The Legal Dilemmas in Achieving Sustainability Goals in Old Factory Redevelopment and the Response Pathways of Design Thinking

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Abstract: Old factory redevelopment plays a critical role in urban renewal and ESG-oriented sustainable transformation. However, the achievement of sustainability goals is frequently constrained by legal bottlenecks, including rigid land-use regulation, ambiguous industrial heritage protection standards, and insufficient enforcement of green building requirements. Existing studies often address legal or design issues separately, lacking an integrated interdisciplinary perspective. This study constructs a "Legal Barriers–Design Responses–ESG Value Transformation" analytical framework and conducts a comparative case analysis of representative projects in China, Europe, and the United States. The findings reveal that China primarily faces procedural complexity and vague regulatory standards, while Europe and the United States are characterized by highly codified legal systems and rigid institutional constraints. Across regions, design thinking-through functional flexibility, reversible renovation, prototype testing, and modular green retrofits-emerges as a mediating mechanism that enables sustainable transformation within regulatory boundaries. Based on the comparative analysis, this paper proposes a Legal–Design Collaboration Toolkit to support policymakers and designers in aligning regulatory compliance with design innovation in old factory redevelopment.

Keywords: Component; Old Factory Redevelopment; Legal Dilemmas; Design thinking; ESG; Industrial Heritage; Urban Renewal

1. Introduction

Old factory redevelopment has become a central strategy in contemporary urban renewal, particularly in the context of carbon reduction targets and ESG-oriented governance agendas. Beyond the physical reuse of obsolete industrial spaces, redevelopment projects are increasingly expected to deliver environmental improvement, social integration, and institutional compliance simultaneously. However, in practice, the pursuit of sustainability goals is often constrained by rigid legal frameworks that were not originally designed to accommodate adaptive reuse.

In China, old factory redevelopment is frequently impeded by multi-layered land-use approval procedures, unclear criteria for identifying industrial heritage, and the predominantly non-mandatory nature of green building standards. These institutional characteristics create uncertainty for developers and designers, often resulting in prolonged vacancy or conservative design interventions. In contrast, Europe and the United States operate under highly codified legal systems, where zoning regulations, heritage legislation, and environmental standards are more explicit but also less flexible. Such rigidity can limit functional transformation, ecological upgrading, and incremental experimentation in redevelopment projects.

Existing studies have examined these challenges from either a legal or a design perspective, focusing on land policy reform, heritage conservation, or architectural strategies in isolation. However, there remains a lack of integrated analytical frameworks that systematically explain how legal constraints shape design feasibility and how design thinking can mediate institutional rigidity to achieve ESG outcomes. This gap is particularly evident in comparative studies that bridge different regulatory contexts.

To address this limitation, this paper proposes an interdisciplinary Law–Design–ESG analytical framework that conceptualizes legal constraints as structural inputs, design thinking as a mediating mechanism, and ESG value creation as the transformation outcome. By comparing representative cases from China, Europe, and the United States, the study aims to reveal common

patterns and contextual differences in legal dilemmas and design responses.

As an overview of the comparative institutional landscape, Table 1 summarizes the key types of legal constraints encountered in old factory redevelopment across regions, providing a structured foundation for the subsequent analysis.

Table 1. Comparison of Legal Constraints in Old Factory Redevelopment: China vs. Europe and the U.S.

Constraint Type	Core Pain Points in China	Core Pain Points in Europe and America
Land Regulation	Multi-level, time-consuming approval process (e.g., Shanghai Yangpu) [5]	Rigid zoning classifications limiting mixed-use functions (e.g., Ruhr Area, Germany) [1]
Cultural Heritage Regulations	Unclear industrial heritage designation → excessive protection (e.g., Guangzhou Taikoo Warehouse) [6]	Mandatory façade retention restricting green upgrades (e.g., Empire Stores, New York) [4]
Green Standards	Non-mandatory standards → symbolic low-carbon retrofits [7]	EPBD mandatory yet insufficiently detailed for implementation [10]

2. Research Background and Significance

2.1 Core Types of Dilemmas

Old factory redevelopment is shaped by multiple layers of legal constraints that directly influence project feasibility, implementation pace, and the scope of design innovation. Across different institutional contexts, these constraints can be broadly categorized into three types: land-use control, cultural heritage protection, and green standard enforcement.

(1) Land Use Control Dilemma

In China, land conversion in old industrial districts such as Shanghai's Yangpu often requires multi-level approval procedures, including land expropriation, auction, and planning adjustment, which results in prolonged vacancy and underutilization of industrial buildings [5].

Similarly, in Germany's Ruhr Area, early redevelopment of the Zollverein industrial complex was constrained by rigid zoning classifications under the BauNVO, which restricted mixed-use redevelopment and delayed adaptive reuse until formal rezoning was completed.

(2) Cultural Heritage Protection Dilemma

In Guangzhou's Taikoo Warehouse, unclear industrial heritage evaluation standards have led to excessive or inconsistent protection, limiting functional adaptation and ecological upgrading [6].

In the United States, Brooklyn's Empire Stores-protected under the National Historic Preservation Act (NHPA)-must retain its historic façade, which restricts structural modification and the integration of certain green technologies [4].

(3) Green Standards Dilemma

China's Green Building Evaluation Standard often remains non-mandatory in redevelopment projects, resulting in symbolic low-carbon measures rather than substantial performance improvements [7].

In the European Union, although the Energy Performance of Buildings Directive (EPBD) is mandatory, implementation at the building level remains challenging due to insufficient technical specifications in many member states [10].

The Helsinki Cable Factory illustrates how phased retrofits supported by temporary-use permits can partially compensate for gaps in green standard enforcement through design-led experimentation.

2.2 Theoretical and Practical Significance

(1) Theoretical Contribution

This study contributes to the literature by proposing a Law–Design–ESG analytical framework that explains how legal constraints shape the feasibility of adaptive reuse and how design thinking mediates institutional rigidity. By integrating legal analysis with design-based responses, the framework advances interdisciplinary understanding of sustainability transitions in old factory redevelopment.

(2) Practical Value

From a practical perspective, the study extracts context-specific strategies for China-such as functional flexibility, reversible renovation, and prototype testing-while also identifying international best practices, including mandatory green standards and detailed retrofit guidelines. These insights provide an operational foundation for developing a Legal–Design Collaboration Toolkit, supporting policymakers and designers in balancing regulatory compliance with innovation.

3. Research Method and Case Selection

This study adopts a comparative case study method, integrating documentary analysis and institutional comparison. Cases are selected based on three criteria: representativeness, diversity of legal constraints, and availability of reliable public documentation. This approach enables cross-regional comparison of how different legal systems interact with design strategies in old factory redevelopment.

The selected cases include:

Shanghai Yangpu Industrial Area (China)

Guangzhou Taikoo Warehouse (China)

IBA Emscher Park / Ruhr Area (Germany)

Brooklyn Empire Stores (USA)

Energy Performance of Buildings Directive (European Union)

These cases cover the three core legal dilemma types identified in Section II-land-use control, heritage protection, and green standard enforcement-and represent different regulatory contexts.

As shown in Table 2, each case is matched with its corresponding legal framework and dominant design response strategy, ensuring comparability across regions and supporting the subsequent case analysis.

Table 2. Selection Criteria and Matching Relationship for Old Factory Cases in China and Abroad

Case Name	*Country/ Region*	*Legal Dilemma Type*	*Legal Basis/Regulation*	*Design Response Strategy*	*Matching Explanation*
Shanghai Yangpu Industrial Area	China	Land-use control	Land Administration Law of the PRC [5]	Temporary use + functional flexibility	Multi-level approval procedures contribute to prolonged vacancy
Guangzhou Taikoo Wharf	China	Cultural heritage protection	Cultural Relics Protection Law [6]	Reversible renovation + historical activation	Vague designation standards lead to overprotection
IBA Emscher Park	Germany	Land-use rigidity	Federal Building Code (BauGB) §9 [1]	Prototype testing + temporary activation	Rigid zoning limits mixed-use scenarios
Brooklyn Empire Stores	USA	Heritage–green conflict	National Historic Preservation Act [4]	Reversible design + façade retention	Façade retention restricts green retrofits
EU EPBD Directive	EU	Green standard enforcement	Directive (EU) 2024/1275 [10]	Technical refinement + enforcement strengthening	Mandatory but insufficient operational detail

4. Case Analysis

This section compares representative cases from China, Europe, and the United States to illustrate how different legal constraints shape adaptive reuse outcomes and how design thinking provides pathways for negotiating institutional rigidity.

4.1 Land Use Dilemma

In China's Shanghai Yangpu Industrial Area, many former factory buildings remain underutilized because land conversion requires multiple layers of approval, including expropriation, auction, and planning adjustments, which prolong vacancy and slow redevelopment [5].

Similarly, in Germany's Ruhr Area, early redevelopment at the Zollverein industrial complex was constrained by rigid zoning classifications under the BauNVO, which prohibited mixed-use activities until formal rezoning was completed.

These cases indicate that land-use rigidity-whether administrative or codified-limits adaptive reuse during early project stages. As summarized in Table 3, design-led mechanisms such as temporary use and prototype testing are commonly adopted to demonstrate feasibility and mitigate regulatory inertia.

4.2 Heritage Protection Dilemma

In China, Guangzhou Taikoo Warehouse faces inconsistent protection outcomes due to unclear industrial heritage evaluation standards, which restrict functional adaptation and ecological upgrading [6].

In the United States, Brooklyn's Empire Stores, protected under the National Historic Preservation Act (NHPA), must retain its historic façade, limiting structural modification and

certain green retrofits [4].

Across both contexts, heritage legislation prioritizes preservation but constrains design flexibility. As shown in Table 3, reversible renovation and modular interior interventions are key strategies for balancing conservation requirements with sustainability goals.

4.3 Green Standards Dilemma

In China, the Green Building Evaluation Standard often remains non-mandatory in redevelopment projects, leading to symbolic low-carbon measures rather than substantive performance improvements [7].

In the European Union, the Energy Performance of Buildings Directive (EPBD) establishes mandatory requirements, yet implementation remains uneven due to insufficient building-level technical specifications in many member states [10].

The Helsinki Cable Factory demonstrates how phased retrofits supported by temporary-use permits can partially compensate for gaps in green standard enforcement through design-led experimentation. As summarized in Table 3, modular green retrofits and staged implementation are frequently used to bridge regulatory and technical constraints.

4.4 Cross-Case Synthesis

Taken together, the three dilemma types reveal a consistent pattern: legal rigidity constrains adaptive reuse, while design thinking functions as a mediating mechanism that enables incremental and compliant sustainability transitions. Table 3 synthesizes these cross-regional comparisons by linking legal constraints to corresponding design responses.

Table 3. Legal Constraints and Design Strategies in China and Europe/US

Legal Constraint Type	***Core Pain Points in China***	***Core Pain Points in EU/US***	***Corresponding Design Strategy***
Land Use Control	Lengthy land conversion approvals; vacancy persists (Yangpu) [5]	Rigid zoning restricts mixed-use redevelopment (Ruhr Area) [1]	Functional flexibility; prototype testing; temporary activation
Cultural Heritage Legislation	Ambiguous heritage designation → excessive protection (Taikoo Warehouse) [6]	Mandatory façade retention limits ecological retrofits (Empire Stores) [4]	Reversible design; modular interior renovation; façade retention + internal optimization
Green Standard Enforcement	Non-mandatory green standards → symbolic implementation [7]	Mandatory but insufficient technical detail hinders enforcement (EPBD) [10]	Modular green retrofits; phased implementation; mandatory standards supported by technical guidelines

5. Legal–Design Collaboration Toolkit

Building on the comparative case analysis, this section proposes a Legal–Design Collaboration Toolkit that translates the interaction between legal constraints and design thinking into operational pathways for old factory redevelopment.

5.1 Conceptual Framework

The toolkit is grounded in the Law–Design–ESG analytical framework, which conceptualizes legal constraints as the structural input, design thinking as the mediating mechanism, and ESG value creation as the outcome.

As illustrated in Figure 1, this framework explains how design strategies operate within regulatory boundaries to facilitate sustainability-oriented transformation.

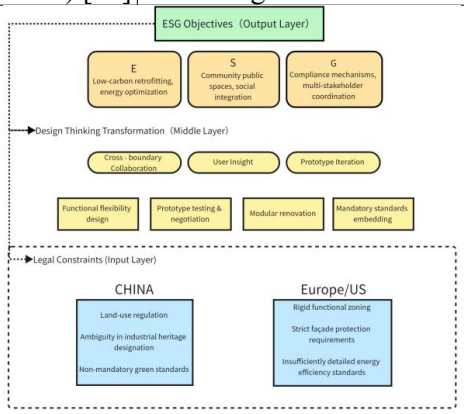

Figure 1. Interdisciplinary Connection Model of Law-Design-ESG in Old Factory Redevelopment and China-Western Differences

5.2 Toolkit Pathways

Based on the identified legal dilemmas, the toolkit is structured around three pathways: Land

Path, Heritage Path, and Green Path. Each pathway links a specific legal focus with corresponding design strategies and intended effects.

As summarized in Table 4, these pathways operationalize legal–design collaboration in practice.

The legal–design collaboration pathways are further detailed in Table 4.

Table 4. Legal-Design Collaboration Tool Pathways

Path Category	*Legal Focus*	*Design Strategy*	*Target Effect*
Land Path	Temporary-use permits; simplified approval; flexible zoning [5]	Temporary activation; prototype testing; flexible functional layout	Reduce vacancy; support legal adjustments
Heritage Path	Layered designation standards; reversible design clauses [6]	Modular interior retrofit; façade retention + ecological systems	Balance protection and sustainability
Green Path	Mandatory standards; detailed guidelines; fiscal incentives [7][10]	Modular green renovation; phased implementation; backward-design	Improve enforcement and long-term performance

5.3 Cross-Regional Optimization

The toolkit also highlights differences in legal–design collaboration between China and Western countries.

As shown in Figure 2, China relies more on policy-driven flexibility and experimental mechanisms, while Europe and the United States operate within highly codified regulatory systems that require design innovation within stricter legal boundaries.

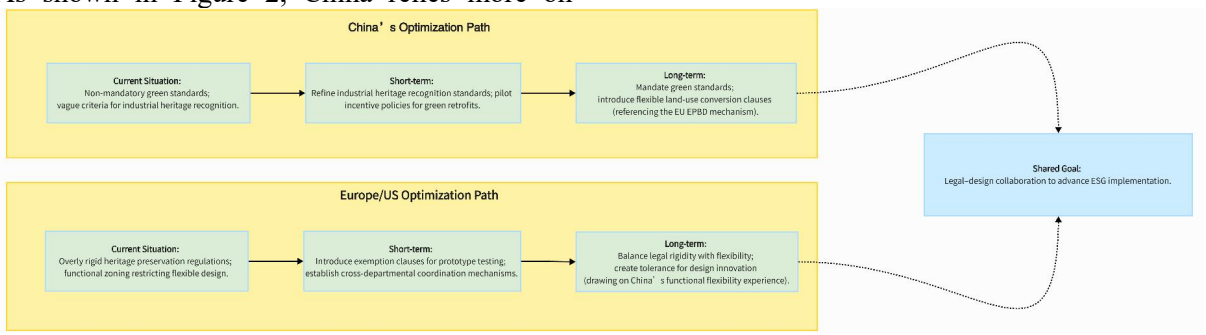

Figure 2. Comparison of Legal Optimization Paths for Old Factory Redevelopment: China vs. Abroad

5.4 Design Thinking Response Matrix

To further operationalize the toolkit, a design thinking response matrix is developed to map legal constraints to specific design tools, including user insight, cross-boundary collaboration, and prototype iteration.

As presented in Table 5, this matrix synthesizes how design thinking responds to land-use, heritage, and green standard constraints across regions.

Table 5. Design Thinking Response Strategy Matrix for Old Factory Redevelopment: China vs. Abroad

Legal Constraint \ Design Tool	***User Insight***	***Cross - boundary Collaboration***	***Prototype Iteration***
Land Regulation	China: Community needs inform mixed-use functions [5]	Europe/US: Temporary-use negotiation pilots support collaboration	China: Prototype testing before zoning change; Europe: temporary activation precedes policy revision [1]
Cultural Heritage Regulations	Europe/US: Historical value assessment guides façade retention [4].	China: Heritage experts + designers collaborate for adaptive designation [6]	Europe/US: Detachable modules avoid irreversible impact [11]
Green Standards	China: Residents' low-carbon preferences increasingly inform design [7]	Europe/US: Technical experts + designers co-implement mandatory standards [10]	China: Green pilots tested before citywide rollout [7]

6. Conclusion and Future Research

This study examines how legal constraints shape the sustainable redevelopment of old factories and how design thinking provides adaptive pathways for negotiating institutional rigidity. Through a comparative analysis of cases from China, Europe, and the United States, three core legal dilemmas-land-use control, heritage protection, and green standard enforcement-are identified as structural barriers influencing redevelopment outcomes.

The analysis demonstrates that, despite regional differences in legal systems, a common pattern emerges: legal rigidity limits adaptive reuse potential, while design thinking functions as a mediating mechanism that enables incremental, compliant, and sustainability-oriented transformation. Temporary use, reversible renovation, prototype testing, and modular green retrofits consistently appear as effective responses within diverse regulatory contexts. On this basis, the study develops a Legal–Design Collaboration Toolkit that translates interdisciplinary insights into practical pathways for policymakers and designers.

From a practical perspective, the findings suggest that China can benefit from refining approval procedures and strengthening green standard enforcement, while Europe and the United States may enhance regulatory adaptability by incorporating experimental and phased design mechanisms. More broadly, sustainable old factory redevelopment depends not on legal reform or design innovation alone, but on their coordinated interaction.

Limitations and future research.

This study is primarily qualitative and relies on comparative case analysis rather than causal testing. While the findings provide robust interpretive insights, they do not establish direct causal relationships between legal adjustments, design interventions, and ESG performance. Future research should adopt econometric approaches or policy experimentation methods to conduct causal verification, thereby strengthening empirical evidence for legal–design–ESG interactions.

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