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# Practice of Public Space Optimization and Functional Enhancement in Cultural Architecture

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**Abstract:** This paper explores the optimization of public space and the enhancement of its functionality within cultural architecture. It first defines the fundamental concepts of cultural architecture and public space, analyzing their roles and value. Subsequently, it examines key strategies, including spatial layout optimization, circulation design, multifunctional space integration, and sustainable, intelligent design. Finally, through approaches such as enhancing cultural experiences and interactions, incorporating historical and cultural elements, and promoting adaptive reuse, the study provides a practical analysis of how to improve public space efficiency and functionality while fostering the sustainable development and innovation of cultural architecture.

**Keywords:** public space optimization; functional enhancement; cultural architecture

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## 1. Introduction

As the physical embodiment of history and culture, the optimization and functional enhancement of public spaces in cultural buildings play a crucial role in shaping user experience and reinforcing architectural significance. Amid urban modernization, balancing cultural continuity and heritage preservation with the need for functional and sustainable public spaces remains a significant challenge. When optimizing public space design, it is essential not only to meet fundamental requirements but also to enrich the cultural atmosphere and foster interaction. By maximizing spatial efficiency, cultural buildings can evolve and adapt to contemporary demands, ensuring their continued relevance and development.

## 2. Fundamental Understanding of Public Space in Cultural Buildings

### 2.1. Definition and Classification of Cultural Architecture

Cultural architecture refers to buildings primarily designed for various cultural activities, serving as representations of a city's heritage, identity, and artistic expression. These structures not only embody deep historical and cultural significance but also hold high social value, reflecting aesthetic ideals of different eras through distinctive architectural techniques, cultural traditions, and historical imprints [1].

Based on their function and purpose, cultural buildings can be categorized into several subtypes, including museums, libraries, theaters, and concert halls. Museums and art galleries focus on showcasing historical and artistic works, preserving and transmitting cultural heritage. Libraries function as repositories of knowledge, facilitating education and cultural dissemination [2]. Theaters and concert halls serve as venues for

performing arts, fostering artistic creation and cultural development. Additionally, cultural centers, which integrate multiple cultural functions, have become essential hubs in urban cultural life, playing a vital role in community engagement and cultural exchange.

## *2.2. Functions and Significance of Public Space*

Public space within cultural architecture serves as a crucial interface between architectural functionality and social engagement. Beyond merely providing areas for rest and circulation, these spaces facilitate cultural exchange, social interaction, and artistic expression. Thoughtfully designed public spaces not only enhance visitor experience but also transform cultural buildings into iconic landmarks of urban cultural dissemination.

Functionally, public spaces regulate and manage pedestrian flow, optimizing circulation pathways to ensure seamless interaction between different functional areas within the building. This enhances spatial efficiency and usability [3]. Additionally, open public spaces create informal gathering areas, encouraging social interaction and reinforcing the communal nature of cultural venues. By fostering public engagement and dynamic exchanges, these spaces contribute to the broader cultural and social ecosystem, enriching the experience of both visitors and the wider community.

## **3. Strategies for Public Space Optimization and Functional Enhancement in cultural architecture**

### *3.1. Spatial Layout Optimization and Circulation Design*

A well-planned spatial layout not only enhances the functional efficiency of a building but also improves visitors' navigational experience, minimizing obstructions and discomfort. The strategic arrangement of functional areas ensures a seamless connection between different activities while maintaining necessary spatial separations, thereby maximizing the utility of each space.

Circulation design plays a pivotal role in spatial optimization, facilitating the efficient movement of people, materials, and information within the building. Given that cultural buildings often accommodate high visitor volumes, circulation pathways must be designed to handle dense crowds while preventing congestion and cross-traffic conflicts. An optimal circulation system should enable visitors to reach their destinations efficiently while utilizing visual guidance to reduce confusion and enhance spatial clarity [4].

Additionally, spatial openness and visibility are key elements of circulation design. Architectural features such as large glass walls, wide corridors, and open entrances can create a sense of expansiveness while reinforcing the communicative and connective nature of the building. These design strategies not only enhance user experience but also foster social engagement by encouraging interactions among diverse user groups.

The Whitney Museum exemplifies how well-planned circulation optimizes public space, enhances accessibility, and strengthens a building's cultural and social impact. Thoughtful zoning, clear movement patterns, and spatial transparency not only improve efficiency but also reinforce the role of cultural architecture as a dynamic and interactive space [5].

Exhibition areas are concentrated on the upper floors, while lower and intermediate levels house open social and leisure spaces, minimizing functional overlap. A seamless circulation system, incorporating escalators, open staircases, and elevators, allows visitors to navigate intuitively. Outdoor terraces further integrate the museum with its urban surroundings, providing both scenic rest areas and an extended exhibition environment.

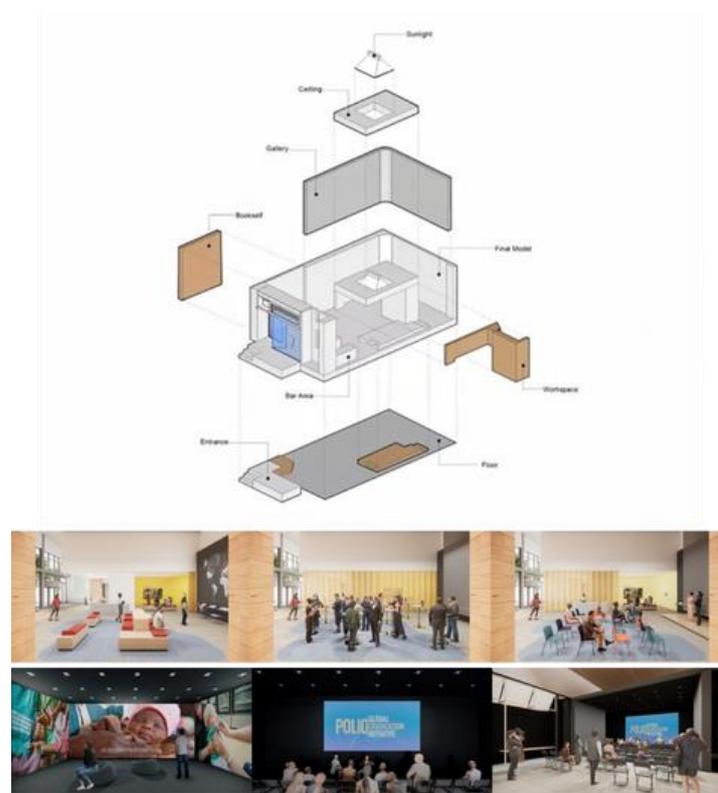
The museum's circulation guides visitors efficiently upward floor by floor and returning to ground level via terrace staircases or elevators, reducing backtracking and congestion. Clear sightlines, enabled by expansive glass curtain walls, enhance wayfinding and spatial orientation, ensuring a continuous and immersive experience.

Wide corridors and generously sized entry points accommodate high visitor traffic, preventing bottlenecks and maintaining a fluid movement flow.

Openness and visibility play a crucial role in reinforcing the museum's connection to its surroundings. Transparent facades blur the boundary between the museum and the city, fostering interaction and reducing spatial enclosure. Multi-level public areas, including terraces, stairway landings, and plazas, encourage social engagement, transforming the museum into an active cultural hub.

### 3.2. Composite Design and Flexible Use of Multifunctional Space

Public Spaces in cultural buildings often need to accommodate different types of activities, including exhibitions, performances, lectures and social interactions, so the design must prioritize the versatility and flexibility of the space. This composite design allows the space to be quickly transformed according to different needs through modular layout, movable partitions and adjustable space configurations (see Figure 1).



**Figure 1.** Infrastructure of multifunctional space composite design.

For instance, the size and shape of exhibition and activity areas can be adapted to suit different event requirements, accommodating both large-scale public events and smaller, more intimate gatherings. Beyond spatial reconfiguration, the adaptability of facilities and equipment is also a key factor. Features such as retractable seating, mobile display panels, and multipurpose exhibition walls allow spaces to be transformed quickly to meet diverse functional needs.

This flexible spatial strategy not only enhances space efficiency but also extends the functional lifespan of the building. By adapting to changing demands, cultural buildings can provide more diverse cultural experiences, maximize their societal contribution, and promote sustainable resource utilization by reducing the need for extensive renovations or new constructions.

### 3.3. Green and Sustainable Design

Green and sustainable design is becoming increasingly important in cultural architecture, mainly in terms of energy efficiency, material selection and environmental protection. As a public building, the design of cultural buildings should fully consider environmental friendliness, reduce the consumption of natural resources, and reduce the negative impact on the ecological environment. California Academy of Sciences (CAS) is one of the greenest museums in the world with LEED Platinum certification. Its design incorporates a variety of sustainability strategies: The Living roof features 2.5 acres of undulating green roofs covered with native plants that enhance heat insulation, reduce stormwater runoff and promote biodiversity; Natural ventilation and daylighting Minimize energy consumption through skylights and smart ventilation systems, allowing fresh air and sunlight to optimize indoor environmental quality. In terms of renewable energy and water conservation, the building features solar panels, a rainwater harvesting system and an efficient HVAC system, reducing the overall carbon footprint (See Figure 2).

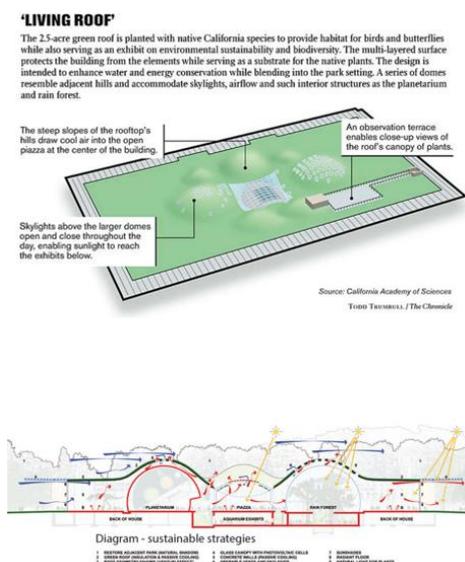


**Figure 2.** Sustainable Design Powering Innovation and Visitor Engagement.

In the design concept, first energy efficiency can be improved through strategies such as enhanced insulation, natural ventilation, and optimized lighting systems. Implementing energy-efficient HVAC systems, photovoltaic solar panels, and rainwater harvesting systems can significantly reduce the building's environmental impact.

Second, sustainable material selection plays a crucial role in resource conservation. The use of eco-friendly materials, such as recycled wood, natural stone, and low-emission coatings, not only reduces pollution but also extends the lifecycle of building materials. These choices minimize construction waste and support long-term sustainability. Additionally, integrating healthy, non-toxic materials enhances both the aesthetic appeal and environmental performance of cultural buildings, contributing to a healthier and more visually engaging built environment.

The California Science Center has achieved LEED Platinum certification, with its green building design emphasizing several sustainable features (See Figure 2). The building incorporates a 2.5-acre living roof covered with native vegetation, which improves insulation, reduces stormwater runoff, and promotes biodiversity. Additionally, the design prioritizes natural ventilation and daylight illumination, utilizing skylights and an intelligent ventilation system to reduce energy consumption while enhancing indoor air quality and maximizing natural light. The center also integrates renewable energy solutions, including solar panels, a rainwater collection system, and an efficient HVAC system, all contributing to the reduction of carbon emissions and resource waste. These strategies demonstrate that sustainable design in architecture goes beyond energy efficiency, encompassing ecological protection and supporting urban sustainability. (Figure 3)



**Figure 3.** Sustainable Strategy Diagram of the California Academy of Sciences (From: <https://ongreening.com/en/Projects/california-academy-of-sciences-1115>).

**3.4. Integration of Intelligent System and Technology**

By integrating advanced intelligent control systems, cultural buildings enable efficient energy management, security monitoring and intelligent services. For example, automated temperature control systems can automatically adjust air conditioning and heating based on indoor and outdoor temperature changes, optimizing energy use and reducing operating costs. In addition, the intelligent lighting system adjusts the light intensity through the sensor, which not only improves the efficiency of energy use, but also creates a suitable atmosphere according to the needs of different scenes. In terms of security, the intelligent monitoring system can realize 24-hour comprehensive monitoring to ensure the safety of the building (see Table 1).

**Table 1.** Analysis of Intelligent Systems, Technical Aims, and Industrial Influence.

Intelligent Systems / Technologies	Aim	Influence
<b>Energy Management</b>	To systematically optimize energy utilization patterns and minimize comprehensive operating costs by intelligently managing heating, ventilation, air conditioning (HVAC), and lighting systems.	Significantly reduces total energy consumption and operational expenditures while substantially enhancing the environmental sustainability and resource efficiency of the enterprise.
<b>Intelligent Lighting</b>	To improve energy efficiency metrics by dynamically adjusting illumination intensity based on real-time personnel occupancy, spatial requirements, and temporal factors.	Enhances overall energy efficiency, elevates the end-user experience through adaptive environments, and provides highly customized, automated lighting solutions.
<b>Safety Monitoring System</b>	To strictly monitor building security parameters and provide high-fidelity, real-time surveillance to mitigate potential risks and improve overall structural safety.	Delivers enhanced security protocols to ensure continuous real-time monitoring, facilitating rapid response mechanisms and robust emergency management.

<b>Visitor Information Management System</b>	To accurately track visitor traffic flows, optimize physical space utilization, and deliver personalized consumer services through integrated data analytics and immersive digital interfaces.	Improves organizational operational efficiency, significantly enhances visitor engagement levels, and enables a sophisticated data-driven management paradigm.
<b>Interactive Technology</b>	To provide an immersive and engaging experience that seamlessly integrates advanced digital displays with Virtual Reality (VR) and Augmented Reality (AR) technologies.	Enriches the overall cultural and educational experience, promotes proactive interactive learning, and substantially increases visitor satisfaction and brand loyalty.

At the same time, intelligent security technologies such as face recognition and access control management can provide visitors with a comfortable and secure access experience. The visitor data monitoring system, which collects and analyzes data, helps administrators track internal traffic and optimize space usage. These intelligent applications also improve the interactive experience and the sense of presence at the venue. For instance, interactive digital exhibits, virtual reality technology, and interactive projections offer visitors a more immersive experience.

#### 4. Practice Path of Public Space Optimization and Function Enhancement in Cultural Architecture

##### 4.1. Enhancing Cultural Experience and Interactivity

Public spaces in cultural buildings serve not only as gathering places but also as important venues for cultural experience and interaction. Through a combination of design improvements and technological advancements, visitor engagement can be heightened, and culture can be more deeply understood and interpreted. For exhibition spaces, digital tools such as multimedia projections, holograms, and other technologies can enable dynamic displays that bring static cultural heritage or artifacts to life, creating vivid historical narratives and allowing visitors to intuitively grasp the historical context and cultural significance (see Figure 4). Immersive experience zones can also be set up, where interactive digital systems encourage visitor participation in the expression and interpretation of cultural content, enriching their subjective experience. Additionally, appropriately scaling the spatial layout can enhance cultural interaction. Open and shared cultural spaces, such as public discussion areas, cultural salons, or small performance venues, foster communication, enabling visitors to exchange ideas and strengthen cultural identity in a free and strengthen cultural identity in a free and interactive environment



**Figure 4.** immersive cultural experience interaction and Holographic projection.

"In the end, it is about the experience," say Ana Paula Ruiz Galindo and Mecky Reuss of Pedro & Juana as they discuss Hórama Rama, the 2019 winner of MoMA and MoMA PS1's Young Architects Program (YAP). The project transforms the MoMA PS1 courtyard into an 'immersive junglescape,' blending architecture, music, and interactive elements to

redefine the visitor experience. The large-scale cyclorama, featuring a panoramic jungle image on scaffolding, repositions visitors within an urban jungle, altering their perception of space and horizon. Beyond its visual impact, the installation functions as an adaptable environment for cultural events, such as MoMA PS1's outdoor music series Warm Up, reinforcing the role of public spaces in fostering engagement and experiential interaction. (See Figure 5)



**Figure 5.** Interactive experience of tourists.

Activating public spaces requires a shift from passive observation to active engagement, transforming these environments into dynamic hubs of interaction, learning, and cultural exchange. Theories of spatial activation emphasize interactivity, immersion, and participatory design as key strategies to foster deeper user involvement.

One effective approach is the integration of digital and physical elements to create multisensory experiences. The Magritte Interpretive Gallery at SFMOMA transforms traditional exhibition formats by integrating augmented reality. This interactive gallery allows visitors to experience Magritte's artistic themes in new dimensions, where digital windows function as both portals and conceptual puzzles, challenging conventional perception. By employing motion-tracking technology and depth-sensing cameras, the gallery blurs the lines between reality and illusion, reinforcing the idea that cultural spaces are not just for observation but for active participation. As Neal Benezra, Director of SFMOMA, states, "Our goal is to help visitors connect to the themes of the exhibition in a playful, visceral way, while also encouraging them to see their everyday surroundings in a new light." This approach underscores the evolving role of museums in leveraging technology to create dynamic, thought-provoking experiences that bridge the past, present, and future. (See Figure 6)



Figure 6. SFMOMA's Magritte Interpretive Gallery.

As exemplified by the Gates Foundation project I have been working on, its immersive niche design—where picking up an object triggers related video content—demonstrates how interactive installations can foster curiosity and facilitate personal discovery. This aligns with embodied cognition theory, which suggests that physical interaction enhances cognitive engagement and information retention. (Figure 7)

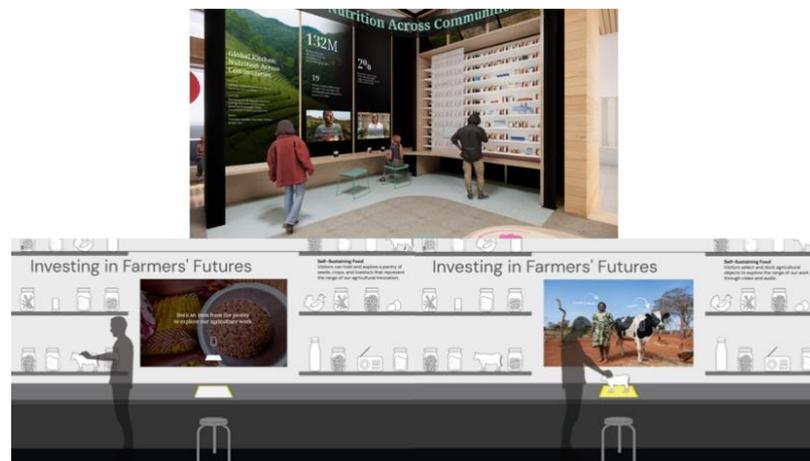


Figure 7. Gates Foundation immersive niche design.

The public space can be further enhanced with touchscreen navigation, intelligent voice explanations, and other methods to offer personalized access to cultural information, catering to the needs of visitors with different age groups and knowledge backgrounds. For example, the Gates Foundation's Changemaker Wall offers an interactive display where digital portraits of partners, visitors, and communities rotate in passive mode. When engaged actively, users can touch a portrait to explore how a partner is addressing global challenges through audio, video, and quotes. This approach not only enhances engagement but also facilitates deeper learning and interaction. Furthermore, the public space of cultural buildings can serve as the core space for cultural knowledge transfer through regular thematic activities, art workshops, and non-physical exhibitions, allowing visitors to engage with cultural knowledge. This way, the space becomes a central hub for the city's cultural life (See Figure 8).



Figure 8. Changemaker Wall Passive mode V.S. Active mode.

#### 4.2. Integrating Historical and Cultural Elements and Shaping the Spirit of the Place

The design of public spaces in cultural buildings should deeply integrate local historical and cultural elements to create a unique atmosphere and sense of place. This integration not only supports the cultural positioning of the building itself but also allows visitors to experience the historical depth and cultural heritage embedded within the space. Through the artistic refinement of local cultural symbols, architecture can serve as a bridge between history and modernity. Designers can incorporate traditional crafts, folk art, or historical events into architectural forms, interior spaces, or decorations to create cultural public spaces. The integration of historical and cultural elements goes beyond decoration; it shapes the spirit of the place. The spirit of place refers to the historical, cultural, or emotional resonance conveyed through the design of buildings and their surrounding environments (see Table 2).

**Table 2.** Integration of historical and cultural elements and shaping of place spirit.

<b>Strategic Pathway</b>	<b>Concrete Implementation Methodology</b>	<b>Expected Strategic Effect</b>
<b>Cultural Symbol Refinement and Presentation</b>	Systematically extract core elements from local traditional architecture, classical sculpture, calligraphy, and regional patterns to integrate them into building facades, interior decorations, and landscape architectural designs.	Strengthens institutional and cultural identification, ensuring the architectural entity possesses distinctive regional characteristics and a high degree of aesthetic recognition.
<b>Place Spirit Shaping</b>	Synthesize historical background, natural environment, and social culture to construct a profound cultural and artistic conception through deliberate spatial atmosphere design, precise color application, and curated material selection.	Enables visitors to perceive the depth of historical precipitation within the physical space, thereby significantly enhancing individual and collective cultural identity.
<b>Traditional Techniques and Materials</b>	Utilize authentic local materials-such as traditional black brick, professional wood carving, and meticulous stone carving-combined with indigenous building techniques to accurately reflect regional cultural heritage.	Enhances cultural authenticity and emphasizes the sense of historical continuity and profound cultural significance inherent in the architectural structure.
<b>Cultural Story Display</b>	Establish specialized cultural corridors, relief walls, and historical event display boards to narrate the developmental trajectory and evolutionary process of local cultural heritage.	Elevates the educational value of public spaces, allowing visitors to acquire a deeper and more structured understanding of the building's complex cultural background.
<b>Interactive Cultural Experience</b>	Facilitate active visitor participation in cultural heritage through designated intangible hand-experience areas, advanced digital displays, and multi-sensory immersive tours.	Enhances cultural interaction and social engagement, while substantially increasing the visitors' sense of active participation and overall experiential satisfaction.

In cultural architecture, shaping the spirit of the place means connecting the building with its surrounding historical context, natural environment, and social culture, thus forming a unique space character. For example, using local traditional materials and folk crafts not only highlights regional characteristics but also evokes historical memories and

promotes a sense of identity among visitors. The public space can also bridge the connection between culture and visitors by telling cultural stories, showcasing artworks, and displaying creative cultural products. This approach ensures that visitors are no longer passive observers but can deeply engage with and experience the cultural value of the building, gaining respect for its history through active participation.

#### 4.3. Space Adaptive Reuse and Innovation

Many cultural buildings with historical and cultural significance face the challenge of functional obsolescence or age-related decline. However, through effective updates to meet contemporary needs, these buildings can be revitalized, preserving their historical value while continuing to serve public interests. The adaptive transformation of spaces focuses on restructuring building layouts and space arrangements. For older buildings, flexible and diverse space utilization can be achieved by installing movable partitions, altering wall placements, or adjusting door positions. This approach not only preserves the building's original appearance but also accommodates the needs of historical, cultural, and public spaces. Additionally, innovative design methods can combine modern technologies with cultural architecture, offering more diverse communication spaces. Adaptive reuse allows cultural buildings to flexibly respond to evolving social needs while preserving historical heritage.

Kyoto Station serves as a prime example of integrating historical and cultural elements into modern architectural design to shape a unique sense of place. (Fig 8) As a major transportation hub in Japan's ancient capital, the station is more than just a functional space; it embodies the city's cultural heritage and historical memory. The traditional spatial layout of Kyoto Station draws inspiration from the design of traditional Japanese temples and gardens. Despite its primary construction of steel and glass, the design of Kyoto Station incorporates visual elements that evoke the traditional wooden architecture of Japan, particularly through its large-span roof structure and grid-like detailing. (Figure 9,10) The open central courtyard, large staircase, and multi-level spatial organization mirror the layout of Kyoto's temples, shrines, and traditional gardens, creating a space that is both ceremonial and conducive to public interaction. This design also incorporates the "stroll-type" experience found in many Japanese gardens and temple buildings, where space is organized to guide people through a series of progressively connected areas, encouraging exploration. This concept has been modernized in Kyoto Station, where passengers can move through different levels of the building using bridges, stairs, and elevators, resulting in a dynamic and fluid spatial experience. (Figure 11-13) Additionally, the station enhances cultural engagement through dedicated exhibition areas showcasing Kyoto's craftsmanship, allowing visitors to experience local traditions firsthand. Regular cultural events and art exhibitions further enrich the space, transforming it into a dynamic platform for cultural exchange rather than merely a transit point. Through its spatial composition, materiality, and immersive cultural programming, Kyoto Station fosters a deep connection between past and present, enabling both residents and visitors to experience the city's rich historical narrative in a contemporary setting.



**Figure 9.** Kyoto Station.



Figure 10. Sanjūsangen-dō Temple.

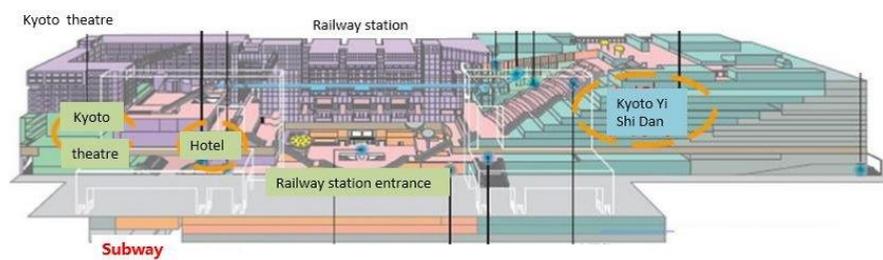


Figure 11. Kyoto Station Model.



Figure 12. Grand Staircases of Kyoto Station.



Figure 13. Kiyomizu-dera.

#### 4.4. Optimizing Public Service Functionality and Convenience

The optimization of public space not only addresses the aesthetic and cultural atmosphere of the space but also focuses on enhancing service functionality and convenience. Thoughtful design of public spaces can significantly improve visitor experiences, ensuring adequate service support during cultural activities. The

optimization of public services begins with the division of functional areas within the building, including information points, rest areas, and service stations, all designed with the visitor's flow in mind to quickly and conveniently meet their needs. Additionally, building signage plays a crucial role. Clear and visible signs help visitors navigate the space without confusion. Whether traditional hand-painted signs or modern digital displays, they should be easily recognizable to accommodate people of all ages. Barrier-free access should also be implemented in public spaces for vulnerable individuals, ensuring that everyone can enjoy equal cultural services. In this way, cultural spaces can offer more humanized, intimate, and convenient services to visitors (Figure 14,15).



Figure 14. Digital Signage and wayfinding at MoMA.

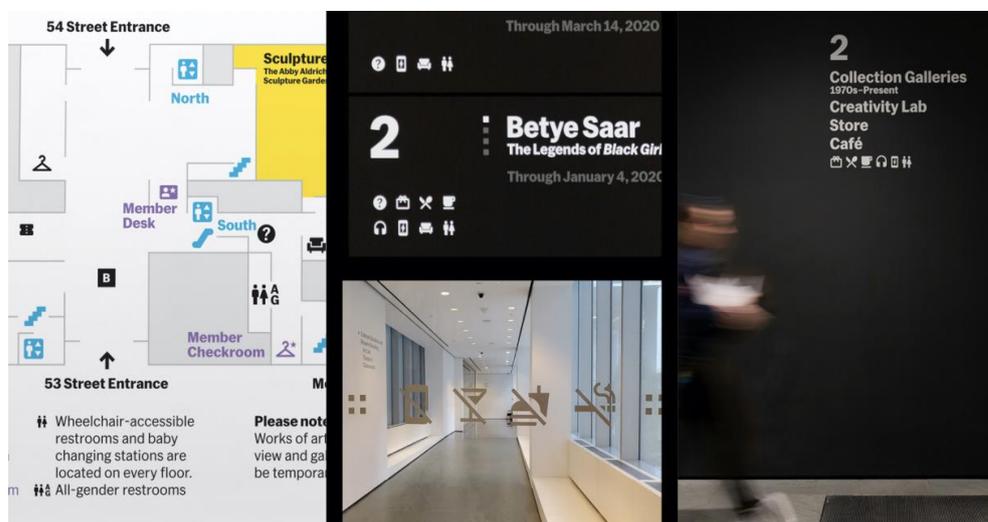


Figure 15. Wayfinding Icons in MoMA's Design System.

### 5. Conclusion

As a vital medium for preserving history and continuing culture, the public space in cultural architecture is not just a physical display but also a venue for cultural exchange and social interaction. In the context of modern urban development and the continuation of traditional culture, optimizing public spaces in cultural buildings and enhancing their function and value have become critical issues in architectural design and cultural research. By analyzing the definition of cultural architecture and the functional value of public space, this paper explores optimization methods such as spatial layout, circulation design, and multifunctional space utilization, aiming to provide practical strategies and

theoretical foundations for improving the design and functionality of public spaces in cultural architecture.

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