian (2022) note, the protection and adaptive reuse of urban historical and cultural elements is no longer regarded as an act of nostalgia, but rather as a sustainable strategy that integrates economic and cultural values. Within this context, the question of how architecture can serve economic and social needs while preserving the “cultural genes” of the city has become a central issue.

Although urban cultural inheritance and sustainable architecture have both been extensively discussed in academic research, studies that combine the two remain limited. Previous scholarship has mainly focused on two areas: first, heritage preservation, which emphasises the conservation of traditional architectural forms and cultural symbols but often overlooks the operational demands and economic feasibility of modern cities (Xie et al. 2024; Zhou et al. 2022); and second, sustainable architectural design, which advances ecological goals through green materials, energy-saving technologies, and low-carbon design, yet frequently lacks cultural considerations (Aduwo et al. 2024; Dash and Shetty 2020). Against this backdrop, this paper adopts a culture-oriented perspective on sustainable architecture to explore how urban renewal can balance cultural inheritance with modernisation. It addresses two core research questions:

1. What are the theoretical foundations of sustainable architectural design in the context of cultural inheritance in Chinese cities?
2. In the context of urban renewal, what design strategies can effectively balance cultural preservation with the demands of modernisation?

The structure of the paper is as follows:

1. Systematic literature review—reviews the relevant literature, examining research developments on cultural inheritance and sustainable design, and establishes the theoretical framework for this study.
2. Multi-case study—outlines the multi-case study approach, including the methodology, case selection, and data sources, and describes how coding and thematic analysis were conducted using ATLAS.ti 9 to enable cross-case comparison.
3. Discussions—discusses the findings and synthesises key design strategies, mapping them onto the theoretical framework.
4. Conclusion—concludes the paper by summarising the main arguments, proposing policy recommendations, and identifying limitations and directions for future research.

Overall, this research makes three key contributions. First, it deepens the theoretical understanding of sustainable architecture through the lens of cultural inheritance. Second, it provides architects and urban planners with practical strategies for balancing cultural preservation with modernisation in design practice. Finally, it offers theoretical foundations and case-based evidence to support the formulation of culture-prioritised urban architectural policies.

SYSTEMATIC LITERATURE REVIEW

By reviewing literature from the past five years, this section synthesises research on sustainable architectural design and cultural inheritance to address the question of what constitutes the theoretical foundations of sustainable architectural design in the context of cultural inheritance in Chinese cities.

Literature Search Method

A rigorous search strategy and precise keyword identification are essential prerequisites for conducting a systematic literature review. To ensure reliability, this study followed the PRISMA 2020 guidelines (Preferred Reporting Items for Systematic Reviews and Meta-Analyses). The search was limited to the period 2020–2025 to capture the latest trends and scholarly advances in sustainable development and cultural inheritance. The databases included both Chinese and English sources: China National Knowledge Infrastructure (CNKI) for Chinese literature, and Web of Science and Scopus for English-language publications. This selection ensured both national and international coverage with adequate scholarly quality. Articles were drawn from multiple disciplinary domains, including Arts and Humanities, Architecture, Building and Construction, Cultural Studies, and Urban Studies.

Search keywords were designed bilingually (English and Chinese) to accommodate both types of databases. Table 1 presents the keyword framework employed. Synonyms and expanded terms were incorporated during the search process to capture the core concepts while also covering related studies across different disciplinary contexts.

Table 1 Literature search keyword framework

Keyword (EN/CN)	Synonyms (EN/CN)	Expanded words (EN/CN)	Notes
Sustainable architectural design/ 可持续建筑设计	Sustainable building design/ 可持续建筑设计; Sustainable building/ 可持续建筑	Green building/ 绿色建筑; Architectural design/ 建筑设计	Covers architectural design related to the concept of sustainability
Cultural inheritance/ 文化传承	Cultural transmission/ 文化传递; Cultural continuation/ 文化延续	Cultural heritage/ 文化遗产; Architectural heritage/ 建筑遗产; Cultural protection/ 文化保护; Cultural identity/ 文化认同; Cultural revitalisation/ 文化振兴	Focuses on cultural inheritance and heritage preservation-related concepts
Chinese cities/ 中国城市	Chinese urban/ 中国城市	Chinese urbanisation/ 中国城市化; Chinese urban development/ 中国城市发展; Chinese urban planning/ 中国城市规划	Reflects the policy and design context of Chinese cities

Due to differences in database syntax, differentiated search strategies were devised for the three databases. In Scopus, the TITLE-ABS-KEY field was used together with the W/x operator to perform order-fixed proximity searches, thereby improving precision. For example, the query “Cultural W/3 inheritance” effectively captured expressions such as “cultural inheritance,” “cultural heritage inheritance,” and “cultural significance and inheritance.” In Web of Science, the topic retrieval method was adopted, with the NEAR/x operator incorporated to control the word spacing between keywords. The advantage of this method lies in its flexibility, as word order is not restricted. For instance, “Chinese NEAR/3 cities” covers Chinese cities as well as variants such as cities in the Chinese context, thereby reducing omissions caused by different word orders or inserted terms. In CNKI, where NEAR/W proximity operators are not supported, searches relied primarily on the “subject” field (covering keywords, title, and abstract), combined with Boolean logic (AND/OR) and truncation (*), to broaden coverage of literature related to the research topic in the Chinese context. This differentiated strategy ensured comprehensive retrieval while enhancing the specificity and comparability of results across languages and disciplinary domains.

Study Selection and Quality Assessment

The screening followed the PRISMA 2020 process, comprising four stages: Identification, Screening, Eligibility, and Included. The initial search across Scopus, Web of Science, and CNKI yielded 532 records. Of these, 67 were duplicates, leaving 465 unique records. After careful review of titles and abstracts, 155 articles were selected for full-text assessment, of which 48 studies were ultimately included in the systematic analysis (Figure 1).

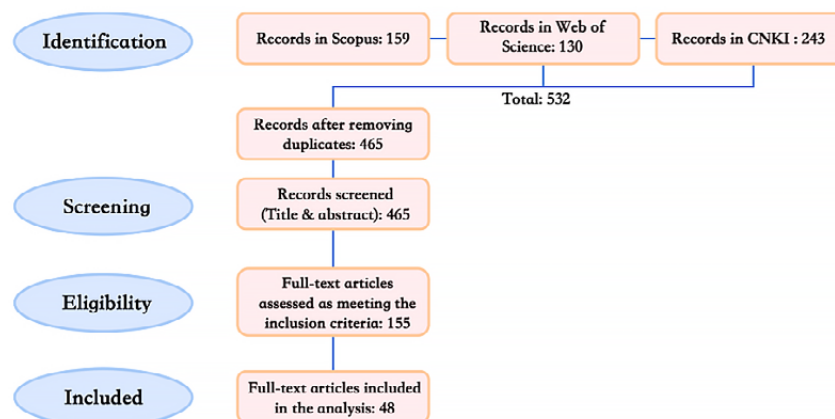


Figure 1 Literature screening flow diagram following PRISMA 2020 guidelines

To enhance the alignment of the study with its core questions, three types of narrowing strategies were applied during the eligibility stage:

1. **Disciplinary narrowing:** Preference was given to studies in architecture, cultural studies, and sustainable development. Literature focusing primarily on engineering and technical issues (e.g., structural mechanics, thermal analysis, material performance) was excluded if it lacked consideration of cultural dimensions in architectural design.

2. Thematic relevance narrowing: Studies addressing only broad issues such as sustainable development, urban development, or urban planning were excluded. Retained studies explicitly examined the intersection of architectural design/sustainable architecture and cultural inheritance/heritage, particularly those directly responding to the research questions.
3. Contextual applicability narrowing: Studies involving Chinese urban cases were prioritised. Research based on other countries or regions was excluded if data and methods lacked transparency, findings could not be transferred, or conclusions relied excessively on specific political or geographical conditions that limited generalisability.

During the quality assessment stage, candidate studies were evaluated systematically across four dimensions:

1. Thematic relevance: Whether the study explicitly addressed “sustainable architectural design × cultural inheritance” in the context of Chinese urban renewal.
2. Theoretical contribution: Whether relevant theories or models (e.g., critical regionalism, urban catalyst theory) were proposed, tested, or applied to support the research questions.
3. Methodological transparency: Whether the research methods, cases, and data sources are presented clearly, comprehensively, and with verifiable reliability. The reference scope of the systematic literature review primarily covers three authoritative academic databases—Scopus, Web of Science, and CNKI—to ensure the systematicity and reliability of the literature retrieval process. All selected studies have been individually catalogued and listed in the literature review table (extended data is available upon request; refer to the Data Availability section) to demonstrate the transparency and rigour of the research process.
4. Academic reliability: Whether the study was published in peer-reviewed journals or in a high-impact outlet with strong citations.

The quality assessment was conducted in two rounds. In the first round, titles and abstracts were screened, resulting in 155 studies. In the second round, full texts were reviewed and rigorously evaluated against the aforementioned criteria, resulting in the inclusion of 48 core studies for analysis. Based on disciplinary distribution and their relevance to the research questions, these studies were grouped into three categories: architecture and construction, culture and the arts, and urban and regional studies. The following section examines the theoretical research on sustainable architectural design and cultural inheritance reflected in this body of literature, thereby addressing Research Question 1.

Theoretical Explorations of Sustainable Architectural Design

Sustainable development has been widely discussed in the fields of architecture and urban planning. Its core principle is to meet the needs of the present without compromising the ability of future generations to meet their own (Lv et al. 2023). As cities expand, the theoretical development of this concept in architecture has shifted from a technical focus to a more integrated approach (Ji et al. 2025; Han et al. 2021). In particular, research in the past five years has emphasised that sustainable architectural design is not only concerned with environmental benefits but also encompasses social and cultural dimensions (Lavaf-Pour and Meraz 2023; Tan

and Tan 2023). For example, Wang and Ramakrishnan (2021) conceptualised its scope in terms of three aspects: adaptive reuse, cultural integration, and environmental compatibility, which they identified as key criteria for evaluating architectural sustainability.

Specifically, adaptive reuse refers to the practice of repurposing existing buildings and structures in ways that meet contemporary functional needs while preserving their historical and cultural significance (Takva et al. 2023). Foster (2020) shows that reusing existing buildings not only reduces carbon emissions and resource consumption, but also preserves cultural value while accommodating modern functions. Cultural integration emphasises combining traditional architectural elements with modern design methods so as to ensure that the built environment authentically reflects local cultural characteristics (Abumere and Ahianba 2025). Such integration strengthens the sense of place and mitigates the homogenisation of urban spaces (Zheng 2024). Environmental compatibility, meanwhile, advocates for designs that harmonise with the surrounding natural and socio-cultural environment, employing sustainable materials and green technologies to minimise ecological footprints (Dauletbek and Zhou 2022).

Overall, sustainable architectural design is moving towards greater comprehensiveness and multidimensionality. This trend not only expands the theoretical boundaries of sustainability but also opens up critical opportunities to deepen urban renewal from a cultural perspective.

Theoretical Foundations of Cultural Inheritance in Urban Renewal

The literature analysis shows that in the past five years, research on cultural inheritance in urban renewal has primarily concentrated on architectural heritage conservation theory (Fayez 2024; Liang et al. 2023), critical regionalism (Giamarelos 2022; Qiu 2023), and urban catalyst theory (Schreiber et al. 2023; Wang 2022). These three approaches, focusing respectively on preservation, expression, and activation, provide the theoretical foundations for sustaining culture and architecture in contemporary urban contexts.

The core of architectural heritage conservation theory lies in maintaining the integrity and continuity of historical environments through restoration and maintenance, while enhancing the scientific rigour and systematic nature of conservation with digital technologies such as BIM, GIS, and 3D laser scanning. Critical regionalism, building on heritage conservation, advances a more critical stance. It argues that under the pressures of globalisation and modernisation, architectural design must be closely connected to its natural setting and socio-cultural context. It emphasises the localised use of materials and adaptive design strategies to balance modernity with locality (Giamarelos 2022). This theory reconceptualises cultural inheritance not as “static preservation,” but as an architectural mode of expression capable of engaging with contemporary societal needs (Cao et al. 2024). Another influential perspective is urban catalyst theory, which provides a dynamic logic for activating cultural inheritance in renewal processes. Otto and Luogan (1989) were the first to apply the concept of a “catalyst” to urban design, arguing that small-scale architectural interventions can trigger chain reactions in the urban system, stimulating broader cultural and spatial renewal. On one hand, the theory highlights the precise restoration, transformation, or revitalisation of historic buildings and cultural sites, combining traditional cultural elements with modern functions to preserve cultural memory. On the other hand, it promotes the idea that “small interventions can catalyse major changes,” offering a sustainable pathway for economic development and value regeneration (Li and Chen 2024).

Together, these three theoretical perspectives highlight the importance of culture in urban renewal from different angles. However, their applicability and complementarity require further synthesis, which forms the focus of the next section: Theoretical Integration and Analysis in the Chinese context.

Theoretical Integration and the Chinese Context

Although the three theories discussed above all provide important conceptual resources for cultural inheritance and urban renewal, their applicability differs. Architectural heritage conservation theory primarily focuses on maintaining the integrity of historical and cultural resources; however, it does not engage with the broader field of sustainable development, making its contribution to this study relatively limited. In contrast, critical regionalism and urban catalyst theory are more applicable and are often applied in combination in specific cases. The former offers design principles rooted in local culture and context, guiding architects to integrate traditional craftsmanship with modern technologies. The latter emphasises small-scale interventions or node-based architectural transformations that sustain and innovate local cultural genes, thereby generating complex and multidimensional sustainable benefits for surrounding areas. In practice, the two are complementary: critical regionalism addresses how to express culture, while urban catalyst theory focuses on how to activate culture. Together, they point towards the revitalisation and regeneration of culture in contemporary cities.

This integrative framework is particularly significant in the Chinese context. Evaluations of Chinese cities' progress towards achieving the United Nations Sustainable Development Goal 11 (SDG 11) indicate that, while overall progress has been positive, it remains uneven and insufficient in pace. Roughly 60% of cities are on track to meet the 2030 target; 38% are stagnant or regressing; and around 2% have achieved only modest improvement (Li, Zhang, and Gao 2023). This reality highlights regional disparities and bottlenecks in the urban development process, underscoring the inadequacy of relying on a single theoretical lens to address such complex transitional challenges.

Drawing on the findings of this systematic literature review, it is evident that critical regionalism has in recent years been widely applied in architectural research and practice, providing a value orientation for localisation and cultural representation. In contrast, urban catalyst theory has primarily been used in urban renewal and spatial governance, emphasising how targeted interventions can generate broader transformations. Therefore, this paper advocates a dual “value–pathway” framework: critical regionalism functions as the theoretical foundation at the value level, ensuring that design responds to local culture and social identity; urban catalyst theory operates as the practical pathway at the operational level, enabling dynamic cultural and spatial regeneration through incremental, node-based strategies. This integration not only compensates for the limitations of individual theories but also provides Chinese cities with theoretical depth and practical feasibility in pursuing sustainable development goals. Figure 2 illustrates this integrated theoretical framework, visually presenting the complementary relationship between values and pathways within the research logic.

MULTI-CASE STUDY

The multi-case study builds on the preceding literature review and integrative framework to address Research Question 2: In the context of urban renewal, what design strategies can effectively balance cultural preservation with the demands of modernisation? By conducting an in-depth examination of representative cases, this study not only illustrates how the theories operate in practice but also, through cross-city and cross-project comparisons, distils transferable strategies and patterns that provide empirical support for culture-oriented sustainable architectural design.

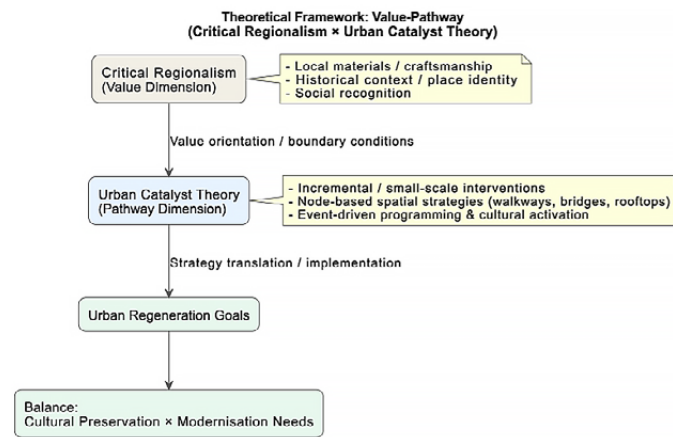


Figure 2 Integrative theoretical framework of value-pathway (Critical Regionalism x Urban Catalyst Theory) for urban regeneration

Methods and Case Selection

To test the applicability of the theoretical framework in the Chinese context and to explore pathways that integrate cultural inheritance with sustainable architectural design, this study adopted a multiple case study approach. This method allowed for comparative analysis across different urban settings and project types, uncovering both commonalities and divergences, thereby providing a practical foundation for theoretical integration. Case selection was guided by four inclusion criteria to ensure representativeness and rigour:

1. Sustainability performance: Cases must reflect the core principles of sustainable architectural design, with demonstrable achievements in energy efficiency, material selection, and environmental adaptability.
2. Cultural and historical value: Cases must explicitly respond to local cultural and historical contexts, achieving continuity through preservation, adaptive reuse, or innovative reinterpretation of cultural elements.
3. Social and cultural benefits: Cases must generate positive social and cultural impacts at the urban or regional level, as evidenced by indicators such as public space activation, cultural programming, community participation, or visitor numbers.
4. Practical feasibility: Cases must offer sufficient project data and diversity in geography and strategic significance.

Based on these criteria, three representative cases were selected: the main buildings of Shenzhen Bay Cultural Plaza (a large-scale coastal cultural hub), the West Wing of Suzhou Museum (a contemporary intervention in a historic cultural city), and the Zhangyan Cultural Museum in Shanghai (a small-scale renewal within rural revitalisation and historic village conservation). These cases encompass different types of architectural practice and provide comparative perspectives for analysing urban renewal strategies.

Data Collection from Archival Documents and its Analysis

Data collection combined fieldwork and archival research. Archival sources included architectural drawings, interviews with architects, visual documentation, policy documents, scholarly publications, and media reports, providing insights into project backgrounds, design

concepts, and the transmission of cultural values. In addition, the archival research drew on secondary materials facilitated by the study's "gatekeeper," a member of the project design team from the same company, including electronic interview videos embedded in the design documents. Fieldwork complemented these sources by focusing on first-hand observation and documentation of adaptive reuse and environmental compatibility (e.g., energy efficiency, material performance, and responsiveness to site conditions), supplemented by data on visitor numbers and cultural activities to assess social and cultural impacts.

In terms of data analysis methodology, this research adopted a combined approach of thematic analysis and comparative case study. Field research data and materials obtained for the case studies, including architectural drawings, Transcripts from archival interviews, visual materials, and policy or media documents, were subjected to open coding using ATLAS.ti 9 software. Initial themes were progressively refined into more specific sub-codes through iterative categorisation and aggregation, ultimately distilling several core themes. Building on these findings, the study then compared the commonalities and differences across the cases in relation to architectural design strategies and cultural heritage pathways. The results were subsequently mapped and interpreted through the lenses of critical regionalism and urban catalyst theory, leading to the identification of key design strategies that are tailored to the Chinese context and that address the study's research objectives.

Analysis and Findings

This section presents a systematic analysis of the selected cases based on the previously proposed value-pathway dual framework. Critical regionalism, as the value dimension, emphasises architectural responses to local culture and social identity, while urban catalyst theory, as the pathway dimension, focuses on incremental and node-based spatial interventions that stimulate cultural and spatial regeneration. During the coding process, the overarching theme of "balancing modernisation with cultural preservation" was identified as the parent category. This was further refined into three first-level themes: regional response, nodal activation, and pluralistic symbiosis. Within this analytical framework, a tripartite of case studies—Shenzhen Bay Culture Plaza, the Suzhou Museum West Wing, and the Shanghai Zhangyan Cultural Museum—systematically illustrates their distinct approaches to advancing cultural sustainability in the context of urban renewal. The formation of their key design strategies is elucidated through the interplay between coded qualitative evidence (extended data is available upon request; refer to the Data Availability section).

Case One: Main Building of Shenzhen Bay Cultural Plaza

Shenzhen Bay Cultural Plaza is located in the core coastal area of Houhai, Nanshan District, Shenzhen. It represents a new-generation urban cultural landmark that integrates green spaces with public activities. Jointly designed by MAD Architects and the East China Architectural Design and Research Institute, the project adopts the concept of "seaside megaliths." Through the use of extensive stone curtain walls and massive pebble-shaped volumes, the design creates a surreal primordial landscape that resonates with both the coastal environment and the city's collective memory. Covering a total floor area of approximately 182,000 m², the project consists of two main parts (Yuan 2020): the North Hall (Shenzhen Design Museum) and the South Hall (Shenzhen Science and Technology Museum). The South Hall includes the Floating Stone Pavilion (19.3 m high), the Cloud-Gazing Stone Pavilion (31.3 m high), the Suspended Stone Pavilion (26.3 m high), and the Flowing Stone Pavilion (12.3 m high). The North Hall comprises the Rainbow Stone Pavilion (25.3 m high), the Cloud-Capturing Stone Pavilion (52.3 m high), the Sea-

Embracing Stone Pavilion (15.4 m high), and the Pearl Stone Pavilion (10.3 m high). The overall master plan is presented in Figure 3, while the distribution of the pavilions and representative renderings are shown in Figure 4.



Figure 3 Master Plan of Shenzhen Bay Cultural Plaza

Source: MAD Architects (2021)



Figure 4 Pavilion distribution and renderings of Shenzhen Bay Cultural Plaza

Source: MAD Architects (2021)

Regional Response: Material Adaptation and Cultural Imagery

According to MAD Architects (2021), the stone curtain wall system of the building employs approximately 340,000 curved granite strips in widths of 50 mm, 80 mm, and 100 mm. These strips are installed using a 4 mm staggered tight-joint method to create a continuous curved surface. Precise installation was achieved through Rhino+GH parametric modelling and full-process BIM application, resulting in a seamless and monolithic visual effect. The exterior resembles coastal megaliths eroded by seawater, evoking a dual imagery of both “primitiveness” and “futurity.” The granite surface is treated with a flamed finish, providing excellent weather resistance to humidity, rain, and intense sunlight. Maintenance relies on 3D scanning combined with BIM model comparisons to pinpoint and replace damaged stone strips, thereby enhancing sustainability throughout the building’s lifecycle. As one designer noted: “This stone will not require replacement for 50 years” (DAYUCLASS 2022). Compared with glass curtain walls or coated surfaces that typically require renewal every 15 to 20 years, this choice significantly reduces long-term resource consumption and carbon emissions.

In addition, only about 8% of the facade is composed of glass curtain walls (MAD Architects 2021). The use of high-thermal-mass stone improves the building’s heat capacity, effectively buffering indoor environments against external temperature fluctuations. The glass components are coated with Low-E films, ensuring natural lighting and transparency while reducing solar heat gain, which lowers cooling loads and enhances environmental stability. By integrating material adaptability with cultural imagery, these strategies not only reshape coastal cultural symbols in architectural form but also strengthen environmental resilience in performance, embodying the principle of “locality” emphasised by critical regionalism.

Node Activation: Spatial Connectivity and Cultural Catalysis

Through multi-layered spatial organisation and nodal design, the project achieves a dual objective of spatial connectivity and cultural vitality. The design introduces a sunken plaza at -10.40 m, directly linked to subway and commercial entrances, organically integrating leisure, commerce, and transportation nodes. This design effectively resolves the 2.20 m height difference with adjacent plots while strengthening the interface between underground commercial space and the metro system, thereby forming a key hub for circulation and activities (field notes, ATLAS.ti code: SN-01). One designer remarked: “The sunken plaza naturally attracts people and activates the vitality of the place” (interview, ATLAS.ti code: SI-02).

At the core of the plaza lies a central interactive waterscape: a shallow pool measuring 88 m × 55 m (approx. 3,450 m²), with water depth ranging from 15 to 35 cm, equipped with mist sprays, wave generators, and fountain jets. The central square can accommodate up to 12,000 people, while the central stage within the pool directly functions as a seaside theatre (design documents, ATLAS.ti code: SD-03). Together, these features create a critical node for civic gathering and cultural performances, enhancing both the frequency of public use and the capacity for hosting cultural events.

Notably, the preservation of the bay passage allows citizens to freely traverse the site even when the museum is closed, maintaining continuous urban access to the coastal landscape. As the design brief emphasises, these spaces are intended to “facilitate encounters and interactions across different levels through nodal organisation” (interview, ATLAS.ti code: SI-05). Collectively, these strategies demonstrate how spatial connectivity and vertical integration contribute to cultural vitality and reinforce publicness.

Polyphonic Symbiosis: Environmental Resilience and Cultural Co-creation

The green-slope roof and the curtain wall rainwater recycling system constitute key highlights of the project's environmental resilience. The continuous and curvilinear green roofs not only provide stormwater retention and management functions but also play an active role in mitigating the urban heat island effect. The design adapts to varying slope conditions through differentiated technical strategies and controlled soil depth: approximately 85 cm in lawn and shrub areas, and 1.2 m to 2 m in tree-planted zones. Areas with a slope gentler than 1:3 employ conventional soil layering, while steeper sections adopt structural soil systems to ensure substrate stability (MAD Architects 2021). The resulting multi-layered vegetative landscape enhances rainwater regulation and further improves overall ecological performance. Field measurements show that during summer, roof surface temperatures are 1.5°C to 2 °C lower than surrounding areas, effectively improving the microclimate of public spaces (on-site monitoring, ATLAS.ti code: SM-02). In addition, concealed rainwater collection systems embedded at curtain wall joints enable water recycling and pollutant reduction.

In the design practice of Shenzhen Bay Cultural Plaza, environment and culture are not treated as separate ends but as interdependent forces forming a symbiotic pattern. The undulating green slopes create elevated outdoor platforms for leisure and social interaction, while the “grey spaces” beneath the slopes and between the stone clusters offer flexible venues for encounters, conversations, and diverse activities or exhibitions. Skylights integrated into the structural system generate organic and dynamic gallery spaces, while the interweaving and floating relationship between the stone clusters and green slopes produces a spatial language that unites interior and exterior, fostering a spiritually engaging exhibition environment. Variations in spatial scale and proportion enrich visitors' perceptions and memories: some ground-floor and basement-level galleries feature clear heights of 6 m, providing functional and standardised exhibition halls (design documents, ATLAS.ti code: SD-06), whereas other compact and meandering spaces deliver a more immersive and intimate cultural experience. The two complement each other and jointly achieve the organic integration of cultural display and public activities.

Case Two: Suzhou Museum West Wing

The Suzhou Museum West Wing, designed by the German architectural firm GMP, is a large-scale modern museum that integrates exhibition, education, and public service functions. The overall structure consists of 10 box-shaped units, each approximately 25 m in length, interconnected by glass corridors. This configuration creates an architectural ensemble that

combines a sculptural unity with a sense of spatial fluidity (Figure 5). The project is located in the Lion Mountain Cultural Plaza of Suzhou High-tech Zone, with a site area of 37,600 m² and a total floor area of 48,300 m², of which 13,400 m² are dedicated to exhibitions. Serving as a cultural hub between the old city and the new urban districts, the museum establishes itself as a vital link bridging historical heritage and contemporary urban development.

Regional Response: Traditional Dwellings and Cultural Narrative

In both appearance and materiality, the architecture deeply responds to the spatial texture of Suzhou's traditional lanes and the vernacular dwellings of Eastern Wu. For instance, the composition of the building massing consists of 10 cubic volumes, each separated by approximately 5.8 m. This spacing evokes the scale of alleyways, recalling memories of everyday life and the lived atmosphere of the historic city (Wang 2021). As illustrated in the sectional drawing (Figure 6), the interplay between glass corridors and curtain walls creates a dialogue between solidity and transparency, lending fluidity to the volumetric relationships. One visitor observed: "This architecture introduces the memory of the old city into the present, making the visit not only a cultural experience but also a rediscovery of local ways of life" (interview, ATLAS.ti code: MI-08). This strategy of "fragmenting and recomposing volumes" not only continues the historic urban fabric but also enables visitors, as they move through the museum, to look outward towards the surrounding park landscape. Through this process of shifting perspectives, they experience a layered, sequential journey reminiscent of the spatial storytelling tradition of Suzhou gardens.



Figure 5 Aerial view of Suzhou Museum West Wing

Source: Song (2022)



Figure 6 Sectional view of Suzhou Museum West Wing

Source: Song (2022)

The facade materials further reinforce this dialogue. Portuguese grey natural stone, with its warm tone and natural texture, resonates with the "whitewashed walls and dark tiled roofs" of Suzhou's traditional dwellings, establishing a coherent inside-outside unity. In addition, antibacterial copper panels are incorporated as decorative elements, gradually oxidising over time from yellow to a distinctive patina of green, harmonising with the environment. These "breathing" and "living" materials allow the building to change continuously with the passing of seasons and time, embodying the qualities of a living organism. In doing so, the design situates the building in conversation with the city's historical depth, achieving an integration of cultural resources with architectural form.

Node Activation: Light Strategies and Spatial Order

The spatial design of the Suzhou Museum West Wing employs a combination of sunken courtyards and punctuated apertures to activate critical spatial nodes and establish a

nuanced order of light and shadow (Figure 7). The sunken Chinese courtyard functions as the compositional core of the complex, serving not only as an aesthetic focal point but also as an instrument for stormwater management and microclimate regulation (design documents, ATLAS.ti code: MD-07). Its rigorous geometric layout mitigates the enclosure of subterranean space, while tall glass curtain walls and overhead openings channel natural light deep into the interior, transforming the courtyard into a vast “container of light.” As daylight shifts throughout the diurnal cycle, patterns of illumination traverse walls and floors, producing a dynamic scenography in which visitors, in motion, appear to participate in a silent drama orchestrated by light.

Concurrently, the stone facades are punctured with small apertures inspired by the vernacular technique of “cut-wall light borrowing” (Wang 2021). These discreet perforations introduce daylight into the galleries in delicate, pointillistic traces (Figure 8). The resulting constellation of light spots contrasts with the broad illumination of the central courtyard, generating a layered interplay between solidity and void. Beyond enhancing sensory experience, this strategy reinterprets and extends the geometric discipline and luminous order originally articulated by I. M. Pei in the first Suzhou Museum, situating them within a contemporary design vocabulary. In doing so, it reactivates collective memory of the earlier museum and establishes perceptual continuity between the old and new wings. Visitors experience the rhythm and rituality embedded in the shifting play of light, thereby reinforcing the cultural significance of spatial order.



Figure 7 The sunken courtyard of Suzhou Museum West Wing

Source: Photographed by the author

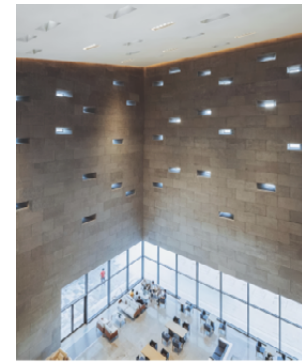


Figure 8 The small holes on the building's stone wall

Source: Photographed by the author

Polyphonic Symbiosis: Functional Integration and Cultural Hub

The Suzhou Museum West Wing achieves a diversified integration of exhibition, education, leisure, commerce, and public activities within its spatial programme, reflecting a symbiotic relationship between the museum, the city, and its citizens. The core exhibition areas present the history and craftsmanship of Suzhou, while the Discovery Pavilion is designed for children aged 3 to 12 and enhances cultural transmission through interactive and hands-on experiences (design documents, ATLAS.ti code: MD-11). This facility represents the first dedicated children's space within a Chinese museum. It positions the West Wing as a rare cultural venue suitable for family visits, significantly expanding the demographic profile of visitors and ensuring a stable flow of audiences during weekends and holidays. In addition, the lecture hall, academic rooms, and multifunctional hall provide platforms for forums, talks, performances, and international collaborative exhibitions, enabling the museum to function as a site of both knowledge production and cultural exchange. Supporting facilities such as cafes, restaurants, and cultural retail outlets further extend its public character, embedding the museum into the rhythms of daily urban life. Through the layering of these multiple functions, the West Wing operates as a self-sustaining cultural ecosystem that promotes coexistence and interaction among diverse groups. Operational data indicate that since 2023, the West Wing has recorded an annual average of more than one million visitors (Suzhou Museum 2023), with the figure continuing to rise each year, underscoring its significant social value as a public cultural resource.

In addition to functional hybridity, the strategic location of the West Wing gives it a distinctive role as a cultural hub. Situated in the Cultural Plaza of Suzhou's High-tech Zone, the museum occupies the central node of the new urban district and complements the original Suzhou Museum located in the historic city centre. The West Wing, through its open modern spaces, supports historical education, craft display, and international exchange. The original museum, drawing on the imagery of classical gardens, preserves the refined traditions of Suzhou's literati culture. Together, the two institutions establish a dual-museum structure that unites ancient and modern qualities while forming a cultural network across the old and new districts. This configuration allows the Suzhou Museum to mediate between past and present and to connect inner-city heritage with outer-city development. Within the broader framework of urban regeneration, the West Wing functions both as an engine of cultural vitality in the new town and as an extension of cultural memory rooted in the historic city.

Case Three: Zhangyan Cultural Centre, Shanghai

The Zhangyan Cultural Centre is located in Zhangyan, a millennium-old village in Chonggu Town on the western outskirts of Shanghai. It represents a typical case of restoration and renewal of village heritage sites under the broader agenda of rural revitalisation. Figure 9 presents an aerial view of the project site. The site covers approximately 1,435 m² and includes a Qing Dynasty village history museum, the late-Qing Zhang family residence, and several vacant plots. Guided by the design philosophy of "survival-growth-rebirth," the project team undertook a process of repair, renovation, and reconstruction. The approach simultaneously safeguarded the historical context and met contemporary functional requirements, endowing the ancient village with renewed social and cultural significance (Horizontal Design Office 2020).

Regional Response: Preservation of Heritage Remains and Modern Translation

The project is situated within an ancient village established during the Northern Song Dynasty, where remnants such as Qing-era courtyards, stone columns, and stone foundations still remain. During the renovation, the designers deliberately preserved four rows and five columns of stone pillars along with the stone slab foundations from the original structure within Exhibition Hall 2 (Figure 10). They also reinforced the exterior walls of the late-Qing Zhang family residence, enabling them to endure as a "cultural skeleton" that continues to carry regional memory (design documents, ATLAS.ti code: ZD-02). As one villager remarked: "These stone columns and bases are the soul of the architecture, the most direct evidence of the village's history" (field notes, ATLAS.ti code: ZI-05). These relics not only embody local craftsmanship and aesthetic values but also imbue the new spaces with a profound sense of historical gravity.



Figure 9 Aerial view of Shanghai Zhangyan Cultural Centre

Source: Horizontal Design Office (2020)



Figure 10 Interior of Exhibition Hall 2 at the Zhangyan Cultural Centre

Source: Horizontal Design Office (2020)

At the same time, the architects adopted a strategy of “formal translation,” reinterpreting traditional elements through contemporary means. The newly constructed exhibition hall features a double-pitched roof that continues the vernacular roof profile of the village, while substituting traditional tiles with light-grey titanium-zinc panels to enhance durability and performance. The exterior walls employ white fair-faced concrete, whose texture and tone recall the local “paper-fibred lime plaster” facades, thereby creating visual continuity between old and new. This translation of form and material regenerates the architectural vocabulary of the ancient village through modern techniques rather than severing or replacing it. By combining preservation with translation, the Zhangyan Cultural Centre establishes a dialogue between past and present at the spatial level. On the one hand, it respects and protects the authenticity of local heritage; on the other hand, it extends the vitality of traditional forms through contemporary design language. In doing so, it embodies the principle of “locality” emphasised in critical regionalism (Lu and Zhou 2021) and provides a model for cultural reproduction within the framework of rural revitalisation.

Node Activation: Spatial Superposition and Memory Reconstruction

The design of spatial nodes within the museum epitomises the superimposition of historical relics and contemporary functions, while continually reactivating cultural memory through everyday use. The most representative strategy is reflected in the treatment of the exterior wall of the Zhang family residence. The design team preserved the late-Qing exterior wall while inserting a new modern gallery inside (Figure 11), deliberately leaving a gap of more than 30 cm at the narrowest point between old and new so that the two structures remain physically and visually independent (design document, ATLAS.ti code: ZD-11). This method of “juxtaposition without fusion” avoids concealing historic fabric while enabling visitors to perceive the layering of temporal dimensions as they move through the space. As one architect noted in interviews, the aim was for audiences to sense both the weight of history and the immediacy of contemporary intervention within a single spatial experience (interview, ATLAS.ti Code: ZI-03). Through such nodal strategies, history and modernity are set side by side in the same domain, enriching cultural narratives and stimulating renewed recognition of local memory.



Figure 11 Juxtaposed walls of the Zhang family residence

Source: Horizontal Design Office (2020)

The Cultural Centre further embodies a “small intervention, big transformation” approach. Using modest-scale, reusable units, courtyards, corridors, and galleries are flexibly combined, allowing spaces to be adapted for diverse programmatic needs. This strategy avoids large-scale demolition, reduces costs, and ensures long-term vitality and efficiency. It preserves the historical environment while simultaneously creating a public space that can be readily shared by residents and visitors, thereby establishing a cost-effective and sustainable model of operation. According to media reports, new cultural and tourism projects in the area have attracted more than 50,000 visitors within a single year (Changjiang Life Diary 2024), significantly boosting local tourism appeal and demonstrating the catalytic role of cultural nodes in rural revitalisation.

Polyphonic Symbiosis: Traditional Courtyards and Cultural Regeneration



Figure 12 The courtyard in the Zhangyan Cultural Centre

Source: Horizontal Design Office (2020)

“Polyphonic symbiosis” in the Zhangyan Cultural Centre is most evident in the respect shown towards the traditional courtyard layout. The design continues the Qing-era spatial logic of “courtyard–well–corridor”, with the courtyard serving as both the connective node among galleries and the social heart of the site (Figure 12). The central well and encircling water channels form a closed hydrological system, complemented by permeable paving and rainwater harvesting devices. During heavy rainfall, this system effectively manages drainage and recycles water for irrigation, creating a small-scale ecological cycle. Through these technical strategies, the courtyard not only

revives the vernacular wisdom of “dwelling nourished by water” but also performs practical functions in regulating humidity and providing fire separation (Horizontal Design Office 2020). At the same time, the paving incorporates a variety of materials such as bluestone slabs, gravel, lawn, and water surfaces, complemented by native vegetation including bamboo groves, dawn redwoods, and locust trees. Together, these elements create a richly layered landscape that can be experienced across the seasons, blending the atmosphere of daily life with the poetic quality of cultural expression.

In terms of architectural form, the modern galleries employ minimalist design characterised by clean lines and restrained proportions, which contrast sharply with the preserved late Qing period (late 19th to early 20th century) residences’ upturned eaves and curvilinear roofs. The former highlights the rational clarity of contemporary architecture, while the latter embodies the craftsmanship and aesthetic sensibilities of local tradition. This juxtaposition of “straight lines and curves” creates not only visual tension but also a cultural dialogue: the austerity of minimalism accentuates the elegance of the traditional form, while the persistence of traditional roofs ensures that the modern structures remain grounded in the local context. The three galleries, thematically organised as “Tradition, Contemporary, and Future”, establish a narrative chain across temporal dimensions. The visitor’s journey thus becomes a continuous experience of engaging with local history while envisioning future development (design documents, ATLAS. ti code: ZD-16). This curatorial logic responds to the heritage of place while also projecting cultural identity forward, thereby achieving the coexistence of tradition and modernity within a single spatial domain.

Coding Results

Analysis of the three cases demonstrates that, although situated in distinct urban and socio-cultural contexts, their design strategies converge in a progressive sequence. Regional response safeguards the authenticity of history and translates cultural vocabularies; node activation juxtaposes and catalyses spatial elements to express cultural memory in contemporary form; and polyphonic symbiosis integrates architecture, environment, and social function into a system of continuous interaction. To clearly situate these strategies within the theoretical framework, this paper constructs a thematic coding tree based on the open coding results from ATLAS. ti. This tree visually elucidates the common logics and distinctive characteristics of the three cases from three perspectives: Regional Response, Node Activation, and Polyphonic Symbiosis (Figure 13).

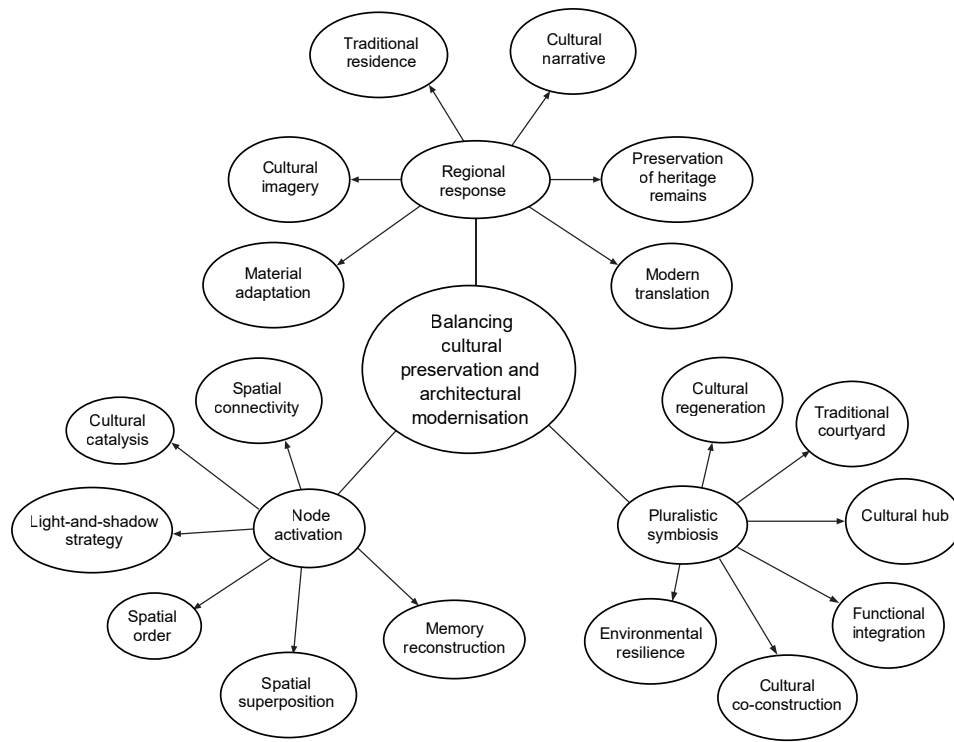


Figure 13 The tree-node relationships of core codes

Cross-case comparison reveals consistent yet differentiated patterns. In terms of regional response, all three cases regenerate cultural vocabularies through local materials and formal translation, although with varied emphases: Case One highlights stone craftsmanship combined with maritime symbolism, Case Two emphasises the continuation of street texture and garden narratives, and Case Three focuses on courtyard morphology and historical relics. Strategies of node activation diverge in spatial scale and form: Case One establishes a metropolitan catalytic hub through a sunken plaza and coastal passage; Case Two layers perception through courtyards and light installations; and Case Three juxtaposes walls and combines small-scale units to reinforce local memory. In terms of polyphonic symbiosis, the approaches span from macro to micro: Case One centres on green roofs and rainwater cycling to strengthen environmental resilience; Case Two integrates multiple functions to build a cultural hub; and Case Three relies on courtyard ecology and the juxtaposition of old and new structures to regenerate rural culture.

DISCUSSIONS

Despite their differing design contexts, the three cases converge on the central research question of how cultural heritage can be sustained within a framework of sustainable urban development. Each transforms cultural transmission into a set of operative design strategies that mediate between preservation and modernisation. The results can be synthesised into four dimensions of effectiveness:

Responding to Cultural Continuity Through Materiality

In all three cases, material selection and reuse serve not only constructional functions but also symbolic and mnemonic roles. Shenzhen Bay Cultural Plaza employed 340,000 granite strips to evoke coastal identity; Suzhou Museum West Wing adopted Portuguese grey stone and copper

cladding resonant with vernacular dwellings; and Zhangyan Cultural Centre preserved stone columns, brick walls, and courtyard morphology as the structural skeleton of contemporary narratives. Material reuse and translation thus enhance durability and adaptability while embodying and transmitting regional memory.

Facilitating Cultural Integration Through Technology

Technological interventions improved building performance and simultaneously reinvigorated traditional spaces. At Shenzhen Bay Cultural Plaza, the use of BIM modelling and parametric construction enabled the precise installation and long-term maintenance of a complex stone curtain wall. Suzhou Museum West Wing employed light manipulation strategies and a rainwater management system to enhance spatial experience and microclimatic conditions while preserving the ambience of traditional Chinese courtyards. At Zhangyan Cultural Centre, concealed steel reinforcements and anti-corrosion treatments were applied during the structural consolidation of historic remains, enabling traditional components to meet contemporary standards of safety and durability while continuing to contribute to the architectural narrative. In each case, technology mediated between tradition and performance, ensuring functional resilience and cultural integration.

Enhancing The Formation of Identity and Sense of Belonging

Cultural identity was reinforced through spatial narratives that sustained collective memory. Shenzhen Bay's "stone clusters" became public anchors of everyday life and maritime imagery. Suzhou Museum West Wing reinterpreted alley textures and garden narratives, embedding visitor experience within local logics of light and movement. Zhangyan Cultural Centre curated a thematic chain of "Tradition–Contemporary–Future," enabling continuity of village history across temporal dimensions. Together, these practices demonstrate that architecture operates not only as physical infrastructure but also as a medium of cultural identity and belonging.

Optimising Spatial Structure and Organisation

Optimised spatial structures enabled modern functions while fostering cultural interaction. Shenzhen Bay's "grey spaces" and coastal passage mediated between large-scale volumes and the city, creating civic zones of flow and encounter. Suzhou Museum West Wing's courtyards and corridors interwove exhibitions, education, and leisure, reviving the rhythm and intimacy of traditional alleys. Zhangyan's courtyards and corridors linked old and new, with flexible units supporting exhibitions, community gatherings, and daily use.

In conclusion, the three cases illustrate the deep entanglement of cultural heritage and sustainability across material, technological, social, and spatial dimensions. From the perspective of critical regionalism, these practices resist homogenisation by balancing modern functionality with local identity. From the perspective of urban catalyst theory, they underscore the role of public spaces in stimulating cultural vitality, positioning architecture as a civic catalyst rather than a neutral container.

CONCLUSION

This research, situated within the context of Chinese urban regeneration (The Central People's Government of the People's Republic of China 2025), addressed the central question of how cultural heritage can be sustained under a sustainable development framework. By integrating

a PRISMA 2020–guided systematic literature review with multiple case studies, the research constructed a “value–pathway” framework: critical regionalism provides the normative orientation, ensuring responsiveness to local culture and identity; and urban catalyst theory provides the operative pathway, activating public life and cultural vitality through incremental and nodal interventions. Supported by coding and thematic analysis in ATLAS.ti 9, cross-case comparison validates the framework’s contextual relevance and operational applicability in China.

The findings suggest that sustainable urban development in China benefits from a culturally grounded architectural methodology. Specifically, sustainable design can balance cultural transmission and modernity through four synergistic strategies: (1) employing materials as carriers of continuity; (2) deploying technologies as mediators of integration; (3) cultivating identity and belonging; and (4) optimising spatial organisation. These strategies align with theoretical expectations: the first two echo critical regionalist principles of resisting homogenisation through material and form, while the latter two substantiate urban catalyst mechanisms of activating culture and public life through spatial nodes.

Policy Implications

This study, grounded in the May 2025 document *Opinions on Continuously Advancing Urban Renewal Initiatives* issued by the General Office of the Central Committee of the Communist Party of China, proposes three policy implications focused on strengthening cultural heritage transmission and promoting the deep integration of sustainable building practices with cultural heritage conservation. These implications are intended to better guide urban renewal practices, enhance urban resilience, and maximise long-term socio-ecological benefits:

1. Incorporate the dual assessment criteria of “regional responsiveness” and “node activation” into the approval and evaluation of urban renewal projects. This ensures that initiatives not only serve local areas but also exert sustained influence on regional dynamics and public-space vitality, thereby enhancing overall synergistic effects.
2. Employ small-scale, replicable public-space interventions to stimulate activation at the regional level. Through short-cycle pilots and transferable designs, achieve low risk, rapid learning, and high-impact regional activation, ensuring replicability and scalability across different areas.
3. Strengthen institutional frameworks and incentive mechanisms to promote the reuse of traditional materials and low-energy maintenance, thereby reducing environmental and fiscal costs across the lifecycle. Improve transport and maintenance systems for sustainable materials, establish incentive-based construction mechanisms to lower long-term costs and carbon footprints, while safeguarding cultural heritage.

Study Limitations

Limitations of this study include the modest number and uneven typology of cases, as well as incomplete long-term operational data. Other limitation is the use of secondary and archival data (such as interviews and design documents for cases), which did not allow a deep dive into experts’ more direct and nuanced views. This study is an exploratory qualitative investigation aimed at addressing the research questions and synthesising strategies; consequently, it does not employ quantitative reliability procedures such as Cohen’s kappa. Future research should expand the sample size and temporal scale, build longitudinal cross-city databases and incorporate

systematic social impact assessments—including indicators such as community participation, public space utilisation, cultural activity frequency, and transmission effectiveness—to enhance the verifiability of cultural, ecological, and social benefits.

Overall, this research demonstrates that, in the Chinese context, combining the normative orientation of critical regionalism with the operative pathway of urban catalyst theory yields a design framework that balances cultural continuity and sustainable performance. The proposed framework and strategy set provide actionable instruments for practice, enabling Chinese cities to sustain cultural identity while advancing modernisation. At the same time, they foster the dynamic transmission of urban culture and offer both theoretical grounding and practical insights for formulating culturally prioritised architectural policies.

Data Availability

The data that support the findings of this study are available from the corresponding author upon reasonable request. Additionally, the design specifications used for the case studies are freely available on the official websites of MAD Architects, German architectural firm GMP, and Horizontal Design Office. The data sources pertain to the following public-domain resources:

1. <https://i-mad.cn/projects/shenzhen-bay-culture-park>
2. <https://www.gmp.de/cn/projects/11611/suzhou-museum-west>
3. <https://www.cnhorizontal.com/cn/works/174.html>

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