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Article

Optimization Strategies for Industrial Heritage Landscape Design in Zhengzhou

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Abstract: As Zhengzhou, a key industrial and transportation hub in central China, urbanizes, its industrial heritage becomes a key space where historical culture and modern functions intersect. The challenge in urban renewal is preserving historical value while adapting to modern needs. This paper analyzes Zhengzhou's industrial heritage renovation cases, focusing on the integration of historical preservation, green design, and social function innovation. It identifies issues such as conflicts between preservation and modern demands, insufficient ecological restoration, and the lack of social functions. The paper proposes strategies, including multi-level cultural expression, integrating green design with ecological restoration, and social function innovation, to ensure sustainable development. This research provides both theoretical support and practical guidance for Zhengzhou's transformation and offers insights for other cities with similar challenges.

Keywords: industrial heritage; landscape design; historical preservation; green design; social function; Zhengzhou; urban renewal; ecological restoration

1. Introduction

1.1. Research Background

As the economic, transportation, and industrial hub of central China, Zhengzhou has played a key role in the country's industrialization. However, with rapid urbanization, many of the city's industrial heritage sites are facing functional decline and environmental challenges. Preserving these sites while adapting them to modern urban needs has become a critical issue for Zhengzhou and other cities involved in industrial heritage design [1]. Zhengzhou's industrial heritage holds significant cultural and historical value. Sites like the Zhengzhou Second Grinding Wheel Factory and Zhengzhou Railway Station are milestones in both industrial history and the city's development. However, the preservation and effective utilization of these sites have become increasingly urgent due to the city's ongoing transformation. Global attention to industrial heritage has led many cities to successfully repurpose these sites into cultural parks, commercial complexes, or public spaces, bringing social and economic benefits. Examples such as the Ruhr Region in Germany and High Line Park in the U.S. show how adaptive reuse can preserve history while meeting modern needs. Zhengzhou can draw inspiration from these cases to revitalize its industrial heritage through innovative landscape design [2].

1.2. Research Significance

Industrial heritage landscape design is not only about restoring and preserving heritage sites but also integrating them with modern social functions and ecological needs, thereby adding new cultural, economic, and social value. For Zhengzhou, this design approach enables effective preservation of cultural assets while playing a key role in urban renewal and supporting the diversified development of the local economy.

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Zhengzhou's industrial heritage is diverse, primarily concentrated in the city's core areas and surrounding regions. These sites witness the city's industrial history and reflect its social transformations over time. Through design transformation, Zhengzhou can enhance the modern functionality and ecological value of these spaces while preserving their historical and cultural significance.

The following table provides an overview of the types, functions, and current transformation status of major industrial heritage sites in Zhengzhou:

Table 1. Zhengzhou's Industrial Heritage Overview.

Industrial Heritage Name	Construction Year	Type	Main Function	Current Transformation Status
Zhengzhou Second Grinding Wheel Factory	1950s	Factory Building	Steel Production	Transformed into a Creative Park
Zhengzhou Railway Station	1930s	Transportation Facility	Railway Transportation	Partially Under Renovation
Former Zhengzhou Power Plant	1960s	Power Facility	Power Generation	Converted into a Commercial Complex

As shown in the table, Zhengzhou's industrial heritage spans multiple sectors but faces challenges in terms of transformation and reuse. A key issue in this study is how to balance the historical and cultural value of these sites with modern functional requirements. Effective landscape design can preserve their cultural significance while promoting sustainable urban and economic development.

The significance of industrial heritage landscape design is reflected in the following aspects:

1) Historical and Cultural Preservation: Ensures that the historical and cultural value of industrial heritage is preserved, transforming these sites into cultural resources for modern society.
2) Ecological Restoration and Sustainability: Enhances the ecological functions of these sites by applying ecological restoration techniques and green design concepts, supporting sustainable development.
3) Urban Renewal and Social Innovation: Transforms industrial heritage into multifunctional spaces, fostering the growth of creative industries, commerce, and culture, bringing new vitality to the city.

The transformation of Zhengzhou's industrial heritage is crucial not only for cultural preservation but also for the city's sustainable development. Thoughtful landscape design allows these sites to continue contributing to the city's social, economic, and cultural modernization.

1.3. Research Objectives and Structure

The primary objective of this study is to explore the challenges and opportunities in the landscape design of industrial heritage in Zhengzhou, proposing feasible optimization strategies. The specific objectives are:

1) To analyze the historical and cultural value of Zhengzhou's industrial heritage: This involves examining the historical, cultural, and social significance of Zhengzhou's industrial heritage and its potential role in urban renewal.
2) To develop a comprehensive landscape design framework: Propose a multi-dimensional framework that integrates historical preservation, modern functionality, and ecological restoration, aiming to achieve the sustainable reuse of Zhengzhou's industrial heritage.
3) To propose specific design optimization strategies: Based on field research, case studies, and data analysis, this objective focuses on strategies to optimize industrial heritage landscape design, incorporating technological innovation, green design, and interdisciplinary collaboration.

2. Literature Review

2.1. Global Research Progress on Industrial Heritage

The reuse of industrial heritage is increasingly recognized as a key aspect of cultural heritage preservation. However, many scholars have overlooked its unique role as a "conduit for transforming into modern urban functions." [3]. Industrial heritage is not only a historical carrier but also a bridge between the past and modern society. Through landscape design, industrial heritage can be "recreated" to serve modern urban functions. This approach challenges the traditional notion of preservation as stagnation, driving the exploration of dynamic and interactive heritage designs.

1) Balancing Historical Preservation and Cultural Continuity: Early research focused on preserving the physical structure. More recent studies emphasize infusing vitality into heritage sites, using interactivity and dynamic displays to engage the public [4]. This approach allows heritage sites to preserve their historical significance while integrating into modern urban life.
2) Green and Low-Carbon Design: Ecological and low-carbon technologies are essential in the transformation of industrial heritage. While existing research often focuses on restoring the original appearance, successful examples show how using native plants and recycled materials can enhance ecological functions and reduce external dependencies.
3) Innovation in Social Functions: The reuse of industrial heritage should serve societal needs. These spaces should be multifunctional platforms for community activities and social innovation, promoting the integration of industrial heritage into urban life.

2.2. Current Research on Industrial Heritage Landscape Design in China

China's industrial heritage preservation has rapidly developed alongside urbanization. Scholars focus on balancing preservation with modern functional needs, especially in the context of cultural and creative industries [5].

1) Historical Preservation and Reuse: Many scholars explore balancing historical preservation with modern needs. In Zhengzhou, industrial heritage has been transformed into creative parks, preserving cultural value while introducing new functions.
2) Green Design and Ecological Restoration: Green design and ecological restoration have become central to industrial heritage transformation. Techniques like green roofs and solar systems are being integrated into heritage projects to support sustainable development.
3) Public Participation and Social Recognition: Public participation is key to the success of industrial heritage projects. Ensuring these spaces are integrated into the community and valued by locals is a focus in Zhengzhou's heritage transformation.

By analyzing case studies of Zhengzhou's industrial heritage transformation, this study offers innovative ideas, particularly in ecological restoration and social function innovation, providing theoretical support for design optimization.

3. Analysis of the Current Status of Industrial Heritage Landscape Design in Zhengzhou

3.1. Overview of Industrial Heritage in Zhengzhou

Zhengzhou, a central industrial hub in China, is rich in industrial heritage, primarily from the rapid industrialization of the 20th century. These heritage sites represent key sectors, including manufacturing, transportation, energy production, and machinery, reflecting both the city's industrial past and its cultural significance [6].

Zhengzhou's industrial heritage is mainly categorized into the following types:

1) Factory Buildings: For example, the Zhengzhou Second Grinding Wheel Factory and Zhengzhou Power Plant, originally used for steel production and energy supply, are now repurposed into cultural and creative parks and commercial complexes.
2) Transportation Facilities: Such as Zhengzhou Railway Station, which played a vital role in the city's development. Some sections of the station are being renovated to meet modern transportation and commercial demands.
3) Energy Facilities: The Former Zhengzhou Power Plant, now a key part of urban renewal, presents the challenge of being transformed into low-carbon and green spaces.

Zhengzhou's industrial heritage is distributed across the city's core areas and surrounding industrial zones. These sites serve as witnesses to the city's development and reflect significant social changes. The challenge now is how to protect and adapt these sites within the modern urban environment.

3.2. Current Status of Industrial Heritage Landscape Design in Zhengzhou

Although Zhengzhou has made progress in preserving industrial heritage, significant challenges remain, particularly in balancing historical preservation with modern functional needs. Existing designs often prioritize commercialization and creative industries, overlooking the social functions and cultural values of these sites.

1) Conflict between Historical Preservation and Modern Needs: Many of Zhengzhou's industrial heritage buildings have suffered from aging and neglect. The primary challenge is to preserve their historical significance while meeting modern demands for functionality, comfort, and safety.
2) Insufficient Ecological Restoration and Green Design: While some projects have introduced green design concepts, the application of ecological restoration and low-carbon technologies is still limited. Many renovations focus primarily on architectural restoration, neglecting ecological aspects, which compromises the sustainability and ecological value of these spaces.
3) Lack of Social Functions: Zhengzhou's industrial heritage transformation has often emphasized cultural and commercial aspects, with less attention paid to creating public spaces that foster social interaction and community engagement [7]. Future designs should focus on transforming these spaces into multifunctional platforms that serve both public and social needs.

3.3. Case Analysis

In Zhengzhou's industrial heritage landscape design, several typical cases reflect the current challenges and feasible transformation paths. Analyzing these cases helps identify shortcomings and propose optimization suggestions.

3.3.1. Zhengzhou Second Grinding Wheel Factory Creative Park

The Zhengzhou Second Grinding Wheel Factory Creative Park (formerly the site of the Zhengzhou Second Grinding Wheel Factory) is one of the earliest industrial heritage transformation projects in Zhengzhou. The park has transformed old industrial buildings into multifunctional spaces that integrate cultural industries, art exhibitions, commerce, and leisure. The historical buildings have been preserved and renovated with modern architectural styles, creating a space that blends history with modern functionality.

Table 2. Project Overview.

Project Name	Original Function	Post-Renovation Function	Transformation Achievements
Zhengzhou Second Grinding Wheel Factory Creative Park	Steel Production	Cultural and Creative Industries, Art Exhibitions, Commercial Activities, and Leisure	Thriving cultural activities and creative industries, attracting business and visitors

Specific Issues Faced:

1) Superficial Cultural Content: Although the park has attracted businesses and creative industries, its cultural displays lack depth. The challenge is to explore the social value and history of industrial heritage through design, rather than just presenting it visually. Future renovations should focus on multi-dimensional display methods to engage the public with the history and stories behind these sites.
2) Lack of Functional Space: While the park provides space for creative industries, its design does not prioritize public functionality and interactivity. Most spaces serve commercial and cultural activities, but local residents' needs are not sufficiently met. Future designs should enhance community services, ensuring the park serves both visitors and local residents.
3) Weak Green Design and Ecological Restoration: The park's green design and ecological restoration efforts are limited. Future renovations should incorporate more ecological restoration techniques, such as rainwater harvesting and green roofs, to enhance its ecological function and sustainability.

3.3.2. Rui Guang Creative Factory

The Rui Guang Creative Factory, located in the former Rui Guang Printing Factory area, is one of Zhengzhou's more successful industrial heritage transformation projects. The park has effectively integrated modern office spaces, creative industries, cultural exhibitions, and community functions, becoming a significant platform for cultural and commercial exchange in Zhengzhou. Key highlights include:

1) Successful Transformation of Multifunctional Spaces: The park retains the factory's original industrial features, transforming production spaces into creative studios, galleries, and exhibition areas. This preserves the site's historical value while providing modern, multifunctional spaces for work and living, blending history with contemporary design [8].
2) Community Participation and Cultural Identity: The park encourages public involvement through community events and art exhibitions, enhancing local residents' sense of belonging and cultural identity. This integration with urban life stimulates the creative industry and attracts artists, entrepreneurs, and creative teams.

However, the project also faces several challenges:

1) Balancing Commercial and Cultural Functions: While various functions were introduced, excessive commercialization in some areas has weakened the park's cultural and social roles. Future development should balance commercial growth with cultural and public service functions.
2) Insufficient Ecological Restoration: Despite the use of green design elements, ecological restoration remains limited. More investment in techniques like rainwater harvesting and vegetation restoration is needed to improve sustainability and ecological value.

3.3.3. Sesame Street 1958 Innovation and Entrepreneurship Park

The Sesame Street 1958 Innovation and Entrepreneurship Park, formerly the Zhengzhou Coal Mining Machinery Factory, is one of the latest industrial heritage transformation projects in Zhengzhou. The park has transformed the original site into a multifunctional space combining innovation, entrepreneurship, cultural creativity, commerce, and art exhibitions. By preserving historical buildings and integrating modern design techniques, the park successfully blends culture, commerce, and creative industries, making it a key innovation platform in Zhengzhou.

Table 3. Project Overview.

Project Name	Original Function	Post-Renovation Function	Transformation Achievements
Sesame Street 1958 Innovation and Entrepreneurship Park	Coal Mining Machinery Factory	Innovation and Entrepreneurship, Cultural Creativity, Commercial Activities, and Art Exhibitions	Becomes a center for cultural creativity and commercial innovation, attracting numerous businesses and visitors

Challenges Faced:

1) Excessive Commercialization: While focusing on creative industries and cultural displays, excessive commercialization has hindered the development of public spaces and social functions. Some areas are overly commercialized, reducing the availability of social services and public functions. Future designs should better balance commercial needs with community interaction and public service spaces.
2) Lack of Ecological Function: Although the park incorporates green design concepts such as energy-efficient materials and green roofs, ecological restoration efforts remain insufficient. Comprehensive techniques like rainwater harvesting and vegetation restoration are lacking, and low-carbon goals are not fully achieved. Future renovations should introduce more ecological restoration technologies to improve sustainability and the park's ecological value.

3.4. Analysis and Insights

From the above case studies, several important conclusions can be drawn:

1) Balancing History and Modern Needs: Successful transformation requires balancing historical preservation with modern functionality. Many projects restore the appearance but lack innovation in functionality. Future designs should preserve history while meeting modern needs, avoiding excessive commercialization. For example, the Zhengzhou Second Grinding Wheel Factory Creative Park preserves history but lacks community interaction.
2) Green Design and Ecological Restoration: While some projects have adopted green design, ecological restoration still needs improvement. Future designs should focus on ecological restoration and integrate low-carbon technologies. Using the site's topography for natural landscape restoration, rainwater harvesting, and green roofs can enhance sustainability.
3) Social Functions and Community Participation: Many projects focus on commercialization, neglecting social functions. Future designs should enhance social aspects by promoting community interaction. For instance, the Rui Guang Creative Factory has commercial functions but lacks community service spaces. Designs should incorporate community activities to foster participation and cultural identity [9].
4) Low-Carbon Design and Sustainability: Industrial heritage transformation should prioritize sustainability. Zhengzhou's projects have not sufficiently focused on low-carbon design. Future designs should incorporate smart systems,

energy-efficient technologies, and recycled materials to reduce energy consumption and carbon emissions, supporting sustainable development.

3.5. Summary and Strategic Recommendations

Through analyzing key industrial heritage transformation projects in Zhengzhou, it is clear that the city has made significant progress, particularly in cultural creative industries and commercial development. However, issues remain, including excessive commercialization, insufficient green design, and a lack of social functions.

To ensure the sustainable development of industrial heritage in Zhengzhou, future designs should focus on:

1) Balancing Historical Preservation and Modern Needs: Designs should integrate historical preservation with modern functionality, creating a harmonious connection between heritage and urban life.
2) Green Design and Ecological Restoration: The application of green design and ecological restoration is essential to preserve cultural value while ensuring ecological sustainability.
3) Innovation in Social Function Integration: Future designs should enhance the social value of industrial heritage, transforming these spaces into centers for community interaction and social innovation.
4) Low-Carbon and Sustainable Development: Low-carbon design and sustainable practices should be core objectives, encouraging more environmentally friendly and efficient designs.

By examining case studies like the Zhengzhou Second Grinding Wheel Factory Creative Park, Rui Guang Creative Factory, and Sesame Street 1958 Innovation and Entrepreneurship Park, this study highlights the progress and challenges in Zhengzhou's industrial heritage landscape design and provides strategies for future improvements.

4. Design Optimization Strategies and Innovative Approaches

4.1. Balancing Historical Preservation and Modern Needs

Historical preservation is key in industrial heritage landscape design, but balancing it with modern functional demands is a challenge. Zhengzhou's transformation should focus on achieving harmony between history and modernity.

To balance cultural preservation with modern utility, future designs should prioritize:

1) Multi-Level Cultural Expression: Beyond façade restoration, designs should incorporate spatial design, landscape features, and information displays to explore the social and historical value. For example, Zhengzhou Second Grinding Wheel Factory can use interactive exhibitions to engage visitors and residents with its cultural history [10].
2) Flexible Functional Space: Adapt space layouts to modern needs while preserving architectural elements. For instance, former production spaces can be converted into commercial or cultural areas while retaining historical features.
3) Cultural Recreation: Encourage public interaction through historical displays, digital exhibits, and art installations, enriching both functionality and cultural impact.

4.2. Green Design and Ecological Restoration

In Zhengzhou's industrial heritage transformation, green design and ecological restoration have been insufficient, leading to weak ecological functions. Future designs should integrate green principles to promote sustainability.

1) Ecological Restoration and Native Plants: Green design should focus on ecological functions, using native plants, soil restoration, and rainwater management.

Techniques like green roofs, vertical gardens, and wetlands can enhance ecological sustainability and restore biodiversity.

2) Green Architecture and Energy-Saving: Renovations should prioritize green materials (recyclable and energy-efficient) and techniques like natural ventilation and solar systems. Zhengzhou's industrial heritage projects should meet green building standards (e.g., LEED, BREEAM) to improve energy efficiency and resource recycling.
3) Low-Carbon Technologies: Incorporating low-carbon technologies like smart systems, energy-efficient lighting, solar power, and rainwater harvesting is essential for sustainability. Additionally, adding sustainable transport options, such as bike lanes and public transit, will support low-carbon travel.

4.3. Social Functions and Community Participation

Future industrial heritage transformations should prioritize social functions, creating public spaces that foster interaction and community involvement. These spaces should serve as hubs for social innovation and public services, in addition to business and creative industries.

1) Designing Multifunctional Public Spaces: Designs should transform industrial heritage into multifunctional spaces, integrating cultural displays, educational activities, and recreation. For example, in the Zhengzhou Second Grinding Wheel Factory Creative Park, adding community centers and hosting cultural festivals can increase public participation.
2) Promoting Social Innovation and Collaboration: Industrial heritage can be repurposed as centers for innovation and collaboration, such as incubators, maker spaces, or shared studios. Including communal areas like markets and shared kitchens will enhance interactivity and community engagement.
3) Encouraging Community Participation: The design process should involve the community through forums, design competitions, and public voting. This approach ensures the design aligns with actual needs and fosters a stronger sense of community ownership, leading to more adaptable designs.

5. Conclusion and Future Outlook

5.1. Main Conclusion

This study analyzes the current state of industrial heritage landscape design in Zhengzhou, drawing insights from domestic and international literature and case studies. Key conclusions are as follows:

1) Balancing Historical Preservation with Modern Needs: Zhengzhou faces multiple challenges in industrial heritage transformation, primarily balancing historical preservation with modern functional needs [11]. Effective design goes beyond facade restoration and should include innovative solutions like multi-level cultural expression and flexible space layouts to breathe new life into historical sites.
2) Strengthening Green Design and Sustainability: Green design and ecological restoration are critical for enhancing sustainability in industrial heritage transformation. Future projects should prioritize the integration of low-carbon principles, energy-efficient technologies, and ecological restoration throughout the design process to ensure long-term environmental benefits.
3) Integrating Social Functions and Community Engagement: Industrial heritage spaces must serve not only as platforms for creative industries but also as vibrant social spaces. Future designs should enhance community interaction and ensure these spaces are embedded in the daily lives of local residents, fostering social innovation and public services rather than just serving as tourist destinations.

5.2. Future Outlook

While Zhengzhou has made progress, many challenges remain. Future research and design should focus on the following areas:

1) Digital Preservation and Local Community Engagement: Future designs should integrate digital technologies such as Virtual Reality (VR) and Augmented Reality (AR) for preserving and displaying industrial heritage, while ensuring designs are rooted in local history and community needs. This will help enhance public engagement and foster social innovation.
2) Green Design Innovation and Sustainable Development: Zhengzhou should prioritize advanced green technologies like energy-efficient systems and smart energy management. These innovations, combined with ecological restoration, will enhance the sustainability and ecological benefits of industrial heritage spaces.
3) Strengthening Policy Support and Interdisciplinary Collaboration: To address complex challenges, Zhengzhou should strengthen policies and promote collaboration across architecture, landscape design, sociology, and ecology. A comprehensive approach involving both public and private sectors will drive successful heritage protection and sustainable development.

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