


Article

Typology, Preservation, and Regeneration of the Post-1949 Industrial Heritage in China: A Case Study of Shanghai

Chaoyu Mo, Lin Wang * and Fujie Rao * 

Department of Architecture, School of Design, Shanghai Jiao Tong University, Shanghai 200240, China

* Correspondence: wanglinalice@sjtu.edu.cn (L.W.); raofujie@gmail.com (F.R.)

Abstract: Industrial heritage is one of the most neglected types of cultural heritage and urban landscape, often being vulnerable to rather than blessed by urban (re)development. China is confronting an unprecedentedly intensive challenge of preserving industrial heritage, as the country has rapidly shifted towards post-industrialization only several years after being recognized as the “world’s factory” in the 21st century. However, none of the existing literature has systematically investigated the typology and preservation of China’s post-1949 industrial heritage. This research selects Shanghai—the largest metropolis and a prime industrial hub in China—for the case study, and examines 83 accredited modern industrial heritage sites in the city through typological analysis, descriptive statistical analysis, and GIS spatial analysis. Two principal findings are identified. First, there is a diverse range of the post-1949 industrial heritage in China, by industries, time, and spatial forms. Particularly the industrial block—where industrial development is intermingled with the surrounding urban fabric—is the dominant spatial type. Second, the preservation and regeneration of China’s post-1949 industrial heritage in the suburbs are substantially more complex and more threatened than those in the inner city. This study concludes by providing implications for enhanced management and investigation of China’s post-1949 industrial heritage preservation and regeneration.

Keywords: China’s post-1949 industrial heritage; typology; preservation; regeneration; Shanghai



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1. Introduction

Industrial heritage is a key component of cultural heritage, with significant historical, social, cultural, technological, economic, and aesthetic value [1–3]. Promoting the preservation and regeneration of industrial heritage has become an international consensus, supported by the United Nations Educational, Scientific and Cultural Organization [4] and the International Council on Monuments and Sites [5]. In China, the preservation of industrial heritage confronts pressing challenges. China is experiencing a rapid transition from what some called the “world’s factory” [6] to the era of post-industrialization—the gross domestic product (GDP) of manufacturing (43.9%) was beaten by that of services (46.1%) in 2013 and the former decreased to 69% of the latter in 2020 [7]. Meanwhile, the mode of urban growth mode in China has shifted from extensive greenfield development to intensive urban regeneration, creating more demands for brownfield redevelopment. In Shanghai, according to the latest master plan 2017–2035, the area of industrial land to be transformed ranges from 359 to 519 km², or from 43% to 62% of the total industrial land (see Figure 1). As a result, a large number of industrial facilities are about to be reconfigured, posing a threat to the preservation of industrial heritage, and highlighting the urgency of preserving China’s post-1949 industrial heritage.

The existing literature of industrial heritage focuses on three key aspects. First is the typology of industrial heritage by industries, time, spatial forms, and so forth. Second is the mode of industrial heritage regeneration, embodying a range of ways, such as turning industrial heritage into museums, tourism sites, parks, cultural and creative industrial

enclaves, apartments, and more. The third research focus is on the management of industrial heritage preservation, covering rules (e.g., laws, codes, and regulations), supporting technologies, finance, and more. With respect to the research of China's industrial heritage, much attention has been paid to the preservation of industrial heritage that emerged in the colonial era before the establishment of the People's Republic of China in 1949 [8–10], in particular, 1840–1949 Shanghai [11–13]. However, China's post-1949 industrial heritage, with unique socialist and modernist styles, has not been well investigated.

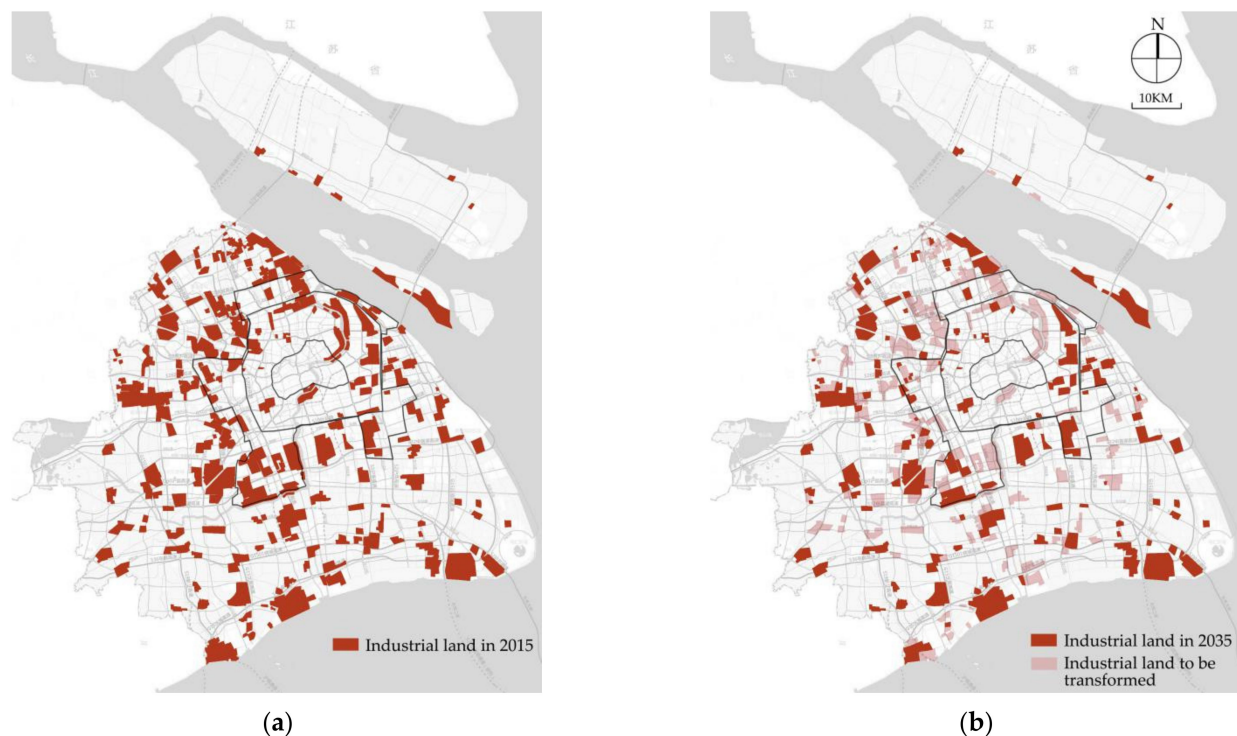


Figure 1. Distribution of industrial land: (a) 2015; (b) 2035.

In an attempt to tackle the research gap, this study revolves around two key topics. First is to systematically investigate the types of industrial heritage by industries, time, and morphology. Second is to interrogate how well the current industrial heritage preservation has been made and to assess the scale and trend of future industrial heritage preservation and regeneration. This research selected Shanghai for the case study, with a focus on 83 accredited post-1949 industrial heritage sites in the city. Key research methods incorporate typological analysis, descriptive statistical analysis, and spatial analysis using ArcGIS 10.2. Principal findings unveil a diverse range of the post-1949 industrial heritage in China—particularly the industrial block acts as the dominant spatial type—and highlight the complexity and significance of preserving and regenerating such industrial heritage in the suburban area.

In what follows, this paper first reviews the industrial heritage research geared to the international and Chinese contexts, respectively. Next is the section of research methods, describing the case selection, data collection, and data analysis. Then, the analytical section presents the results of typological and temporal-spatial research. Lastly, the paper reflects upon the key findings, provides policy implications for industrial heritage preservation management, and points out future research opportunities.

2. Literature Review

The literature review contains two subsections based on the international and Chinese contexts. Each is organized by two strands of themes: one is centered on history and definition; the other focuses on spatial types, modes of regeneration, and preservation management.

2.1. International Industrial Heritage

In the mid-twentieth century, major western countries led the socio-spatial transition to the post-industrial world, with more workers employed in the service industry than manufacturing. The term ‘industrial heritage’ was first used by the American bridge engineer Steinman in 1952, and industrial heritage preservation practices took place in a range of countries [14–16]. A proliferation of industrial heritage preservation research and practices emerged, after *Ironbridge Gorge* was recognized as a world heritage site in 1986—this is the first industrial heritage ever to be included under the list of world heritage. By the early twenty-first century, international organizations reached a consensus on promoting industrial heritage preservation [4,5].

One of the most important and authoritative international documents on industrial heritage is the *Nizhny Tagil Charter*, adopted in 2003. The *Nizhny Tagil Charter* defines industrial heritage as the tangible or intangible remains of industrial culture, with significant historical, technological, social, architectural, or scientific value. The tangible heritage mainly refers to material remains including buildings, machines, workshops, mills, mines, factories, warehouses, transport, places used for social activities related to industry, and more. The intangible heritage is mostly geared towards socio-economic processes and forces shaping industrial development, incorporating industrial processes, traditional crafts, data recording, enterprise archives, and more [17]. The physical industrial remains at various scales—e.g., the building, site, and zone—have been prioritized by existing studies, such as factories (e.g., *London Bankside Power Station* [18] and iron and steel plants in Slovakia [19]), mining sites (*Belgium’s Limburg Region Mining Sites* [20], *Spanish Rio Tinto Mining Area* [21]), and more [22–24]), railways (e.g., *High Line Park in New York City* [25]), and large industrial zones (e.g., *Ruhr Industrial Base* [26,27]).

When it comes to the modes of regeneration, the existing literature focused on the functions to which industrial heritage has been transformed. While art museums (e.g., *London Tate Modern* [18] and *Germany Gasometer Oberhausen Gas Tank Exhibition Hall* [28]) and industrial tourism (*Ruhr Industrial Culture Tourism Route* [26], *Poland Industrial Monuments Route* [29], and more [30]) were most frequently investigated, a diverse range of industrial heritage reuse has received increasing attention in recent years, such as urban open space (e.g., *New York High Line Park* [25]), cultural and creative industrial enclaves (e.g., *SoHo* [31]), and apartments (e.g., *Manchester Royal Cotton Mill* [32]).

In terms of preservation management, current studies mainly cover rules, technologies, and finance. Researchers analyzed industrial heritage preservation rules at various governance levels ranging from the city to region, state, and the globe [33–35]. Some researchers have recently applied two-dimensional geographic information system (GIS) and three-dimensional building information modeling (BIM) to establishing, analyzing, and managing industrial heritage databases, leading to heritage building information modeling (HBIM) technologies [36–38]. Several researchers also emphasized the importance of establishing accountable and sustainable financial systems for fostering successful industrial heritage preservation and regeneration projects [39].

2.2. China’s Industrial Heritage

In China, industrial heritage preservation started to catch research attention around the 1990s [40–42]. The preservation of industrial heritage in China was boosted in 2006 when the first Industrial Heritage Preservation Forum was held that led to the “*Wuxi Proposal*”. The definition of industrial heritage by the *Wuxi Proposal* is in line with that by the *Nizhny Tagil Charter*. In addition to conceptualizing a variety of tangible and intangible industrial heritage, the *Wuxi Proposal* highlighted the importance of differentiating the industrial heritage of two eras—the early-industrialization and colonial era of 1840–1949 and the post-1949—according to the Chinese context [43]. One year after the *Wuxi Proposal*, the State Council of China published *The Third National Cultural Relics Survey*, in which industrial heritage was included for the first time, stimulating the rise of industrial heritage preservation practice and research in China.

A diverse range of physical industrial remains have been investigated by existing studies, such as industrial buildings [2,44–46], waterfront industrial heritage (e.g., *Shanghai Huangpu River Industrial Heritage* [47]), railways and related facilities (e.g., *China Eastern Railway Industrial Heritage* [48]), and large industrial zones (e.g., *Beijing Shougang Industrial Zone* [49] and *Jingdezhen Ceramic Industrial Heritage* [50]). China's 1840–1949 industrial heritage has received frequent attention, with a focus on Shanghai, Beijing, and Tianjin [11,51,52]. In particular, Xu and Aoki [8] established a systematic typology of China's 1840–1949 industrial heritage and comprehensively reviewed the preservation system of such industrial heritage. However, less attention has been paid to China's post-1949 industrial heritage, and the relevant literature has been largely limited to case studies: such as *Beijing Second Cotton Factory* [51] and *Shanghai Baosteel Stainless Steel Zone* [52]. There is a lack of systematic typology of China's post-1949 industrial heritage.

With respect to the modes of regeneration, the existing literature covered three typical types: turning industrial heritage into museums, cultural/creative industrial compounds, or public parks. Museums (e.g., *Shenyang Industrial Museum* [53,54]) and cultural and creative industrial parks (e.g., *Beijing 798 Art District* [55] and *Shanghai M50 Art Creative Park* [56]) were frequently investigated, yet a few researchers examined cases where the industrial heritage is reused as a heritage park [57,58]. Furthermore, current studies have focused on the policies, planning, and technologies for managing industrial heritage preservation. Researchers analyzed policies of industrial heritage preservation at the city, provincial, and national levels [59,60]. Researchers also argued that cities should prepare special plans for industrial heritage preservation and integrate such special plans into master plans [61,62]. More recently, researchers have applied GIS and BIM technology to analyzing the temporal-spatial evolution and genealogy of China's 1840–1949 industrial heritage [63,64].

3. Research Methods

This research selected Shanghai for the case study and examined 83 accredited industrial heritage sites in the city through typological analysis, descriptive statistical analysis, and GIS spatial analysis.

3.1. Case Selection

Shanghai was chosen for the study for four key reasons. First, Shanghai has a rich industrial development history with a diverse range of industrial facilities [11,65–67]. From 1840 to 1949, the industrial development of Shanghai mainly revolved around light industries—e.g., *Ewo Cotton Spinning & Weaving Co., Ltd.*, *Fou Foong Flour Mill Co., Ltd.*, and *Union Brewery*, operated by foreign companies and domestic entrepreneurs. From the establishment of the People's Republic of China in 1949 to the 1980s, the focus of Shanghai's industrial development shifted to large state-owned factories or enclaves for heavy industries, marked by the rise of *Si Fang Boilers Works*, *Shanghai Baosteel Stainless Steel Zone*, and more. From the 1990s to the present, Shanghai's industrial development has been reoriented towards high-tech and creative industries and the use of foreign direct investment, leading to new forms of industrial development that are better integrated with other urban functions such as living, shopping, and working.

Second, there has been an urgent need for the preservation and regeneration of industrial heritage in Shanghai, as the city is leading the post-industrial and urban transitions of Chinese cities [68–70]. With the rapid development of global urbanization, Shanghai, as a super metropolis, is facing a new round of urban regeneration. Large-scale post-1949 industries are also decaying and disappearing periodically, or upgrading and transforming. Therefore, it is necessary to study the preservation of post-1949 industrial heritage in Shanghai.

Third, Shanghai has one of the most advanced industrial heritage preservation management systems and practices among Chinese cities. In 1989, the city of Shanghai published the first accredited list of historic buildings (1840–1949) for preservation, which officially

included examples of industrial heritage—*Yangshupu Water Plant*—for the first time in mainland China. The city of Shanghai then added industrial building preservation in municipal regulations in 1991 [71], and introduced industrial heritage preservation under municipal bylaws in 2002 [72].

Fourth, the industrial heritage database in Shanghai tops other cities in mainland China. The city of Shanghai carried out a survey of 1840–1949 architectural heritage in 1986, and conducted a comprehensive survey of industrial heritage in 2007. Furthermore, the literature regarding industrial heritage in Shanghai accounts for around 18% of the total studies related to industrial heritage in Chinese journals, according to the China Knowledge Network database (2022). There have been a range of discrete data sources of Shanghai’s industrial heritage from recent publications [73–77].

3.2. Data Collection

The data of 83 accredited industrial heritage sites are obtained from all four of the latest authoritative official lists of cultural relics and heritage buildings and blocks in Shanghai, as shown in Table 1, consisting of 53 sites from the list of *Shanghai’s Immovable Cultural Relics*, 6 sites from the list of *Shanghai Heritage Architecture*, 5 sites from the list of *Shanghai Heritage Blocks*, and 26 sites from the list of *Shanghai Industrial Heritage Survey*.

Table 1. Data sources of 83 accredited industrial heritage sites in Shanghai.

Number	List	Source	The Number of Industrial Heritage Sites
1	<i>Shanghai Immovable Cultural Relics</i>	Shanghai Municipal People’s Government	53 ^{1,2}
2	<i>Shanghai Heritage Architecture</i>	Shanghai Municipal People’s Government	6 ¹
3	<i>Shanghai Heritage Blocks</i>	Shanghai Urban Planning Bureau	5 ²
4	<i>Shanghai Industrial Heritage Survey</i>	Shanghai Cultural Relics Bureau	26

Notes: ¹ There are two overlaps of industrial heritage sites between the lists of Shanghai Immovable Cultural Relics and Shanghai Heritage Architecture. ² There are five overlaps of industrial heritage sites between the lists of Shanghai Immovable Cultural Relics and Shanghai heritage blocks.

Through field investigations and virtual observation in Baidu Map and Streetview, this study collected the geographical coordinates, construction year, building age, industrial type, morphological type, status of preservation, and modes of regeneration of the selected industrial heritage sites.

3.3. Data Analysis

This study adopted three research methods: typology, descriptive statistical analysis, and GIS spatial analysis. First, to systematically scan and analyze the selected post-1949 industrial heritage sites in Shanghai and also according to the existing literature, the typology of this study considered the following four key criteria: geographical distribution, industrial type, spatial form, and preservation and regeneration, as shown in Table 2. Second, this study applied descriptive statistical analysis to analyzing the numeric distribution of industrial heritage sites by different typologies. Third, this study employed GIS spatial analysis using ArcGIS 10.2, consisting of the “simple analysis” of the geographical distribution of industrial heritage sites of various types and the “overlay analysis” through which different layers of thematic analysis were combined to explore their interrelationships.

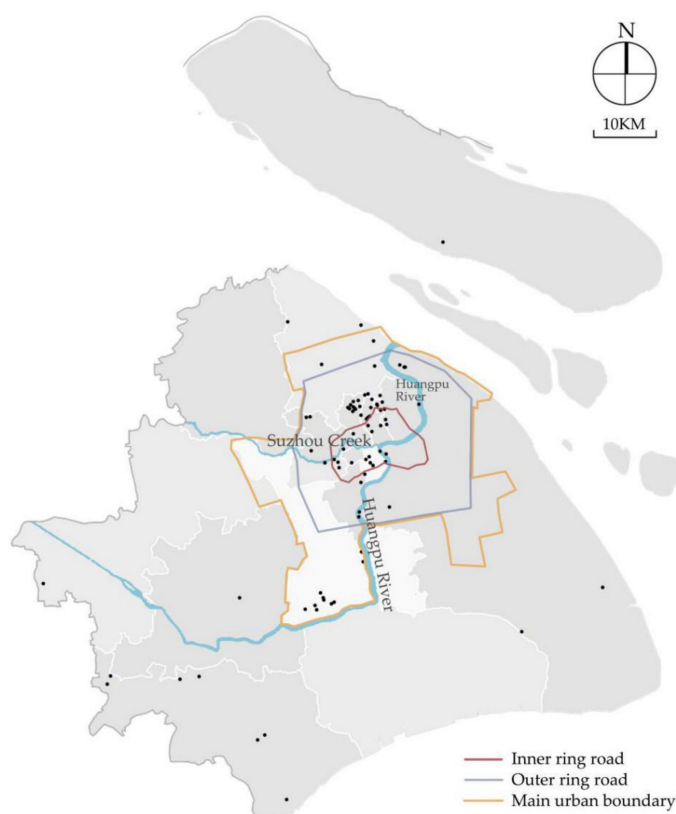
Table 2. The industrial heritage typological criteria of this study.

Number	Criteria	Types
1	Geographical distribution	The inner city (within the inner ring road; mostly the previous concessions and the core of Pudong New District) Mature neighborhoods (in-between the inner and outer ring roads; mostly 1949–1990s urban expansion) Suburbs (outside the outer ring road)
2	Industrial type (according to <i>Shanghai Local Chronicles</i> and <i>National Industrial Classifications GB/T4754-2011</i>)	Heavy industry Light industry Non-industrial infrastructure and functions
3	Spatial form	Industrial building Industrial block Industrial zone
4	Preservation and regeneration	Functional continuation (maintaining the original industrial production) Functional regeneration (adapted to other functions) Not in use Demolished

4. Results

4.1. Geographical Distribution

The geographical distribution of the 83 accredited modern industrial heritage sites is analyzed by ring roads, major rivers, and the planned main city boundary, as shown by Figure 2. The majority of the selected modern industrial heritage sites—21 out of 83—are located within the inner ring road, with 36 located in-between the inner-outer ring roads and 26 located outside the outer ring road. In addition, 28 industrial heritage sites are distributed along the river, with 14 near the *Huangpu River*, such as *Shanghai Wusong Shipyard* and *Maritime Watchtower*, and 4 near the *Suzhou Creek*, such as *Shanghai Fine Arts Film Studio* and *Daming Rubber Factory*. Further, more than 80% of the selected industrial heritage sites are located within the main urban area (yellow) of Shanghai envisioned by the latest master plan Shanghai 2017–2035.

**Figure 2.** Distribution of the 83 accredited industrial heritage sites in Shanghai.

4.2. Industrial Type

The 83 accredited industrial heritage sites in Shanghai cover a wide range of industries as shown in Table 3, incorporating all three major categories of heavy industry, light industry, and non-industrial infrastructure and functions, and 26 subcategories such as shipbuilding industry, textile industry, and warehousing—covering 72% of the total industrial classifications in China.

Table 3. Industrial types of the 83 accredited industrial heritage sites in Shanghai.

Major Categories (I)	Number	Subcategories (II)	Quantity	Proportion
I Heavy industry (65%)	1	Shipbuilding industry	4	5%
	2	Electric power industry	4	5%
	3	Electronic instrumentation industry	2	2%
	4	Iron and steel industry	4	5%
	5	Aviation industry	2	2%
	6	Chemical industry	7	8%
	7	Electromechanical industry	22	27%
	8	Building materials industry	3	4%
	9	Coal industry	1	1%
	10	Automobile industry	2	2%
	11	General equipment manufacturing industry	1	1%
	12	Rubber industry	2	2%
II Light industry (28%)	13	Film machinery Industry	3	4%
	14	Textile industry	5	6%
	15	Household electrical appliance industry	1	1%
	16	Metal products industry	1	1%
	17	Food industry	7	8%
	18	Toy industry	1	1%
	19	Culture, education, sports industry	1	1%
	20	Camera manufacturing industry	1	1%
	21	Pen making industry	2	2%
	22	Lock making industry	1	1%
III Non-industrial infrastructure and functions (7%)	23	Transportation	1	1%
	24	Warehousing	1	1%
	25	Maritime	1	1%
	26	Educational R & D	3	4%

Among the major categories, the number of sites is dominated by heavy industry (65%), followed by light industry (28%) and non-industrial infrastructure and functions (7%). The heavy industry is dominated by electromechanical industry (27%), followed by chemical industry (8%), shipbuilding industry (5%), electric power industry (5%), and iron and steel industry (5%). With respect to the light industry, there are two primary subcategories, food industry (8%) and textile industry (6%).

The numeric distributions of the selected industrial heritage sites by industrial types vary in three focused areas, as presented in Figure 3. Within the inner ring road, the proportion of heavy industry and light industry is 48% and 43%, with balanced distribution. In-between the inner-outer ring roads and outside the outer ring road, the industrial sites are dominated by heavy industry, while the light industry only accounts for 22% and 23%.

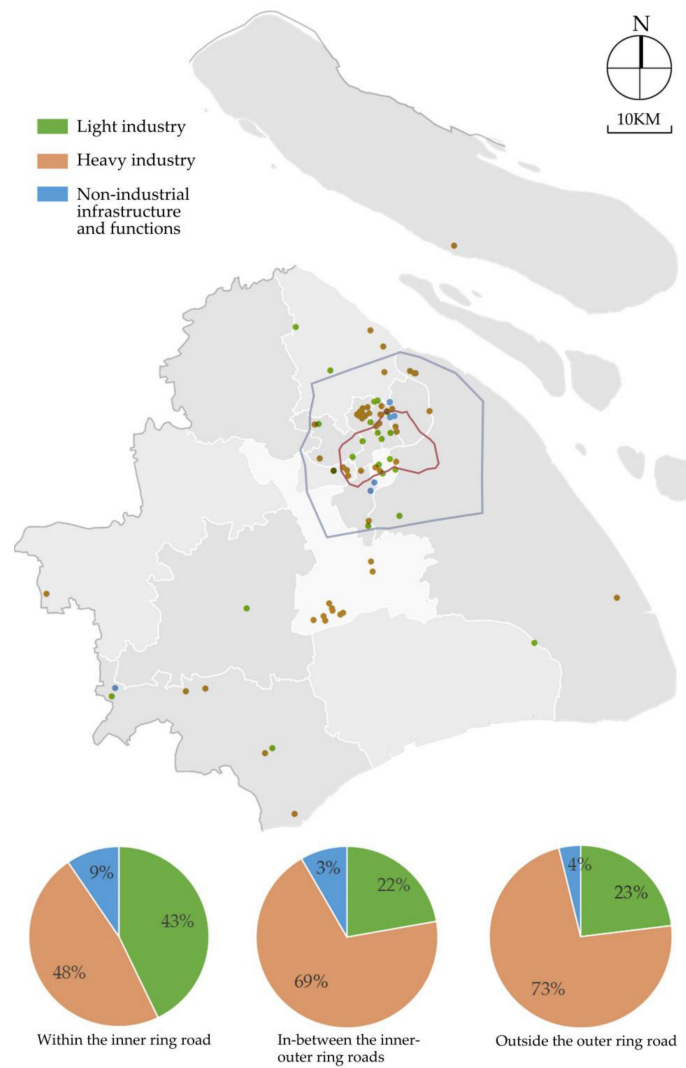


Figure 3. Distribution of the 83 accredited industrial heritage sites by industries in Shanghai.

4.3. Spatial Form

The 83 accredited industrial heritage sites in Shanghai embody three primary spatial forms: the building, block, and zone. Industrial building is mostly a standalone factory, warehouse, or structure, such as *Maritime Watchtower* (Figure 4a) and *Fengjing Railway Station*.

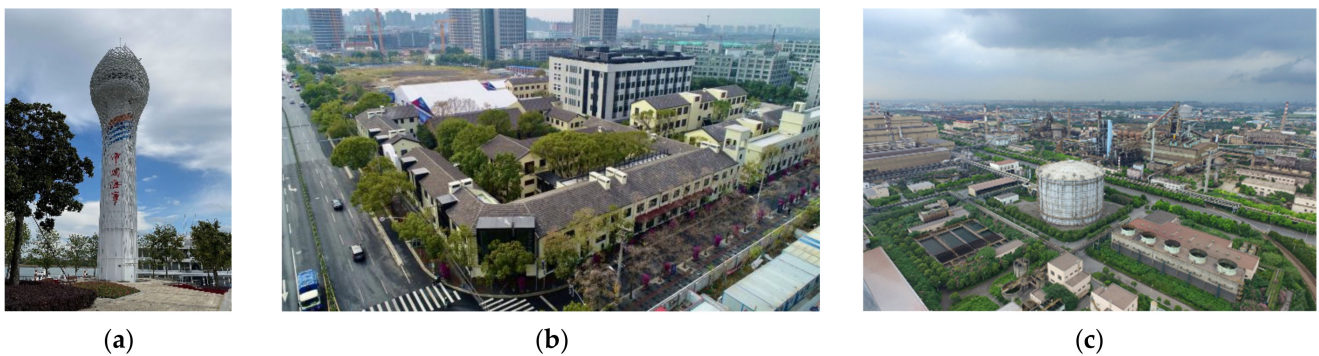


Figure 4. Photographs of industrial heritage sites by spatial forms: (a) *Maritime Watchtower* (building); (b) *Shanghai Hero Golden Pen Factory* (block); and (c) *Shanghai Baosteel Stainless Steel Zone* (zone).

Industrial block refers to a cluster of industrial buildings intermingled with the urban neighborhood at the walkable scale. For example, as shown in Figure 4b, the *Shanghai Hero Golden Pen Factory* is surrounded by several residential neighborhoods, with a site area of about 26,500 m² and 20 buildings for a variety of functions such as production, storage, working, catering, and childcare.

Industrial zone refers to a large independent industrial compound, often attached with a workers' neighborhood. For example, as shown in Figure 4c, *Shanghai Baosteel Stainless Steel Zone* covers an area of 3,370,000 m², with 447 buildings and structures. Furthermore, in addition to a set of full-process stainless steel production lines for iron making, steel making, hot rolling, and cold rolling, *Baosteel Stainless Steel Zone* incorporates a series of buildings supporting neighborhood functions (e.g., office, residential, commercial, and more).

These 83 industrial heritage sites are dominated by industrial blocks (71%), followed by industrial buildings (20%) and industrial zones (9%).

The numeric distributions of the selected industrial heritage sites by spatial forms vary in three focused areas, as presented by Figure 5. Within the inner ring road and in-between the inner-outer ring roads, only two spatial types of industrial heritage are identified: the industrial building and block. Within the inner ring road, the distributions of the selected industrial heritage sites in the building and block are largely balanced, with 47% and 53% in the total, respectively. In-between the inner-outer ring roads, the number of industrial blocks dominates, with 81% in the total. Outside the outer ring road, all three spatial types are covered, with 68% industrial block, 24% industrial zone, and 8% industrial building.

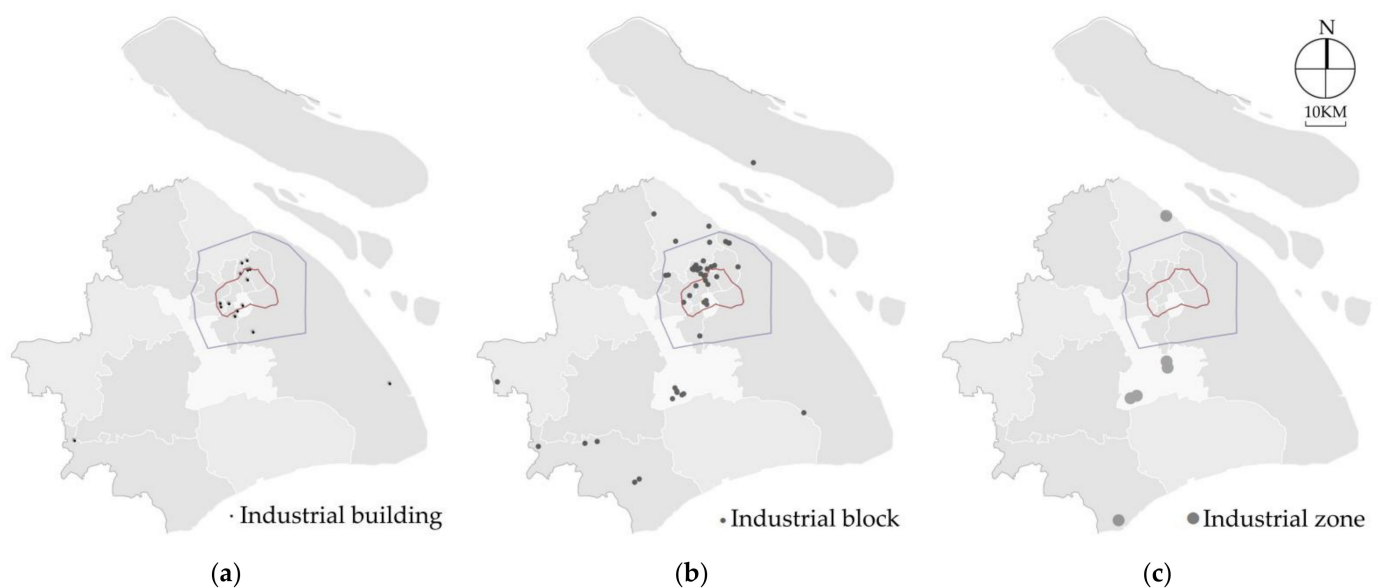


Figure 5. Distribution of the spatial form of all existing industrial heritage sites: (a) Building; (b) Block; and (c) Zone.

4.4. Temporal Evolution

In the second half of the 20th century, industrial development often required several decades of construction to become mature. For example, as shown in Figure 6a, the industrial construction of *Shanghai Hero Golden Pen Factory* lasted for five decades from the 1950s to 1990s.

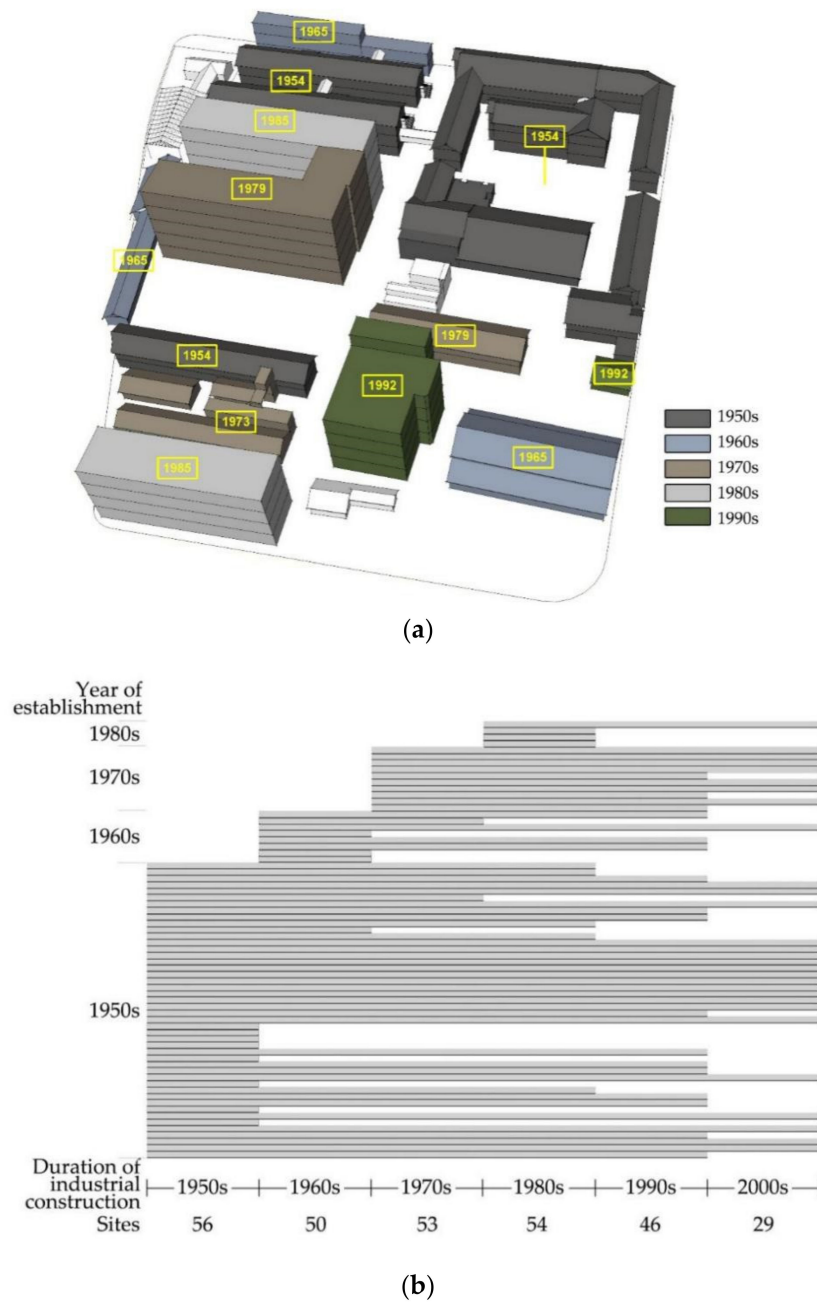


Figure 6. Duration of industrial construction in industrial heritage sites: (a) A typical example—*Shanghai Hero Golden Pen Factory*; (b) All existing sites.

The construction of industrial buildings in all the 83 selected industrial heritage sites covers the six decades between the 1950s and 2000s well. Figure 6b depicts how many decades the construction of industrial buildings covers in each of the selected industrial heritage sites between the 1950s and 2000s. The intensity of industrial building construction—measured by the number of heritage sites constructing new industrial buildings—was largely stable from the 1950s to the 1990s, ranging from 46 to 56, yet it significantly diminished from 46 in the 1990s to 29 in the 2000s. In addition, most selected industrial heritage sites—56 out of 83—started the construction of industrial buildings as early as the 1950s. In 20 out of the 83 selected industrial heritage sites, the construction of industrial buildings spans across the six decades between the 1950s and 2000s.

According to Figure 7, from the 1950s to 2000s, within the inner ring road, the number of the selected industrial heritage sites with industrial construction plummeted from 16 to

2; in-between the inner-outer ring roads, the number was halved, from 22 to 9; outside the outer ring road, the number remained the same: 18 (Figure 7a,b). Particularly, 14 out of the 20 industrial heritage sites with continuous industrial construction from the 1950s to 2000s are located beyond the outer ring road, with 5 in-between the inner and outer ring roads and only 1 inside the inner ring road (Figure 7c).

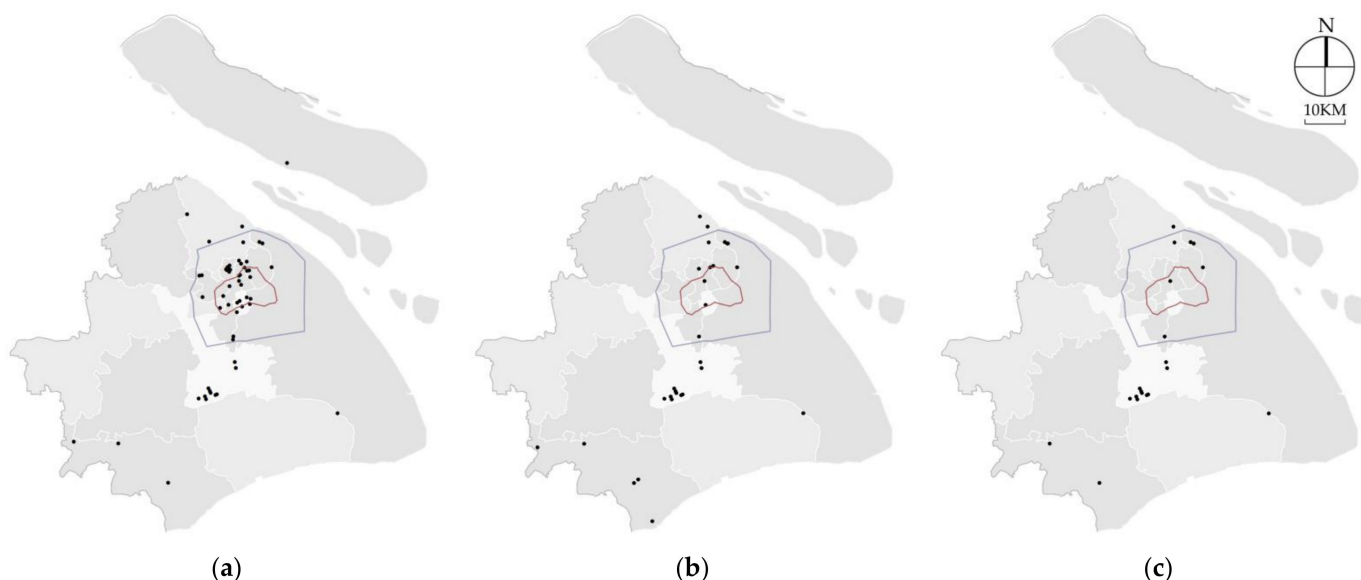


Figure 7. Distribution of the industrial construction in industrial heritage sites: (a) 1950s; (b) 2000s; and (c) 1950s to 2000s.

4.5. Preservation and Regeneration

Among the 83 accredited industrial heritage sites in Shanghai, 37% of the total keep industrial functions, 30% have been regenerated, 15% are not in use, and 18% have been demolished.

One typical example of the preserved industrial heritage is *Shanghai Baosteel Stainless Steel Zone*. It ceased industrial production in May 2018. The blast furnace plant—43 m tall—has been transformed into a steel museum and the section steel plant—856 m long, 120 m wide, 20 m high—has been proposed to be transformed into the new campus of the *Shanghai Academy of Fine Arts*.

One typical example of the demolished industrial heritage is the *Bayi Film Machinery Factory*, known as the cradle of China's film machinery industry. It was once a state-owned industrial compound with a range of functions (e.g., production, education, and public activity facilities) surrounded by farmland and villages, and it has been demolished and redeveloped into a mixed-use area and is now part of the established city.

According to Figure 8, among the 83 accredited industrial heritage sites in Shanghai, the sites with continued functions are mainly—20 out of 31—located outside the outer ring road, with merely 3 sites within the inner ring road (Figure 8a). The sites of regenerated functions are mostly located within the outer ring road, with only one outside the outer ring road (Figure 8b). Half of the not-in-use sites are located in-between the inner and outer ring roads, with four beyond the outer ring road and only two within the inner ring road (Figure 8c). The sites of the demolished are mainly—9 out of 15—located in-between the inner-outer ring roads, with 5 sites located within the inner ring road and only 1 outside the outer ring road (Figure 8d).



Figure 8. Distribution of industrial heritage sites in preservation and regeneration: (a) Functional continuation; (b) Functional regeneration; (c) Not in use; and (d) Demolition.

The 25 industrial heritage sites of functional regeneration cover six models of regeneration according to the new function, including 18 cultural and creative industrial parks—72% of the total; the dominant function for regeneration, 2 museums, 2 shopping centers, 1 heritage park, 1 hotel, and 1 large-scale urban regeneration project.

5. Conclusions

This research sought to examine the post-1949 industrial heritage in China, focusing on the geographical distribution, industrial type, spatial form, and the status of preservation and regeneration. A rare database of 83 accredited industrial heritage sites in Shanghai was constructed and used for the typological investigation, descriptive statistical analysis, and GIS spatial analysis. The analytical results led to four key findings as follows.

First, Shanghai's post-1949 industrial heritage embodies a diverse range of types by *industries*—consisting of heavy industries, light industries, and related infrastructure in as many as 26 subtypes—covering 72% of the total industrial classifications in China, *morphologies*—covering three types of building, block, and zone, and *time*—from the 1950s to 2000s. These typologies of the post-1949 industrial heritage by this study enriched the previous research of industrial heritage in China which revolved on the years between 1840 and 1949 [8,10,11].

Second, among the three key spatial types of Shanghai's post-1949 industrial heritage: the building, block, and zone, the block acts as the dominant type in terms of number—48 sites; more than half of the total, and of geographical distribution—industrial blocks are widely distributed across the city, reinforcing the recent argument that the focus of industrial heritage preservation is increasingly evolving from standalone buildings to industrial blocks and zones [26,65].

Third, the temporal-spatial analysis highlighted the pressing need to preserve and regenerate post-1949 industrial heritage in the suburban area of Shanghai, contrary to many existing studies of industrial heritage that focused on the central city such as in Shanghai, Tianjin, and London [18,52,62]. The significance of the suburban industrial heritage preservation and regeneration in Shanghai is evidenced as follows. Most of the post-1949 industrial heritage sites—62 out of 83—are located beyond the inner city. The heritage sites in the form of the industrial zone only exist outside the outer ring road, and those with persistent industrial construction from the 1950s to 2000s are mainly located outside the outer ring.

Fourth, the preservation and regeneration of Shanghai's post-1949 industrial heritage confront two key challenges. There is a pressing need for preserving such industrial heritage. Among the 83 accredited post-1949 industrial heritage sites, 15 have been unfortunately demolished and 12 are not in use—in danger of potential destruction. Meanwhile, modes of regeneration need to be diversified, as 72% of the regenerated post-1949 industrial heritage sites in Shanghai are reused for cultural and creative industrial parks. The dominance of cultural and creative industrial parks in industrial heritage regeneration has also been identified by previous studies in other cities such as New York City [31] and Manchester [32]. The lack of diversity in the land use of regeneration projects may hinder the sustainability of industrial heritage preservation.

The findings of this study afford four implications for practice. First, the planning authority should promote the survey and assessment of the post-1949 industrial heritage in Shanghai, particularly in the suburban area, in collaboration with related municipal bureaus such as cultural heritage administration and economic development. Second, more attention should be paid to the industrial heritage sites in the form of block and zone. The preservation and regeneration of such industrial heritage need to focus on the spatial fabric, streetscape, landscape, and sense of community in addition to buildings and industrial processes and crafts. Third, for industrial heritage regeneration projects, local municipalities could encourage the industrial site to be transformed into a more diverse range of urban spaces besides cultural and creative parks (e.g., higher-education campuses, sports venues, shopping centers, and apartments), and provide incentives for a wider range of stakeholders to join regeneration initiatives and projects—particularly, it is crucial to attract more market talents and investments. Fourth, the intensity of industrial heritage preservation should be enhanced by establishing special laws or codes, introducing more financial resources from the government and industry, encouraging public participation, and promoting the public education of industrial heritage.

Lastly, future studies could consider the following directions. Researchers could continue to build and analyze the database of the post-1949 industrial heritage sites in Shanghai as the current rapid transition towards post-industrialization would likely lead to more industrial sites to be added to the heritage list. In addition, researchers could apply quantitative modeling to examine the interrelationship between the degree of preservation and a range of socio-spatial attributes besides the four criteria considered in this paper, such as the land and floor area, geographical location, spatial type, year of establishment, degree of damage/regeneration, and modes of regeneration. Next, researchers could conduct qualitative interviews and observations in typical industrial heritage sites to record collective memories and interrogate the related place attachment.

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