



REVITALIZING INDUSTRIAL HERITAGE ARCHITECTURE: DESIGN STRATEGIES FOR ART SPACES - A CASE STUDY OF TATE MODERN IN LONDON, UK

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ARTICLE INFO	ABSTRACT
Article History: Received: 14 May 2024 Revised: 22 November 2024 Accepted: 20 January 2026 Published: 15 May 2026 Keywords: Artspace, industrial heritage architecture, preservation, renovation, Tate Modern.	This study investigates the design strategies and challenges involved in transforming industrial heritage buildings into vibrant art spaces, using Tate Modern as a case study. While the adaptive reuse of such structures has gained popularity due to their historical and aesthetic value, many projects encounter obstacles such as budgetary constraints, operational inefficiencies, and the complexities of meeting modern functional requirements without compromising historical integrity. Employing qualitative research methods, including fieldwork and case study analysis, this research explores three key dimensions of Tate Modern's transformation: Urban memory preservation and regional revitalisation, safeguarding industrial heritage, and innovative art museum design. By analysing the theoretical, practical, and historical aspects of its design strategy, this study identifies universal principles for successful adaptive reuse, particularly the effective integration of historical authenticity and contemporary cultural needs. The findings underscore the importance of balancing preservation and innovation to ensure the sustainability and cultural relevance of such projects. This research offers valuable insights for policymakers, designers, and urban planners interested in adaptive reuse as a tool for urban renewal and cultural development.

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Introduction

Background Research

As seen in Western and subsequently Asian nations, the shift from industrial to post-industrial culture profoundly changed the socioeconomic composition of cities. According to Bell (1976), the shift from industrial to post-industrial civilisation represents a substantial transformation in the socioeconomic structure of cities. Significant changes in societal forms and the centre of the productive forces were brought about by this shift, first observed in Western countries in the 1950s and thereafter in Asian countries (Bell, 1976). The functional obsolescence of industrial structures became evident as economies restructured and the use of electronic information technology increased,

requiring urban restructuring and improving district quality (Hyslop, 2012). Technological developments and economic restructuring led to the functional obsolescence of industrial structures, necessitating urban reconstruction and quality improvement.

Alongside this shift in society, there were efforts for urban redevelopment that centred on repurposing abandoned industrial structures. Jacobs (1961) noted that this phenomenon involved both the preservation of history and the redefinition of urban places to meet the needs of modern society. Industrial remains are transformed into dynamic municipal places

through this approach, as demonstrated by Shanghai's 1933 Old Millfun and London's Trinity Buoy Wharf, as well as Shanghai's industrial buildings transformed into the Shanghai Sculpture Art Centre (Hyslop, 2012). Reviving urban areas and enhancing the city's image, these projects demonstrate the transition from industrial use to cultural and artistic relevance (Jacobs, 1961). Such initiatives underscore the potential of adaptive reuse to address urban challenges and preserve industrial heritage.

Industrial building transformations come with special difficulties, including operational and financial constraints as well as compliance with construction and zoning standards. The requirement to modify existing buildings to fit new uses while maintaining their historical and cultural significance exacerbates these difficulties (Vernes, 1987). This transformation requires a careful balance between maintaining historical authenticity and meeting modern functionality, emphasising innovative design approaches and adaptive reuse strategies.

One well-known example of this transformation is the Tate Modern, which embodies the artful transition of an industrial building into a cultural landmark. Given its significance and influence as "the most important new cultural building in Britain in the last 20 years", Tate Modern was a carefully chosen study subject (Dercon & Serota, 2006). Housed in the old Bankside Power Station, the museum marks a paradigm shift in how art is integrated into urban environments and how industrial heritage is preserved. Its alteration emphasises the importance of preserving historical integrity while adapting for new applications (Dercon & Serota, 2006). Thus, Tate Modern is a prime example of how creatively repurposing industrial legacy to create important cultural icons while balancing historical preservation with modern urban and artistic demands.

The transformation of the Tate Modern serves as a reminder of the crucial role of historical context in modern design. This entails

being aware of the building's history, its place in the urban landscape, and its possible influence on modern culture. Repurposing industrial spaces for cultural and artistic reasons is part of the process, which extends beyond simple physical preservation. This approach aligns with Venturi's (1977) theories of complexity and contradiction in architecture, demonstrating how industrial structures can serve as dynamic venues enriched by historical and modern design elements.

In conclusion, a crucial aspect of the shift to a post-industrial society is the conversion of industrial structures into art venues, as demonstrated by Tate Modern. It highlights the need to preserve old structures while adapting them for modern use, reflecting the shifting requirements and ideals of urban cultures. Studying the Tate Modern provides valuable insights into the interplay of urban redevelopment, industrial heritage preservation, and cultural innovation, serving as a model for similar adaptive reuse projects worldwide.

Research Aim and Objectives

This study aims to examine and comprehend the design techniques used to convert industrial historical structures into vibrant art spaces, using Tate Modern as a case study. The objectives of this study are as follows:

RO1: Analyse the transformation of Tate Modern

- To conduct a thorough examination of Tate Modern's metamorphosis, looking at the way the Bankside Power Station was converted into a prestigious art museum.
- To recognise and assess the particular design approaches, architectural tactics, and preservation techniques used in this transition.

RO2: Explore the Role of Industrial Heritage in Urban Renewal

- To examine the larger significance of industrial historic structures concerning cultural and urban revitalisation.

- To comprehend how the adaptive reuse of such buildings aids metropolitan regions' cultural and artistic revival.

RO3: Assess the Challenges and Success Factors

- To identify the primary obstacles, such as financial, legal, and structural limitations, to transforming industrial historic buildings into art spaces.
- To determine the critical elements that make these transformation initiatives successful (with an emphasis on design innovation, community involvement, and sustainable practises).

Research Significance

This study is significant because it provides a thorough analysis of the transformation of industrial buildings into cultural venues, using Tate Modern as a case study. This research enhances understanding of urban redevelopment and the adaptive reuse of industrial history in modern society. The study provides insights into the preservation of industrial history and its integration into urban settings by examining the Tate Modern, highlighting the effective transformation of an industrial building into a noteworthy cultural landmark.

Moreover, the research provides insights into the socioeconomic transitions from industrial to post-industrial countries, as delineated by Bell (1976), and the consequent consequences for urban environments. It emphasises the importance of protecting historic industrial structures, preserving urban memory and regional vibrancy, and creating art museums relevant to modern society. The renovation of Tate Modern is one example of how such initiatives can reinvigorate metropolitan areas and enhance a city's cultural and artistic image. Overall, this research provides insights into how urban planning, historical preservation, and cultural development interact. It emphasises the need for a balanced strategy that preserves historical integrity while adapting to new uses and societal expectations, making it an essential

resource for future urban redevelopment initiatives.

Literature Review

Historical Perspectives on Industrial Heritage Building Transformation

A few prominent theorists have contributed significantly to the theoretical underpinnings of industrial heritage building transformation, although the field has evolved mostly through actual case studies. British academic Michael Rix led the way in the 1960s in developing the notion of industrial sites in archaeology, placing special emphasis on their historical validation and preservation. His method laid the groundwork for understanding industrial heritage as essential reservoirs of historical and cultural significance rather than merely physical structures. In 1961, Jane Jacobs offered a distinct viewpoint when she emphasised the significance of "old buildings" in urban development. Her support for their renovation stemmed from her conviction that they play a crucial role in the urban fabric and from the realisation that historic industrial structures can add character and vibrancy to urban landscapes (Jacobs, 1961).

A major change in the assessment of building functions was introduced by Lawrence Halprin's 1965 publication of the Building Recirculation Theory. His people-centred approach promoted a more inclusive vision of architectural transitions, with an emphasis on the social and human dimensions, reevaluating the role of industrial heritage buildings in relation to their users and communities. The research by Dieterich (2003) highlighted the changing significance of post-industrial structures and industrial heritage in the contemporary day, broadening our understanding of both. Furthermore, Powell (2011) gathered case studies of successful restorations of historic structures, including workplaces, retail establishments, museums, libraries, and train stations. The findings of this study demonstrated the viability of repurposing industrial heritage

buildings through real-world examples and the usefulness of this area.

Overall, the findings of these studies have greatly advanced the field of industrial historic building transformation. Their observations have expanded our knowledge of these structures as historical and cultural artefacts and created new opportunities for their creative repurposing and modification. By integrating archaeological viewpoints, ideas from urban development, people-centred design theories, and post-industrial issues, a multifaceted framework for addressing industrial heritage has been established. This paradigm allows these buildings to evolve and remain relevant today while also honouring the past and embracing the future. Their work emphasises the importance of encouraging adaptive, practical reuse while maintaining historical integrity, ensuring that industrial legacy will continue to play a crucial role in our changing urban landscapes.

Early 20th Century Developments

In Western nations, interest in preserving and repurposing old industrial buildings started to grow in the early 20th century. This was a time of primary development, marked by a dearth of systematic literature and few theoretical works. On the other hand, it established a cutting-edge contemporary perspective on the preservation of historic buildings and set the stage for upcoming changes.

Recent studies have further investigated the industrial architecture of this era. Blaginyh *et al.* (2023) focus on early 20th-century industrial architecture, particularly the Kuzbass city transportation infrastructure. They examine design choices, architectural and ornamental features, and the stylistics of the modern-to-early modernist transition. This study specifies the restoration algorithm for cultural heritage items, emphasising the significance of a building's construction period in determining the inspection stages during rebuilding.

Moreover, Jashari *et al.* (2017) conducted another study examining the industrial legacy

of the 20th century in Europe and Kosovo, with particular emphasis on Pristina. They examine the current state of industrial buildings, as well as their potential and opportunities for reuse in urban settings. As an increasing trend in Western European nations, this research emphasises the adaptive reuse and rehabilitation of industrial zones for the benefit of the community and economic development. Serebryanaya *et al.* (2019) investigate the historical industrial architecture of the Volgograd region from the late 19th and early 20th centuries. In their work, they classify the major industrial building styles from this century, determine the level of preservation of industrial heritage assets, and suggest ways to adapt them for current use.

Using a multi-story concrete frame industrial building characteristic of the early 20th century, the research by Mortensen (2015) explores the emergence of daylight factories in the American industrial landscape and their potential for adaptive reuse. This study emphasises the historical relevance of the daylight factory and the need to preserve its adaptable industrial space. Together, these studies show how attitudes towards industrial buildings changed in the early 20th century, from mere utilitarian constructions to important cultural heritage, opening the door to modern preservation and adaptive reuse techniques.

Shifts in the 1960s and Beyond

The 1960s saw a dramatic shift in how ancient industrial buildings were viewed in Western societies amid economic transition. This change resulted in more studies, real-world projects, and government legislation. During this time, the relationship between postmodern architecture and building transformation also deepened, shifting the emphasis from individual structures to entire streets or factory complexes. Recent studies provide proper insights into these processes. Hamama *et al.* (2021) highlight the significant social and physical transformations of cities brought about by shifts in political and economic systems in their discussion of

the transformational elements of post-industrial urban settings in China and Italy. Radical urban transformation occurred during this time due to the real estate industry's reconstruction of urban land and market forces, which frequently resulted in social unrest and the reorganisation of local communities.

Pernice (2012) examines the legacy of the 1960s visionary architects and planners, including the Metabolist Movement, emphasising how these ideas continue to inform modern inventive and experimental urban design. This indicates that the 1960s were a time of transition and upheaval, encouraging the creation of mega architecture and brand-new, extravagant utopian towns as urban models for the future. In their study of the shift from Fordism to post-Fordism in the twenty-first century, Roost and Jeckel (2021) concentrate on how industrial regions are being transformed to make way for mixed-use and reidentification. Their analysis of Kassel, Germany, demonstrates how younger businesses are utilising innovative land-use and urban-planning methods to construct low-emission factories on vacant lots in urban settings.

Moreover, Poon (2017) examines urban design and architectural methods across several cultural contexts, considering the influence of social change and economic progress on urban planning. In addition to highlighting the role of urban design planning in helping communities adapt to changing conditions, including climate change, economic demands, and social needs, the study makes the strategic case for the value of cultural design aesthetics in creating resilient, adaptive communities. Overall, these studies show how the approach to industrial buildings changed dramatically in the 1960s and beyond, reflecting the shifting social, cultural, and economic contexts of Western cultures.

Art Spaces as a Form of Transformation

In Western nations with strong ties to their industrial past, art spaces have become an increasingly popular approach to transforming derelict industrial buildings. These spaces preserve the original forms and historical-

cultural legacies of the buildings while providing flexibility for contemporary art. However, limited research provides insight into this specific transition. Graur (2016) discusses the unique characteristics of closed industrial sites and their potential for adaptive reuse, highlighting how these historical remnants offer opportunities for imaginative architectural reinterpretation that not only document but also emphasise social dynamics and modern influences. Similarly, Cano Sanchiz (2022) explores the functions of contemporary art within industrial ruins, presenting a typology of art-obsolescence relations. This typology includes the transformation of large, obsolete spaces into creative hubs and the conversion of industrial buildings into art galleries and museums, underscoring art's role in recognising technological and industrial heritage, mediating public perception of "dark heritage", and adding value to cultural sites. While this typology provides a useful framework for understanding the potential of industrial ruins, it often overlooks the practical challenges of retrofitting these spaces for modern use, such as the need for structural reinforcement or the difficulty of adapting obsolete spaces to contemporary architectural needs.

The transformation of Madrid's Mediodía power plant into CaixaForumMadrid, a modern architectural landmark, as described by Iglesias and Bernardo (2022), exemplifies how contemporary design can co-exist with the conservation of pre-existing structures, preserving the aesthetic appeal of industrial heritage while providing new purposes. Likewise, Tsilika and Vardopoulos (2022) analyse the adaptive reuse of the FIX brewery in Athens, emphasising the importance of façades in maintaining structural and historical integrity during transformations. Their study advocates a comprehensive approach to preserving the cultural heritage of industrial buildings by maintaining their functionality, character, and historical essence. However, while these case studies highlight successful transformations, they also raise the question of whether such

approaches are universally applicable, especially in cases where the industrial heritage is in poor condition or lacks strong architectural features.

These studies collectively illustrate the growing trend of converting industrial sites into art venues, balancing urban development, heritage conservation, and contemporary art. Nevertheless, the focus on idealised examples often leaves out the realities faced by developers and architects in less prosperous or historically less significant regions.

Building on this, the design of art spaces involves not only architectural modifications but also cultural regeneration and the reconstruction of social identity. Iglesias and Bernardo (2022) propose the concept of industrial heritage as both “text” and “pretext” for contemporary architecture, adding cultural depth to art space design. However, this perspective may be overly theoretical, lacking practical case studies to validate it. The theoretical model proposed by Iglesias and Bernardo offers valuable insights into how industrial heritage can inform cultural regeneration, but it does not address the specific challenges of integrating contemporary art within these spaces in ways that respond to local socioeconomic conditions.

In contrast, Febianti *et al.* (2021) provide a more practical framework by studying the adaptive reuse of heritage buildings within the fashion industry, showcasing how sustainability and modern functional needs can be integrated in adaptive transformations. While Febianti *et al.* (2021) applied research offers concrete guidance for art space design by balancing cultural preservation with commercial or exhibition requirements, it is primarily focused on the fashion industry, which may differ from the specific needs of art museums or other cultural spaces. On the other hand, the theoretical model presented by Iglesias and Bernardo (2022) has strong academic value in framing art spaces within the context of cultural regeneration but may be challenging to implement directly. While the Febianti *et al.* (2021) framework is practical, it may not fully address the nuances of integrating contemporary art and heritage

preservation in larger, more complex industrial buildings, where flexibility and adaptability are paramount.

By combining these perspectives, designers can gain a more comprehensive understanding that balances theoretical depth with practical applications, supporting art space design that harmonises cultural preservation with contemporary functionality.

Adaptive Reuse and Conservation

The notion of adaptive reuse has attracted a lot of attention lately, especially when it comes to converting industrial buildings into movie theatres and sustainable regeneration frameworks. Two noteworthy studies in this area provide light on creative reuse techniques for the preservation and enhancement of industrial heritage.

Appiotti *et al.* (2020) researched the conversion of Istanbul’s industrial structures into cinema venues. This study emphasises the twofold advantage of these changes: They preserve the historical significance and architectural integrity of buildings while also allowing them to take on new cultural and artistic uses. This study also highlights the importance of preserving these structures’ inherent qualities so that their conversion into movie theatres does not diminish their historical and cultural relevance. This suggests that the adaptive reuse of historic structures as film locations not only offers a distinctive backdrop for cinematic productions but also enhances the cultural and economic liveliness of the metropolitan landscape.

De Matteis *et al.* (2021) offer a framework for the sustainable rehabilitation of urban industrial heritage, which is another noteworthy contribution. Their research emphasises the importance of a thorough decision-making process that considers a range of variables, including sociocultural dynamics, economic viability, and environmental sustainability. They argued that a strategy strikes a balance between the need for practical, sustainable

urban growth and the preservation of historical and architectural qualities. By making industrial heritage sites relevant and useful for modern urban societies, this framework seeks to steer their development in a way that honours their history. However, while De Matteis *et al.* (2021) framework emphasises sustainability, it does not fully engage with the social complexities of adaptive reuse projects, particularly in areas prone to gentrification or displacement.

Collectively, these examples demonstrate how adaptive reuse and conservation are evolving and offer creative solutions for repurposing industrial heritage while preserving its essential historical and cultural elements. However, while De Matteis *et al.* (2021) framework emphasises sustainability, it does not fully engage with the social complexities of adaptive reuse projects, particularly in areas prone to gentrification or displacement.

The adaptive reuse of industrial heritage buildings is widely considered an effective way to sustainably preserve historic architecture. While the examples of cinema conversions and sustainable frameworks underscore the advantages of this approach, various studies reveal contrasting perspectives and unique challenges associated with adaptive reuse. For instance, Ma *et al.* (2023) proposed a “dual strategy” aimed at preserving cultural heritage values while integrating contemporary functional needs. aimed at preserving cultural heritage values while integrating contemporary functional needs. In contrast, Blaginyh and Serenkov (2023) emphasise the socio-political and economic complexities tied to preservation, highlighting how diverse cultural contexts and global influences shape the feasibility and perception of adaptive reuse strategies. Ma *et al.* (2023) offers a promising model for balancing heritage and modern functionality, yet it may not fully account for budgetary or regulatory constraints often faced by smaller-scale or less-funded projects.

This critical comparison not only deepens our understanding of adaptive reuse but also reveals contradictions and complementarities

among different approaches, paving the way for further exploration. For instance, while the dual strategy proposed by Ma *et al.* (2023) aims to balance cultural heritage preservation with modern functionality, it overlooks practical challenges posed by budgetary limitations and policy constraints. On the other hand, the cultural and political perspectives provided by Blaginyh and Serenkov (2023) remind us of the significant regional differences in the perception and management of industrial heritage within the globalised framework.

Contemporary Approaches in Adaptive Reuse and Art Spaces

Contemporary knowledge of the adaptive reuse of industrial historic buildings has been considerably enhanced by recent studies, especially in the context of art spaces and sustainable development. The adaptive reuse of heritage buildings for fashion spaces is examined by Febianti *et al.* (2021), who emphasise the sustainability of these changes at the economic, social, and environmental levels. This method creates a distinctive fusion of the past and present by preserving the historical significance of these structures while also adapting them for contemporary commercial use. However, Febianti *et al.* (2021) focus on fashion spaces, which may not fully translate to the more complex needs of art museums or galleries, where spatial adaptability and environmental conditions (lighting, climate control) are critical for exhibiting large-scale artworks or preserving sensitive pieces.

Ma *et al.* (2023) discuss the dual adaptive reuse strategies of the Shanghai West Bund waterfront projects, guided by landscape and the arts. This case study shows how art and landscape can work together to change industrial historic sites in a way that balances public accessibility, social relevance, and urban gentrification. Similarly, Ingaramo *et al.* (2022) introduce the idea of incremental architecture in adaptive reuse and offer a process for cleaning up contaminated former industrial sites. Their methodology, exemplified by a

project in Venice, Italy, emphasises community engagement, strong heritage awareness, and modest investment, making it a workable option for large industrial sites. Additionally, Bottero et al. (2019) introduce a multicriteria decision-aiding technique for assessing adaptive reuse strategies, particularly in vulnerable contexts. This method provides a comprehensive framework for decision-making in the adaptive reuse of industrial heritage, accounting for both tangible and intangible effects.

The reuse of industrial heritage buildings involves not only the buildings themselves but also the enhancement of their social and environmental value. Ingaramo *et al.* (2022) proposed an incremental approach, emphasising minimal intervention to achieve long-term sustainability for the building. However, this strategy may face technical and resource challenges, especially for complex structures with high historical value. However, Febianti *et al.* (2021) focus on fashion spaces, which may not fully translate to the more complex needs of art museums or galleries, where spatial adaptability and environmental conditions (lighting, climate control) are critical for exhibiting large-scale artworks or preserving sensitive pieces.

Moreover, Ingaramo *et al.* (2022) focus primarily on architectural strategies, with limited exploration of artistic interventions, which may result in insufficient cultural regeneration elements in the design. In contrast, Graur (2016) emphasises the role of contemporary art in activating urban spaces, offering an innovative perspective on transforming industrial heritage. By integrating art with history, industrial buildings are preserved and redefined with new social functions through cultural activities. This synergy between art and architecture helps create more dynamic and engaging spaces, but it requires careful management to avoid diluting the building's historical essence.

While Graur's approach offers a compelling vision of art's role in transformation, it may not be suitable for all types of industrial heritage buildings, particularly those that are more traditional or in poor condition. This highlights

the challenge of balancing artistic interventions with architectural preservation, as well as the practical constraints of adapting complex industrial structures. Ultimately, the success of these transformations depends on a nuanced understanding of both the building's heritage value and the community's needs, ensuring that the transformation supports both cultural and functional purposes.

Overall, these contemporary studies highlight the variety and evolution of approaches to the adaptive reuse of historic industrial structures. They offer valuable insights and strategies for transforming industrial heritage into vibrant, functional spaces, demonstrating the intersection of creative repurposing and sustainable development.

Research Gap

In the process of transforming old industrial buildings, art spaces have become a prominent form of reuse, particularly in Western countries with strong emotional and cultural ties to industrial heritage. These spaces preserve historical and cultural memories while adapting to contemporary uses, maintaining the architectural integrity and cultural significance of the buildings.

However, research on transforming industrial buildings into art spaces is still in its early stages. Existing studies often focus on either architectural strategies or cultural impacts, but rarely offer a comprehensive theoretical framework that integrates both the social and environmental aspects of adaptive reuse. Furthermore, most research tends to emphasise successful case studies, which, while inspiring, fail to address the difficulties developers and architects face in less well-funded or less culturally significant regions.

Successful projects have demonstrated the potential of adaptive reuse to deliver social, cultural, and economic benefits, but more research is needed to identify key success factors and develop a unified framework to guide future transformations. This includes

balancing cultural preservation with modern functional needs and considering the social and environmental impacts of these transformations. In particular, further investigation is needed into the role of artistic interventions in the adaptive reuse process, particularly their ability to activate spaces without overshadowing the building's historical essence.

Methodology

The study employs a qualitative research approach, combining on-site observations and a literature review to conduct a case study. To ensure the validity of the research, data triangulation was used by incorporating multiple sources, including architectural records, renovation documentation, and on-site observations. After a comprehensive assessment, the Tate Modern Art Museum in the UK was selected as a representative case to explore design strategies for transforming old industrial buildings. The choice of the Tate Modern is based on two main reasons. First, Herzog & de Meuron won the design commission for the Tate Museum twice, with an 11-year interval, and the museum has been described by ArchDaily as “the most important new cultural building in Britain in the last 20 years” and a “paradigm of 21st century museums”, demonstrating its influence and significance. Second, the researcher conducted multiple on-site research visits to the Tate Modern Art Museum, which provided a relatively in-depth understanding of its transformation techniques and accumulated abundant first-hand data. However, the study is limited by its focus on a single case, which may affect the generalizability of the findings. Future research could include multiple case studies to enhance the robustness of the conclusions.

A basic analysis of the situation, concentrating on two areas, is where the research starts. An overview of the museum is provided in the architectural background, which also includes information on the designer, the renovation schedule, the renovated floor area, and the spatial qualities. In addition, it provides details on the old industrial building's construction date,

location, and historical context, information that lays the groundwork for further investigation and study. The museum's position within the city and its environs are examined in the second step of the urban context analysis. This analysis offers references for design objectives, including maintaining historical context and energising the urban district by examining the building's location and position within the urban context and researching the growth of the surrounding area.

The study then examines the design approaches used in the instance, concentrating on two areas. It does this by first making the design principles and concepts the designers adhered to clear, enabling a thorough understanding of the case. The analysis of the external environment design and the analysis of the internal environment design comprise the two main sections of the second section, which examines the design methodologies. A thorough examination of all the building's features helps improve and inform the research methods for later studies.

Finally, the study summarises the case's transformation design, focusing on two aspects. First, it summarises and organises the principles of renovation and preservation, identifying the fundamental principles to follow in repurposing old industrial buildings. Second, it evaluates the case's transformation design methodology by integrating the case's information and basic analysis. By assessing the strengths and weaknesses of different aspects of the transformation, the study reflects on the application of the transformation design methodology in practice. Although the single-case focus limits the broader applicability of the findings, it offers valuable insights into the design strategies involved in adaptive reuse. Future research should include a wider range of case studies to further test and refine these insights. The limitations of this study, such as its focus on a single case study, are acknowledged, and the study suggests that future research should include a broader selection of cases to provide more diverse insights.

Overview of Industrial Heritage Renovation Projects

With numerous projects focusing on the transformation of old industrial buildings, their trends can be observed from the distribution of actual cases. This study selects forty representative cases and organises them by the year of renovation. Of the 40 international classic cases analysed, 31 were transformed into art spaces, while 9 were transformed into office, commercial, residential, and dining spaces combined (Table 1). The transformation into art spaces accounted for 77% of the total. It is evident from the actual cases that art spaces dominate the relevant renovation projects. Many well-known projects have achieved remarkable success, making art space transformation the focus of this research.

However, there have also been failures in the transformation of old industrial buildings.

For example, the 798 Art Zone in Beijing, China. The 798 Art Zone used to be an industrial complex of the state-owned 798 Factory, which was transformed into a famous art district. Although the original appearance of the buildings was preserved during the transformation and it gained popularity for a period, it failed to successfully integrate art, culture, and commercial needs. The excessive commercialisation of the art district attracted upscale shops and restaurants, gradually eroding the original artistic atmosphere. This commercial transformation disappointed artists, and many left the 798 Art Zone, leading to a loss of creativity and vitality. Other examples of failures include the Kennedy Centre in New York, a renowned performing arts centre originally built for the World Expo.

Table 1: Case of industrial heritage architecture renovation

Case Name	Location	Time of Construction	Time of Renovation	Function Before Renovation
Today Art Museum	Beijing, China	1957	2002	Boiler Room
Ocean Art Centre	Beijing, China	1986	2002	Spinning Mill
UCCA Edge	Beijing, China	1954	2004	Factory
Jia Pingwa Museum	Xi'an, China	1970	2006	Factory
Madrid Old Slaughterhouse Art Centre	Madrid, Spain	1911	2007–2011	Printing and Dyeing Works
Tangshan City Exhibition Hall	Tangshan, China	1986	2007	Flour Mill
Minsheng Modern Art Museum	Shanghai, China	1950s	2008	Iron and steel works
Hua Art Museum	Shenzhen, China	1982	2008	Laundry
Power Station of Art	Shanghai, China	1985	2010	Power Station
Yue Art Museum	Beijing, China	1950s	2011	Factory
Palais de Tokyo	Paris, France	1937	2012	Factory
Nord-Pas-de-Calais Cultural Centre	France	1927–1965	2012	Mine Works
Industrial Museum	Shenyang, China	1970s	2012	Foundry
Heilongjiang Revolution Museum	Heilongjiang, China	1921	2012	Ordnance Factory
Zeitz Museum of Contemporary Art Africa	Cape Town, South Africa	1921	2013	Warehouse

Minnesota Street Building 1275	San Francisco, USA	1937	2014	Warehouse
Manjinghua Art Museum	Shenzhen, China	1986	2014	Printing
West Bund Arts Centre	Shanghai, China	1950	2014	Ordnance Factory
Mumu Art Museum	Beijing, China	1950s	2014	Ordnance Factory
Kendall Arts Centre	Berlin, Germany	1920	2016	Distillery
Game Streetmekka Viborg Stadium	Denmark	1960s	2017	Factory
Bob the Robot Design Studio	Helsinki, Finland	1950s	2017	The Bread Factory
Communications Agency Joint Office Building	Sheffield, United Kingdom	18th	2018	Iron Foundry
LocHal General Library	Amsterdam, Germany	1932	2019	Train Station
Centre Pompidou Art Centre	Brussels, Belgium	1933	2019	Automobile Factory
National Museum of Contemporary Art	Athens, Greece	2001	2022	FIX Brewery
Ulumbarra Theatre and School	Bendigo, Australia	2004	2023	Bendigo Gaol
Industrial and Technological Ruins	Australia	2006	2022	Art Galleries and Museums

Case Study

Overview

Tate Modern, designed by Jacques Herzog and Pierre de Meuron, is a prominent project. Construction started in 1995 and was completed in 2000. It is a large, specialised art museum with extensive collections and flexible spaces, well-suited to professional, exhibition, educational, and leisure activities. The total internal floor area is 34,500 square meters, including exhibition halls (7,827 sqm), the turbine hall interacting with the street (3,300 sqm), special exhibition suites (1,300 sqm), an auditorium with 240 seats, two cafes accommodating 240 and 200 people, three shops (500 sqm on the first floor, 300 sqm on the second floor, and 150 sqm for the exhibition shop on the fourth floor), an education area (390 sqm), a member activity area (150 sqm), office area (1,350 sqm), and supporting service area (1,500 sqm).

Site Analysis

Before its transformation into a museum, the building was the Bankside Power Station, designed by renowned British architect Sir Giles Gilbert Scott, built in two phases in 1947 and 1963. In the mid-20th century, the power station played a crucial role in supplying electricity to the London metropolitan area. However, as the South Bank area declined overall, the power station became abandoned. In April 1994, the Tate group announced plans to construct the new Tate Modern art museum and, in July of the same year, launched an international scheme to transform the power station into a museum. In January 1995, the proposal by the Swiss firm Herzog & de Meuron was selected, and the renovation work began in May. The project was completed in 2000 and opened to the public, becoming a renowned public art space with remarkable influence and representativeness.



Figure 1: Tate Modern
Source: Britannica

The power station is a heavy industrial-style building with a rectangular footprint of approximately 155m long and 73m wide, parallel to the south bank of the River Thames, running east-west. It is a single-story, large-span space structure, constructed mainly of steel frames and brick walls, 30m high, with a central chimney rising to 99m. The overall space is vast and flexible, consisting of three main parts: The Boiler House with the chimney to the north, followed by the Turbine Hall, parallel to each other and divided by steel columns and footbridges. To the south is the brick Switch House, which maintains the same height as the main structure and is internally divided into

multiple levels. The power station has brick podiums on the southwest and north sides, two additional roof levels, a basement level, and three large underground oil storage tanks below the southern Switch House.

Findings

Design Strategy Research

Analysis of Design Ideas

“To do the least to the existing building”

Herzog & de Meuron always adhere to the concept of “doing the least to the existing building”, focusing on exploring the maximum



Figure 2: The Bankside Power Station
Source: Wikipedia

potential of the original structure and reusing it. “Doing the least” emphasises restraint and simplicity in the renovation approach while demonstrating the necessity of transformation by implementing new requirements within the original building. From an external perspective, Herzog & de Meuron preserved the power station’s iconic features and maintained the building’s industrial atmosphere through these symbolic elements, while carrying out necessary demolitions and minimal additions to better showcase the structure’s original appearance. Internally, the power station’s core components are the Turbine Hall and the Boiler House. The transformation of these spaces primarily aims to adapt them to the museum’s daily activities. To preserve the typical spatial style and basic architectural appearance, the designers employed techniques of “filling” and “adding” layers.

“Create a connection between the building and urban environment”

One of the reasons Tate chose the power station for transformation is its unique geographical location. The rich historical and cultural atmosphere of the South Bank of the Thames provides an excellent context for the museum’s continuity. From the outset, Herzog & de Meuron considered the importance of the connection

between the museum and the urban space, proposing the design concept that “the building should engage in dialogue and blend with the city”. Facilitating communication between the rebuilt building and the outside world is also a core idea of the double decoding theory.

The west side of the museum features a sunken new entrance that cleverly extends the urban space and guides visitors naturally. The north side includes an open souvenir shop and cafe that connect to the riverside garden and provide space for diverse public activities. The underground oil tanks on the south side of the museum were transformed into new exhibition spaces equipped with multimedia devices. The ground pavement was restored, and various recreational facilities were added, making it suitable for entertainment. The new south entrance further enhances the smooth flow between the building’s interior and exterior. The simple treatment method ingeniously fulfils the requirement of the double decoding theory for “communication”. It encourages dialogue between the building, users, and the surrounding area, achieving a perfect integration of urban space, industrial heritage, and modern art.

Similarly, the embodiment of the “dialogue” principle is manifested in an addition to the appearance called the “Light Beam”. This was an initial creative idea conceived by Herzog &



Figure 3: The Bankside Power Station and St. Paul's Cathedral, 1991
Source: Dercon and Serota (2006)

de Meuron. The Light Beam is a two-story glass structure added to the top of the Boiler House. The lightweight glass balances with the brown brick walls in terms of material properties and colour temperature contrast, enhancing the building's recognition. Simultaneously, the design also considers the need for interior lighting. During the day, the Light Beam provides natural lighting for the building's interior, and at night, the lights inside the building project outward, blending into the night sky to create a unique spectacle. Additionally, the Light Beam offers an excellent dining space with panoramic

views, allowing visitors to enjoy food while overlooking London's scenery, enriching the visitor's experience and bridging dialogue between people, architecture, and the city.

In the design of Tate Modern, Herzog & de Meuron fully considered the interaction between the building and the urban environment, as well as users' psychological needs. They continue the design strategy of the double decoding theory, shaping not only a highly open museum space but also an art space that provides high-quality services for urban life.

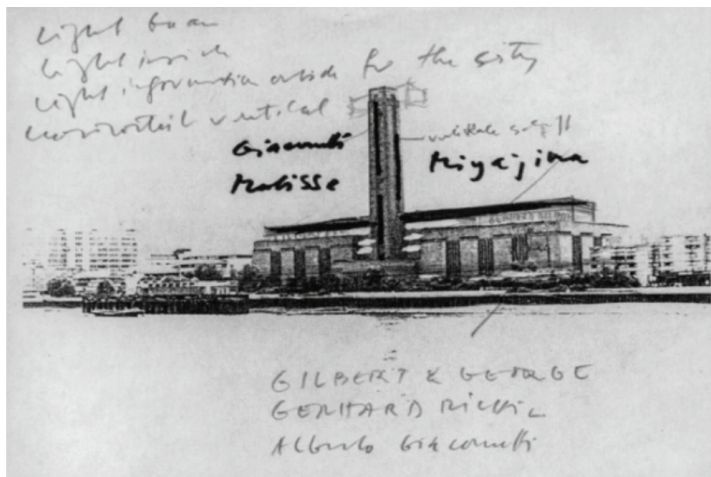


Figure 4: The design sketches, 1994
Source: Dercon and Serota (2006)

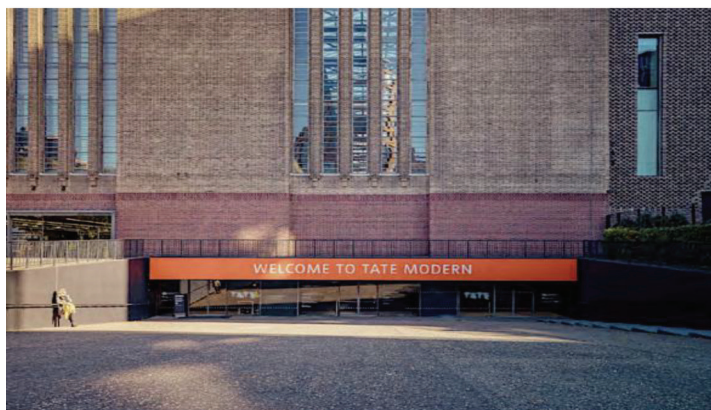


Figure 5: The West Entrance of Tate Modern
Source: Photograph by Author



Figure 6: The Turbine Hall
Source: Dercon and Serota (2006)



Figure 7: Riverside Garden on the north side of the museum
Source: Dercon and Serota (2006)



Figure 8: Leisure Space on the south side of the museum
Source: Photograph by Author

Exterior Construction



Figure 9: The Light Beam
Source: Dercon and Serota (2006)



Figure 10: The Light Beam
Source: Photograph by Author

To respect the architecture of the Bankside Power Station, the Tate Modern art museum's design focuses on preservation and restoration. The original building's exterior was primarily cleaned, repaired, and restored, while some areas were demolished and reconstructed due to functional changes. The chimney on the northern façade and parts of the podium were removed. For the chimney, the designers used brown bricks that matched the main building's colour, creating modern and sleek strip windows that harmonised with the original architecture.

The podium was also filled with bricks of the same colour. In contrast, the external facilities were clad with a glass curtain wall, providing a simple, clean expression. The blurred coexistence of the old and new façades ensured the organic integration of the building with its surroundings.

The new sections of the exterior construction mainly include the "Beam of Light" in the north and the "Glass Box" in the southeast. Both of them utilise glass and lightweight steel as basic materials, combining modernity with

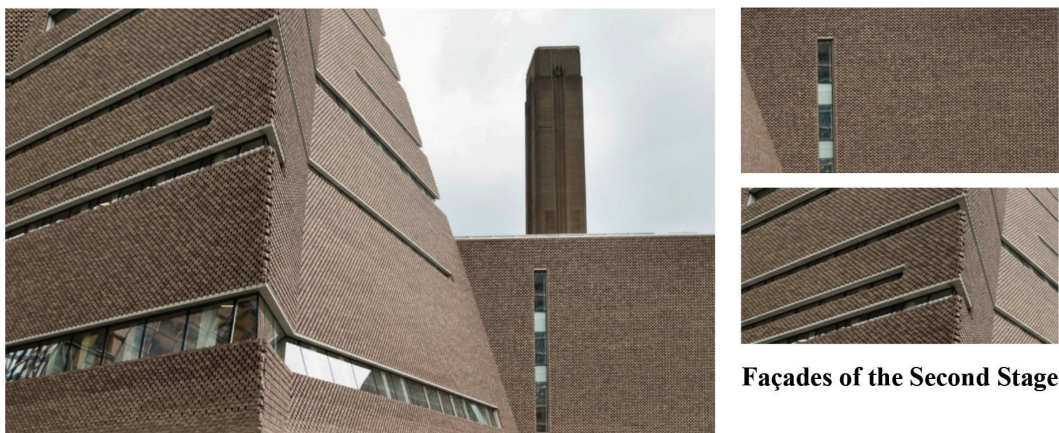
transparency and lightness to avoid significant conflicts with the overall structure. Their innovative and dynamic design language brings modern elements into the old industrial building, achieving an excellent balance. In particular, the “Beam of Light” maintains harmony with the original building’s form and creates a cross shape that intersects with the vertical silhouette of the chimney, resonating with the building’s commemorative features.

A concept that is often debated in current literature about cultural importance in architecture is “dual decoding”, which refers to the intentional act of integrating the museum into its urban environment. The exterior of the museum, a palimpsest of London’s complex past, symbolises the city’s progression, making this integration both physical and symbolic (Table 2). The glass buildings are modernist symbols, but because of their transparency and reflectivity, they may yield to the original structure and let it continue to be the major character in the architectural story. Current architectural discourse, which frequently emphasises the value of such duality in enhancing the user’s experience and the building’s narrative, is increasingly exploring this method of contrasting oneness. Besides its external form, the transparency of the “Beam of Light” structure enhances the sense

of interaction within the museum. Its primary lighting function creates a reverse-illumination effect at night, connecting the interior spaces. Moreover, it provides a viewing and dining space on the top floor of the building, allowing users to resonate with the city.

The new sections in the south directly adopt the same materials, textures, and colours as the original building but recombine them through a straightforward approach. While maintaining the uniformity of the building’s exterior, they exhibit a sense of modernity and create a strong artistic effect. Additionally, the new sections in the south further highlight the image of the “Beam of Light” and the “Glass Box” by echoing the original building.

Overall, the extensive use of transparent new glass façades, contrasting with the enclosed, solid old brick façades, creates iconic architectural elements, endowing the entire building with new meanings. The intriguing collision between the old and the new emphasises the commemorative nature of the old architecture and enhances the museum’s artistic value. It also enables the new building to blend harmoniously into the surrounding cultural atmosphere, enhancing its communicative nature while preserving and showcasing its historical, cultural, and aesthetic values.



Façades of the Second Stage

Figure 11: The façade of the Tate Modern
Source: Photograph by Author

Table 2: Urban location and surrounding environment in Tate Modern Art Museum

Case Name	Location and Surrounding	Value Content	Transformation Results	Comprehensive Feedback
Tate Modern	Location: The famous historical and cultural district of Thames South Bank	Core Urban Area	Integration with and revitalisation of urban surroundings	The location holds historical and cultural significance, which contributes to the urban identity. The transformation not only preserves but enhances the museum's relationship with its surrounding environment, promoting both cultural and economic growth.
	Surroundings: Landscape elements: Thames Architectural elements: Shakespeare's Globe Theatre, Southbank Centre, St Paul's Cathedral, Millennium Bridge	Rich Landscape Resources	Outdoor gardens and viewing spaces developed	The Thames River is a central feature in the design, and the outdoor spaces created provide sweeping views, engaging the museum with its natural environment and surrounding cityscape.
	Architectural elements: Shakespeare's Globe Theatre, Southbank Centre, St Paul's Cathedral, Millennium Bridge	Architectural Heritage	Harmonious integration with surrounding iconic landmarks	The renovation preserves the area's historical significance while introducing a contemporary museum that fits into its cultural and architectural context.

Interior Design Analysis

Structural Treatment Analysis

In the renovation of the old industrial building, there are three main approaches to structural treatment: preservation and reinforcement, integration of old and new elements, and demolition and reconstruction. These three methods have been employed in transforming the Tate Modern art museum.

The Bankside Power Station's overall structure follows a load-sharing pattern with steel and brick walls. The structure is reasonable and durable, and during the renovation, the original structure was largely preserved and continues to serve as the main structural system. In certain areas, new structures were introduced to work together with the existing ones. For example, in the boiler room, the original structure was subdivided on a smaller scale, allowing for more precise spatial divisions and significantly increased utilisation. Due to the low conversion

rate of the original space in the turbine hall, extensive additions were made, incorporating novel architectural structures and more than doubling the usable space. The integration of old and new not only enhances the overall structure and functionality of the spaces but also reveals the tension between the old and new, achieving architectural aspirations.

The architectural structure employs selective demolition to achieve a more modern, streamlined appearance through adjustments to the building's form. This technique is primarily used for the peripheral annexes and roof structures, emphasising the main building and, after demolition, reconstructing the "beam of light" two levels above the roof with glass and steel framework. The diverse design language enriches the functionality, value, recognition, and aesthetics of the roof space. At the same

time, the eastern side of the building undergoes modifications to connect the boiler room and turbine hall with a new two-story glass-and-lightweight-steel structure. It complements the “glass boxes” incorporated into the exterior design, enhancing the building’s diversity and creating a cohesive space that interacts with the glass roof.

Analysis of Functional Updates and Spatial Transformation

Art museums generally require a range of functional spaces, including exhibition areas, collection and research spaces, educational spaces, recreational and entertainment areas, and auxiliary spaces. These spaces are strategically distributed throughout the building and are interconnected by traffic areas. In transforming an old industrial building into an art museum, the core challenge lies in reorganising the internal space and updating its functions to meet the museum’s new requirements.

The Tate Modern Art Museum’s interior spaces are mainly divided into three sections: exhibition halls, external facilities, and auxiliary facilities. The exhibition halls include iconic and regular exhibition spaces. The iconic exhibition halls are located on the basement level, while the regular exhibition spaces are spread across levels two to four of the turbine hall and levels two to five of the switch house. The external facilities are primarily located at convenient transportation levels, such as the sub-basement and ground floor near the two entrances. They include exhibition spaces that require longer visits, as well as areas with additional functions, such as viewing and socialising, on levels five and six. The auxiliary facilities are located on the upper levels of the switch house and in the southeastern corner of the main building. The overall traffic circulation facilitates easy access to various functional spaces.

Several techniques are employed in the spatial transformation of the old industrial building, including space merging, space partitioning, space implantation, and space

connection, all of which have been utilised in the renovation of the Tate Modern Art Museum.

Space Merging

The turbine hall’s grand scale and strong industrial features make it the most representative space within the power station. Thus, the designers chose to preserve this space on a large scale, emphasising the building’s unique characteristics. By removing the ground floor slabs, they created an even more spacious area, expanding the turbine hall to over 3,000 square meters. This space serves as a public leisure area and can accommodate large-scale sculptures and installations, combining its distinctive features with functional requirements. It can be seen as an extraordinary application of the design strategy focused on individuality.

Space Partitioning

The approach to the boiler room’s space involves integrating the existing space with new forms. The designers demolished the platforms and created a more complete, more fluent, high-ceilinged space. They then divided the boiler room vertically by installing floors every 30 meters, creating a semi-open gallery with nearly 8,000 square meters of exhibition space. The space was further equipped with an entrance hall and adjacent areas for product sales. Different partitioning techniques create diverse functional zones while integrating the overall space, effectively utilising the building’s capacity.

Space Implantation

The addition of a two-story glass structure atop the main building contrasts materials and enhances the building’s architectural identity. The added structure on the rooftop expands the building’s space and provides a rooftop leisure area that integrates views, dining, and socialising. Additionally, the use of glass materials considers the lighting requirements, allowing natural illumination during the day and creating a luminous presence at night, complementing the cityscape.

Traffic Flow Analysis

The traffic layout of the Tate Modern Museum is primarily based on the concept of “comprehensive connectivity through intersecting passages”. There are three starting points for visitor routes, with entrances and exits on each side of the building. Nine elevators, six escalators, and several carefully designed staircases vertically connect the different levels. Indoor bridges on the second and fourth floors span the north-south axis, and the well-developed traffic flow efficiently connects the entire building. The overall arrangement is rational and flexible, traversing the entire structure and ensuring a high degree of freedom.

Entrances are provided on the south, west, and north sides of the ground floor to accommodate various flows of people and guide them effectively. The first and second phases of the project are connected by indoor bridges, enabling spatial interaction between the electrical conversion room and the turbine hall. A new platform connects the turbine hall and the boiler room. The boiler room, with the highest exhibition density, is served by four main traffic cores, evenly distributed on both sides of the chimney. These traffic cores consist of stairs, elevators, and auxiliary rooms, effectively connecting the different levels within the boiler room and also linking the two levels of the “Beam of Light” above. Additionally, a traffic core for transporting exhibits and some visitors is located in the northeast corner of the building, enriching the structure’s vertical connections. Due to the building’s large volume, the traffic cores at different levels are colour-coded to assist visitors in locating their current position.

Exhibition Hall Design Analysis

Exhibition Space Creation

The exhibition spaces at the Tate Modern Museum are mainly divided into two types: iconic exhibition halls in the turbine hall and regular exhibition halls in the boiler room and electrical conversion room. The turbine hall features the most fluid space and serves as a

prominent symbol. The designers fully utilise this characteristic by further enhancing and expanding the space with a large sloping ramp that connects the city, blurring the building’s industrial spatial characteristics and harmonising it with the natural surroundings.

Dramatically, the west entrance blends with a massive public display space, reducing the sense of separation between different functional areas. As the ramp progresses, public facilities such as information desks are located in the central part of the space, while the eastern end serves as the endpoint, creating a stable, open area within the vast exhibition hall and providing a unique opportunity to showcase large-scale artworks. The turbine hall retains the highest degree of the original building’s code, including space, structure, and some industrial elements, which are adorned with modern spatial forms. The combination of abstraction and concreteness not only pays tribute to the Battersea Power Station but also creates an intriguing platform for displaying modern art.

The boiler room, located at the northernmost part of the main building, serves as the main entry point and accommodates various functional needs. Taking advantage of the high ceiling height, the designers meticulously divided the boiler room into parallel four-storey exhibition spaces, each with several vertical sections. These exhibition halls adopt the basic “white boxes” style, but their spatial shapes vary, with heights ranging from 5 to 12 meters, providing great flexibility. The partition walls between the exhibition halls are detachable, indicating the designers’ ambitious vision, as they thoroughly consider the different scales of exhibits and various exhibition formats. This elevates the spatial form of the “white box” exhibition halls, creating dynamic exhibition spaces with enhanced adaptability and expressive power.

The electrical conversion room is the second phase of the project, expanding the original building’s foundation into a 10-storey space. The main entrance is on the southern

side of the first floor, providing a spacious area for accommodating a large flow of people and displaying artwork. The basement level features a multimedia exhibition hall, suitable for digital art displays. The second to fourth floors consist of standard-sized exhibition halls that meet daily exhibition requirements. The fifth floor serves as a personal gallery, offering flexible space for temporary art exhibitions. As part of an expansion project, the exhibition halls in the electrical conversion room significantly increase the Tate Modern Museum's available space, enriching its display content.

Exhibition Environment Creation

The creation of the exhibition environment relies primarily on lighting design, the environmental colour scheme, and the material attributes of the indoor spaces. The designers ingeniously combine various elements that influence the environment to create highly expressive environments in each exhibition hall.

Notably, the turbine hall, as the most iconic space within the Tate Modern Museum, exhibits a rich variety of expression techniques and architectural language, representing both the exhibition environment and the presentation of the building's internal façade. The iconic exhibition hall preserves industrial components from the era of the Battersea Power Station, including roof skylights and square windows on the side walls. By combining these existing elements with the "glass box" on the southeast side, the designers create new features that ensure natural lighting within the exhibition space.

The long rectangular windows on the eastern and western walls serve as internal reflections of the building's exterior façade, enriching the spatial hierarchy with a church-like architectural language. The use of light-coloured plaster on the north and south walls emphasises the black steel structural industrial elements through contrast. The overall colour scheme, composed of a grey tone, complements the retained industrial structures, exuding artistic qualities. The underground level and the western

side of the building feature glass curtain walls, creating a light, transparent atmosphere that emphasises the inclusiveness and public nature of the external facility area. Platforms, lobbies, rest areas, and even escalators interspersed throughout the space offer different perspectives on artworks, adding a touch of surprise to the exhibition in the turbine hall.

The regular exhibition halls also strive to utilise natural lighting whenever possible, with floor-to-ceiling square windows in each, providing illumination while framing views of London's urban landscape. In spaces with limited natural light or specific exhibition requirements, artificial lighting is used to supplement natural light. Linear light strips are commonly used. The regular exhibition halls feature white-walled spaces and oak flooring, with distinct colour tones and a warm texture, creating a pure viewing space by isolating distracting elements. The movable partition walls and varying heights of the exhibition halls create inclusive, versatile exhibition spaces that accommodate a wide range of display needs.

From the findings, as shown in Table 3, it has been found that form, space, material, craftsmanship, spirit, and context are some of the value aspects that may be used to analyse the transformation of the Tate Modern Art Museum, a prime example of the adaptive reuse of an abandoned industrial building. Determining the degree to which the transformation measures adhere to the authenticity principle requires careful consideration of this analysis.

The authenticity criterion is upheld by maintaining the museum's shape and space, including its imposing exterior and tall chimney. The methods outlined by Appiotti et al. (2020), who emphasise the importance of preserving the historical and architectural integrity of buildings during conversion, are consistent with this strategy. Though it enhances the commemorative significance of buildings, removing auxiliary structures departs from the historical authenticity of the structures, posing a difficult balancing act between aesthetic improvement and historical preservation.

Table 3: Evaluation and analysis of the preservation of old industrial buildings in the Tate Modern Art Museum

Value Factors of Old Industrial Buildings	Evaluation Object Properties				Transformation Measures	Compliance with the Principle of Authenticity
	Space	Material	Craftsmanship	Spirit		
Milestones in the Art of Brick Architecture	√	√			Basically protect the brick surface (maintaining the original brick surface)	conform to
					New skin design maintains original style, avoiding excessive ornamentation	conform to
Monumental appearance	√			√	Basically protect the original appearance (maintaining historical façade)	conform to
					Demolish auxiliary buildings to enhance commemoration (demolition of some buildings may harm the historical feel)	incompatible
Very large size	√			√	Basically protect the original volume (maintaining the original scale)	conform to
Tall chimney	√			√	Basically protect the original form (maintaining the original position and height of the chimney)	conform to
Façade fenestration	√		√		Basically protect the original form (maintaining window openings)	conform to
					Basic protection and lighting function (optimising natural light)	conform to
Steel structure	√	√	√		Basic protection subject form (retaining original steel frame structure)	conform to

	√	√	√	Basic protective load-bearing function (enhancing stability of steel structure)	conform to
				Basically protect the original form (maintaining original roof structure)	conform to
Light steel roof	√	√	√	Basic protective load-bearing function (enhancing roof's wind and earthquake resistance)	conform to
				Basic protection turbine hall skylight form (maintaining skylight shape for light)	conform to
Industrial skylight	√		√	Remove the boiler room skylight (boiler room skylight no longer serves modern functions)	incompatible
				Basic protection and lighting function (optimising natural lighting)	conform to
Boiler Room	√		√	Vertical space division (division may affect historical space integrity)	incompatible
Turbine hall	√		√	Removing floor slabs to expand space (removal of slabs enhances space utility)	conform to
Underground space	√		√	Horizontal space division (division may damage the architectural integrity)	incompatible

The authenticity principle aligns with the emphasis on maintaining materials and craftsmanship, particularly in the steel structure and the light steel roof. According to De Matteis *et al.* (2021), this aligns with a broader trend in industrial heritage conservation, which seeks to preserve the building's inherent material attributes to maintain its historical and architectural integrity. They provide a framework for sustainable repair that honours the skills and materials of the past. Moreover, modifications that deviate from the building's spirit and context (such as adding an underground parking area or a boiler room) are considered incompatible. This implies a departure from these places' original character, which is a frequent problem in adaptive reuse initiatives. The original spatial experience is altered by the vertical and horizontal partitioning of space, emphasising the conflict between modern functional needs and historical preservation, an issue Poon (2017) examined in relation to urban planning and architecture.

Moreover, the findings indicate that Tate Modern's transformation initiatives, for the most part, adhere to the notion of authenticity, demonstrating a considerate attitude towards adaptive reuse. Form, material, and some structural features are preserved in a way that is consistent with modern sustainable development practises and imaginative reuse of old buildings. However, incompatibilities highlight the inherent difficulties of striking a balance between modern requirements and historical preservation. Roost and Jeckel's (2021) study, which examines the evolution of industrial zones in the context of urban planning and development, echoes this issue. Overall, the transformation of the Tate Modern Art Museum is an example of a sophisticated approach to adaptive reuse, balancing the needs of a modern art space with the preservation of key features. Authenticity, historical integrity, and modern functionality must be carefully negotiated in the field of industrial heritage restoration, as this case study illustrates.

Conclusions

Through qualitative research methods, the following conclusions are drawn from the case study and evaluation of Tate Modern. Before embarking on transforming old industrial buildings into art museums, it is necessary to conduct a comprehensive project analysis, focusing on the urban location analysis and the value analysis of the old buildings.

Firstly, the analysis of the urban location of the old buildings is essential. This step requires considering the surrounding environment, landscape resources, historical context, and economic value of the buildings. By extracting relevant characteristics and context from the surrounding environment and atmosphere, strategies can be developed for the building's exterior façade and ambience. By utilising landscape resources, a strategy of "communication" through symbolic translation can be employed to design architectural viewing spaces and foster interaction with the city. Extracting the building's historical context helps consider the juxtaposition of old and new symbols and meet the requirements for preserving historical and cultural contexts.

Secondly, the analysis should focus on the value of the old buildings themselves. This step involves assessing the reuse value of the building's resources and the economic value it can bring. Evaluating the material resources based on the building's original symbols and spiritual value helps identify reusable materials, which can contribute to subsequent transformation plans, resource conservation, and the enhancement of the project's economic value, while preserving historical context and resolving conflicts between old and new. Analysing the building's economic value is crucial for urban revitalisation and the renewal of urban areas. The requirements for economic benefits translate into driving forces for the design proposal, influencing public and interactive aspects of spatial creation, architectural form, attraction, and the overall positioning of the museum. Detailed and in-

depth research on material resources, contextual preservation, urban location, and economic expectations during the project analysis stage lays the foundation for the smooth development of subsequent design ideas and strategies.

While the findings provide a strong basis for transformation strategies, it is important to note that this study is limited by the case study's scope, which focuses solely on the Tate Modern. Future research could explore additional case studies to test the applicability of the proposed strategies across different contexts, while accounting for regional differences and varying historical backgrounds.

The transformation of old industrial buildings into art museums involves two main directions: The preservation of the old buildings and the design of the art museum. The transformation plans should adhere to the aforementioned directions. Additionally, the three core symbols and three translation methods outlined in the double decoding theory, as a guiding theory for postmodern architectural design, should be incorporated into the transformation plans. This ensures that the corresponding transformation can address design issues, meet user requirements, and comply with contemporary demands.

One potential area for future research is the exploration of how different cultural contexts influence the design and transformation of industrial buildings into art spaces. By comparing various international projects, further insights into the adaptability of design strategies across different cultural environments can be gained.

In preserving old industrial buildings, transformation plans should be guided by the principles of authenticity and integrity. For authenticity considerations, the following points are required: Firstly, utilising preservation and necessary modification methods to preserve the building to a greater extent, as the degree of preservation correlates with the level of authenticity; secondly, considering the value elements comprehensively during the

preservation process. The wider the dimensions of preservation, the more complete the preserved value, and the higher the level of authenticity; thirdly, differentiating the treatment of preserved and newly added sections to enhance distinctiveness and reflect authenticity.

For integrity considerations, the following points are required: Firstly, the degree of preservation should be proportional to the integrity; valuable sections should be preserved as fully as possible. Secondly, the impact of preservation content on integrity should be considered. The main spaces, forms, and styles require greater protection, while partial alterations do not affect the integrity of preservation. Thirdly, the impact of new additions on integrity should be avoided. Adaptability and necessity should guide the approach rather than creating abrupt new structures.

For practitioners in architecture and urban planning, it is recommended that the principles of historical preservation be balanced with functional adaptation to ensure the artistic and historical integrity of the space is preserved while meeting the demands of modern use. These strategies could help guide future projects that aim to transform industrial heritage into dynamic cultural spaces.

The design of the art museum encompasses aspects such as site environment, spatial transformation, structural treatment, traffic flow, façade design, and exhibition hall design. When formulating specific transformation plans, general principles of museum architecture should be considered, balancing functionality, public accessibility, artistic expression, and cultural significance. Additionally, the unique requirements of an art museum should be considered, including diverse exhibition methods, flexible spaces, distinctive lighting, and free movement. The transformation plans should integrate the findings from the project analysis and adopt targeted transformation techniques to maximise the existing value of the old buildings and showcase their distinctiveness to the fullest.

In conclusion, while this study offers a solid framework for transforming industrial buildings into art museums, further research is needed to refine these strategies, taking into account the broader implications of urban revitalisation and community engagement. Additionally, the impact of such transformations on local communities and their economic, cultural, and social development should be explored in future studies.

Acknowledgements

My special thanks first go to Dr. Aainaa Suhardi, who inspired me a lot in the early stages of writing this paper. Also, I want to give my thanks to Dr. Nadzirah Zainordin and Professor Nangkula Utaberta. Without their valuable instruction and advice, this paper would not have been able to be finished smoothly. This research is part of a dissertation which will be submitted as partial fulfilment to meet requirements for the degree of Doctor of Philosophy of Architecture at UCSI University.

Conflict of Interest Statement

The authors agree that this research was conducted in the absence of any self-benefits, commercial or financial conflicts and declare absence of conflicting interests with the funders.

Author's Contribution

Wei Qisi conducted the research, conceptualised the central research idea, provided the theoretical framework, and wrote and revised the article. Nadzirah Zainordin and Nangkula Utaberta designed the research and supervised its progress. Nangkula Utaberta also anchored the review process, revisions, and approved the article submission.

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