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Heritage Tourism Development Should Take Care of Industrial Heritage Protection: A Study on the Development Strategy of Industrial Heritage Tourism in Nanjing

Hechi Wang [1,2,*], Jianwei Ge [1], Xinxin Chen [1], Qi Zhou [3] and Kehao Huang [1]

[1] School of Civil Engineering, Architecture and Environment, Hubei University of Technology, Wuhan 430068, China; gejianwei777@gmail.com (J.G.); cxinxin202211@163.com (X.C.); 18717177408@163.com (K.H.)
[2] Key Laboratory of Intelligent Health Perception and Ecological Restoration of Rivers and Lakes, Ministry of Education, Hubei University of Technology, Wuhan 430068, China
[3] School of Architecture, Architectural History and Theory, Southeast University, Nanjing 210096, China; 101001781@seu.edu.cn
* Correspondence: wanghechi@163.com

Abstract: The tourism development of industrial heritage is an effective way to activate cultural heritage and can provide new solutions for the renewal and protection of industrial heritage. This study focuses on the industrial heritage in Nanjing, aiming to explore its spatial distribution pattern, tourism development strategy, and sustainable development model. This study adopts a combination of quantitative and qualitative research methods. First, relevant information on 93 sites of industrial heritage type historic buildings in Nanjing is collected. Secondly, ArcGIS was used to visualize the evolution of industrial buildings and the spatial distribution of industrial heritage type historic buildings. Finally, the spatial analysis tools of ArcGIS and the accessibility analysis method in space syntax theory are superimposed to comprehensively analyze the spatial distribution pattern and traffic accessibility characteristics of Nanjing's industrial heritage. The research results propose a specific plan to promote the value transformation of industrial heritage through tourism: based on the spatial distribution characteristics of Nanjing's industrial heritage along the water system and traffic arteries, a tourist route of "multi-point, two-axis, one-center" is planned; the tourism development strategy of "point protrusion, linear links, and surface darning" is implemented; and a sustainable development model under the guidance of low-carbon environmental protection goals is explored. This study provides a reference for the protective development of industrial heritage and the expansion of tourism and opens up a new perspective for the regeneration and planning of other urban heritage.

Keywords: industrial heritage; tourism development; spatial distribution; sustainable development; conservation and planning

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1. Introduction

At present, many industrial heritages have abandoned their original production functions and are increasingly transitioning towards the tertiary industry [1]. As a "new combination" of service economy and industry, industrial heritage tourism has important research significance [2]. As early as the 1980s, the United Kingdom launched industrial heritage tourism to form a scene of sustainable development of heritage and community [3]. Germany, the United States, Canada, Japan, and other countries have followed suit [4]. China's research on industrial heritage tourism is relatively late. At present, the Chinese government has issued a series of policies to guide and standardize the development direction of industrial heritage tourism in various places. The "National Industrial Tourism Development Outline (2016–2025) [5]" and the "National Industrial Tourism Innovation

and Development Three-Year Action Plan (2018–2020)" issued by the Ministry of Culture and Tourism of China propose that "industrial tourism will be an important part of the upgrading and transformation of the tourism industry". In this context, our research focuses on the development of industrial heritage tourism and its role in promoting heritage protection and urban cultural construction, rather than a detailed analysis of the industrial structure itself. Exploring sustainable development models for industrial heritage is not only conducive to the protection and revitalization of industrial heritage, but also helps to promote the construction of industrial culture.

Nanjing is a famous historical and cultural city in China. It is the birthplace of modern Chinese industry and an important industrial base of the People's Republic of China, with rich industrial heritage. At present, these industrial heritages are in conflict with urban planning and development [6], and industrial heritages are in urgent need of protection and revitalization. It is of great research significance to "resurrect and utilize" industrial heritage with the help of tourism and achieve sustainable development of Nanjing's industrial heritage.

2. Literature Review

As a new type of special tourism, industrial heritage tourism has attracted the attention of the academic community. Currently, the research on industrial heritage tourism related to this article mainly focuses on the following aspects:

(1) Protection and reuse of industrial heritage: Scholars focus on the integration and interaction between the spatial transformation, functional conversion, and reuse of industrial heritage and sustainable urban development. For example: Ji Chenzi (2018) [7], through a comprehensive study of the existing industrial heritage of the 1865 Creative Industry Park, initially constructed a strategy for the overall protection and reuse of modern industrial buildings at the structural, spatial, and functional levels. Bo Hongtao (2019) [8] took Beijing Shougang Park as an example to summarize the industrial heritage renewal strategy. Guo Ping, Li Qin et al. (2021) [9] believe that quantitative methods can identify and clarify the core driving forces of sustainable redevelopment of industrial heritage, providing important insights for urban renewal. Nobuo Aoki, Zhang Song, Liu Boying et al. (2022) [10] believe that industrial resources can be transformed into cultural resources to achieve added value, thereby driving regional transformation and development and promoting urban revitalization.

(2) Development model of industrial heritage tourism: Scholars have put forward corresponding tourism development models and suggestions based on the various characteristics of industrial heritage and carried out industrial heritage study tours. For example, Edwards [11] analyzed the industrial heritage of mining areas, focusing on tourism development models. Four models are summarized, including production scene, production process, transportation, and social culture. Alfrey and Putnam (1992) [12] emphasized that industrial heritage can be reasonably developed and utilized through educational and artistic development approaches on the basis of protecting unique values. Li Leilei (2002) [13] gave a detailed introduction to the development process and development forms of German industrial heritage tourism. Cohen [14] conducts research trips in Israel through community participation, integrating Jewish culture and community culture in research activities through archaeological ruins, outdoor hiking, and other activities. Qiu Yue [15] combines Jiangsu intangible cultural heritage as a tourism resource with study tours, develops intangible cultural heritage study tours, and innovates and expands specific forms of study. Peng Kua-Hsin et al. (2019) [16] proposed a hybrid modified multi-attribute decision-making model (MADM) to improve the development performance of industrial heritage tourism and formulated a corresponding sustainable development strategy. Eduard Cristobal-Fransi et al. (2020) [17] studied the combination of industrial heritage tourism and the Internet and analyzed the role of Web 2.0 tools in improving organizational performance and competitiveness.

(3) Use GIS or space syntax to study heritage protection and tourism strategies: For example: Zhang Jiahao (2018) [18] conducted a visual analysis of the historical background of Dagu Shipyard and the use of GIS in different historical periods, which provided a scientific basis for later research on the Dagu Shipyard site. Yan Ruijing [19] applied GIS technology to the research on industrial heritage renewal planning, providing a new idea and method for industrial heritage renewal planning and design. Dong Xintong (2021) [20] constructs the Hancheng Heritage Corridor to provide experience in the reasonable protection and utilization of heritage from the aspects of heritage resource point integration and tourism route planning. Wang Chengfang and Sun Yimin [21] used space syntax and GIS to quickly judge the rationality of streets and land layouts and proposed new methods and ideas to assist planning and design in the protection and renewal planning of historical blocks. Wang Xu (2019) [22] obtained reasonable optimization strategies for industrial heritage tourism routes, spatial distribution, and functional zoning in Tangshan City through quantitative analysis of space syntax. Li Linjie (2022) [23] took Changchun City as an example to conduct a triple spatial scale analysis of Changchun's contemporary industrial heritage, explore the connection between industrial heritage and the city, and analyze the spatial form of industrial heritage. Wang Juan, Zhao Jie, and Feng Jiejie (2022) [24] used space syntax to analyze the street structure of Qingdao's historical districts, the kernel density method to characterize the distribution characteristics of tourism elements, and the bivariate correlation analysis method to study the correlation between the two at different scales. Zhao Qianxiang (2023) [25] conducted research and analysis on the spatial form of the Xisi Historic District in Beijing based on the space syntax theory. Ma Mengyao and Tang Jianxiong (2023) [26] proposed four sustainable development models of industrial heritage tourism based on a qualitative analysis of the spatial distribution pattern of China's industrial heritage and factors affecting the development of industrial heritage tourism.

To sum up, current scholars' research on industrial heritage focuses on qualitative research, and there is a lack of multi-level quantitative analysis on industrial heritage-specific tourism research from a spatial perspective or a tourism perspective. Therefore, this article takes the ancient city of Nanjing, China, as an example and uses GIS and space syntax to combine quantitative and qualitative analysis to comprehensively and in-depth analyze the spatiotemporal distribution of Nanjing's industrial architectural heritage and its relationship with urban development. The purpose is to deeply integrate industrial heritage and tourism to create a multi-dimensional, multi-level, and systematic heritage tourism strategy.

The innovations of this article are as follows:

1. Through the collection of historical data and on-site surveys, information on 93 industrial building heritage sites in Nanjing was obtained, providing an important research basis for subsequent research. Using GIS technology, the evolution law of Nanjing's modern industrial buildings and the distribution characteristics, agglomeration characteristics, and spatial directionality characteristics of industrial heritage in urban space were comprehensively, deeply, and systematically analyzed for the first time.
2. Based on the spatial form and distribution characteristics of industrial heritage, using space syntax and GIS quantitative analysis, a tourism path with "multiple points, two axes, one center" was constructed. At the same time, the tourism strategy of "point-like highlighting, linear links, surface darning" was proposed.
3. An industrial heritage tourism model with the characteristics of the ancient city of Nanjing is proposed. The sustainable development model of industrial heritage tourism under low-carbon goals is explored.

3. Materials and Methods

3.1. Materials

3.1.1. Study Area

Nanjing belongs to Jiangsu Province in China (Figure 1) and is located on the lower reaches of the Yangtze River. It was once the capital of the Republic of China and one of the

most representative cities in modern China [27,28]. After 1840, the Chinese government established the first batch of industrial enterprises in modern times [29,30]. After more than a hundred years of development, Nanjing's industrial buildings have a large number of industrial heritages, rich types and high historical value. Nanjing's industrial architectural heritage was chosen as the study area because it is typical and representative.

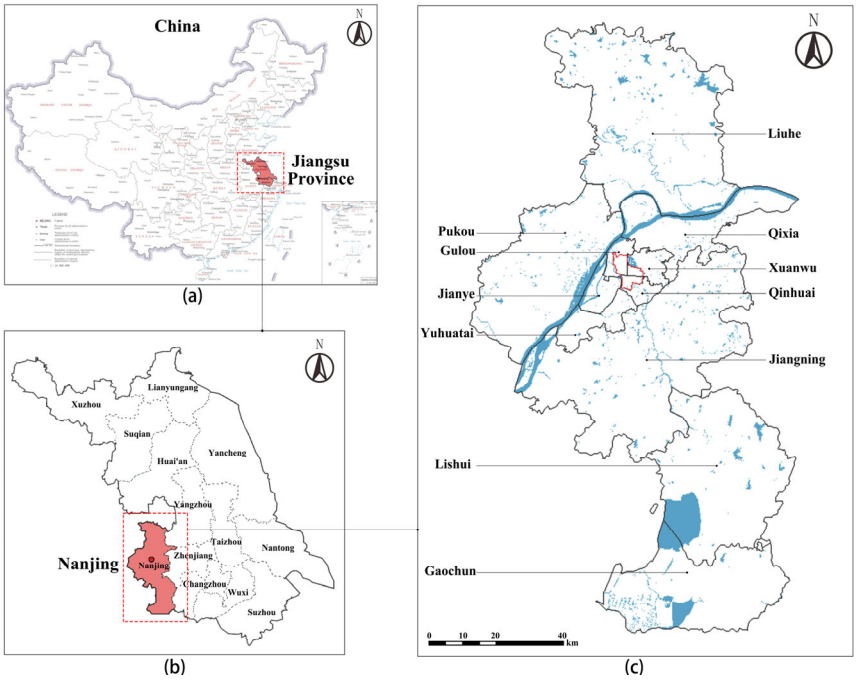


Figure 1. (**a**) The location of Jiangsu Province in China; (**b**) the location of Nanjing City in Jiangsu Province; (**c**) the administrative division of Nanjing City. Base map source: Standard Map Service (http://bzdt.ch.mnr.gov.cn, accessed on 2 October 2023).

This article takes the industrial architectural heritage of Nanjing from 1840 to 1990 as the research object. This is because 1840 was the beginning of China's learning of industrial technology from Western countries [31], and 1990 was determined based on the latest industrial heritage type historic buildings year in the "Third and Fourth Batch of Historical Building Protection Lists Announced by the Nanjing Municipal Government.

3.1.2. Data Sources

The industrial heritage data are derived from "Historical Research on Nanjing Industrial Heritage" and "Comprehensive Survey of Nanjing Industrial Heritage". The sources of historical data are divided into two categories. One is the historical map of Nanjing City, Nanjing Municipal Archives, Nanjing local chronicles, and factory records of various industrial enterprises in Nanjing. The other category comes from related papers and books, such as "Research on Nanjing Modern Industrial Architecture" (Chen Liang) [32], "Modern Industrial History of China" (Zhu Cishou) [33], "Nanjing Industrial Heritage" (Xu Yanping, Xu Longmei) [34], "Nanjing Architecture of the Republic of China" (Lu Haiming, Yang Xinhua, Pu Xiaonan) [35], etc. The number of recorded representative industrial enterprises was 8 by 1911, 62 by 1949, and 183 by 1980. Heritage statistics come from the author's research results and documents published by the Nanjing local government. According to statistics, there are currently 93 industrial heritage type historic building sites announced by the government.

Digital information on industrial heritage is mainly derived from website data and software extraction. The information obtained includes: geographical coordinates of industrial heritage, related geographical elements (water systems, mountains, roads, etc.), tourism elements (food, housing, transportation, etc.), etc. The coordinate information is

extracted through the Baidu map coordinate picking tool, and the road network and river channel information comes from the open source website OSM (Open street map). Tourism element POI (Point of interest) data comes from Baidu Maps and is obtained using POI crawler tools.

3.2. Methods

3.2.1. Research Methods

This article uses industrial heritage information, road water system data, and the tourism element POI (Point of interest) in the study area as the data basis. First, we use the kernel density analysis and standard deviation ellipse tools of ArcGIS10.8 to analyze the spatiotemporal distribution and development trends of Nanjing's modern industrial enterprises and Nanjing's industrial heritage. The space syntax software DepthmapX 0.8.0 is then used to analyze the road structure in the study area. Finally, based on the quantitative analysis of space syntax, the kernel density method was used again to analyze the distribution characteristics of tourism elements on the industrial heritage tourism road.

1. Kernel density analysis—spatial and temporal distribution of Nanjing's modern industrial enterprises and Nanjing's industrial heritage

The kernel density estimation method is used when analyzing the spatiotemporal distribution of Nanjing's modern industrial enterprises and Nanjing's industrial heritage. Based on kernel density analysis, the spatial distribution areas of Nanjing's modern industrial enterprises and Nanjing's industrial heritage were analyzed from the time dimension, and the distribution characteristics and evolution rules of Nanjing's modern industrial buildings were obtained. This function is represented as a bivariate probability density function whose spatial values are centered on a known point and tend to zero over a certain width. The Rosenblatt–Parzen kernel density estimation formula is commonly used [36,37]:

$$R(x) = \frac{1}{nh}\sum_{i=1}^{n} k\left(\frac{x - x_i}{h}\right) \tag{1}$$

where $R(x)$ is the probability value of element R at x. In this study, R refers to modern industrial buildings. $k\ (x-x_i/h)$ is the kernel function, where $(x-x_i)$ is the distance from the estimated value point x to the modern industrial building x_i; h is the bandwidth, greater than 0. Research shows that the kernel function has the smallest impact on the results, while h has a greater impact. There is no authoritative formula for determining the value of h. Based on many calculations, the value of h is determined to be 1.5 km.

2. Mean center and standard deviation ellipse

The migration of the mean center spatial coordinates in different periods can represent the changing trend of the spatial distribution of Nanjing's industrial enterprises. Changes in the shape, size, and direction of the standard deviation ellipse can represent the main distribution range, direction trend, and degree of aggregation of Nanjing's industrial enterprises in different periods. The area of the standard deviation ellipse represents the size of the distribution range, the direction of the long axis represents the direction trend of the element distribution, and the short axis represents the distribution range [38,39]. The formula is as follows:

$$C = \frac{1}{n}\begin{pmatrix} \sum_{i=1}^{n} \overline{x_i}^2 & \sum_{i=1}^{n} \overline{x_i y_i} \\ \sum_{i=1}^{n} \overline{x_i y_i} & \sum_{i=1}^{n} \overline{y_i}^2 \end{pmatrix}, \begin{cases} \left(x_i - \overline{x'}\right) \\ \left(y_i - \overline{y'}\right) \end{cases} \tag{2}$$

where x and y are the average center of mass coordinates. x_i and y_i are the coordinate values of the i-th element. n is the total number of elements.

3. space syntax

Space syntax is a quantitative research method that describes urban morphology based on topological relationships [40,41]. It includes three analysis methods: sight line analysis, axis analysis, and line segment analysis. Among them, the axis line can transform the street space graphically [42]. The study area of this article is large, including all areas within the Nanjing Ring Expressway [43]. So the axis analysis method is used to study the integration of the urban road network. When constructing the axis map, we select important urban roads such as highways, expressways, trunk roads, and secondary trunk roads, and exclude fine secondary branches to reduce errors caused by studying urban-level road space.

The degree of integration reflects the accessibility of spatial nodes. The higher the degree of integration, the better the accessibility. Integration is divided into global integration and local integration. The global integration degree reflects the degree of accessibility from a certain space node to other spaces in the entire study area. The local integration degree represents the local relationship between a certain spatial node and its adjacent nodes within a certain scale range. The formula is [44]:

$$I_i = \frac{m\left[\log_2\left(\frac{m+2}{3} - 1\right) + 1\right]}{(m-1)|D-1|} \quad (3)$$

among them, I_i is the integration degree value of node space i. m is the number of space nodes. D is the depth value of the node space.

Among them, C_i is the selectivity value of node space i. $n_{j,k}(i)$ is the number of times that the shortest path passes through node space i when selecting the shortest path between any two node spaces j and k. $n_{j,k}$ is the total number of shortest paths between any two node spaces j, k. n is the number of space nodes.

4. Kernel density analysis—spatial distribution of tourism elements

Kernel density analysis is a non-parametric estimation method for analyzing spatial point patterns. It can analyze the distribution pattern, density, and other characteristics of tourism element POI (Point of Interest) points in space. The use of the kernel density analysis method to identify the spatial distribution characteristics of tourism elements in the study area is helpful for us to propose corresponding tourism strategy research. The Rosenblatt–Parzen kernel density estimation formula is commonly used:

$$R(x) = \frac{1}{nh}\sum_{i=1}^{n} k\left(\frac{x - x_i}{h}\right) \quad (4)$$

where $R(x)$ is the probability value of element R at x. In this study, R is the tourism element. k $(x-x_i/h)$ is the kernel function, where $(x-x_i)$ is the distance from the estimated value point x to the tourism element x_i; h is the bandwidth, greater than 0. After analysis, the kernel function has the smallest impact on the results, h has a greater impact, and there is no authoritative formula for determining the value of h. After many calculations, this article determined that h is 1.5 km.

3.2.2. Research Framework

First, the author obtained Nanjing's industrial heritage type historic buildings information through historical research and on-site surveys and mapping and concluded that the number of heritage sites is 93, with rich types. GIS was used to construct an industrial heritage database, and space syntax was used to construct an urban road network axis map. Second, using GIS to perform kernel density analysis and standard deviation ellipse analysis. Using space syntax to conduct integration analysis revealed the distribution characteristics of industrial heritage along rivers and urban arterial roads, which led to the construction of a "multiple points, two axes, and one center" tourism path. Finally, based on the spatial distribution characteristics of industrial heritage, combining urban space, digital tourism, industrial heritage characteristics, etc., we developed a reasonable

industrial heritage tourism strategy and explored the sustainable development direction of industrial heritage. The research framework is as follows (Figure 2):

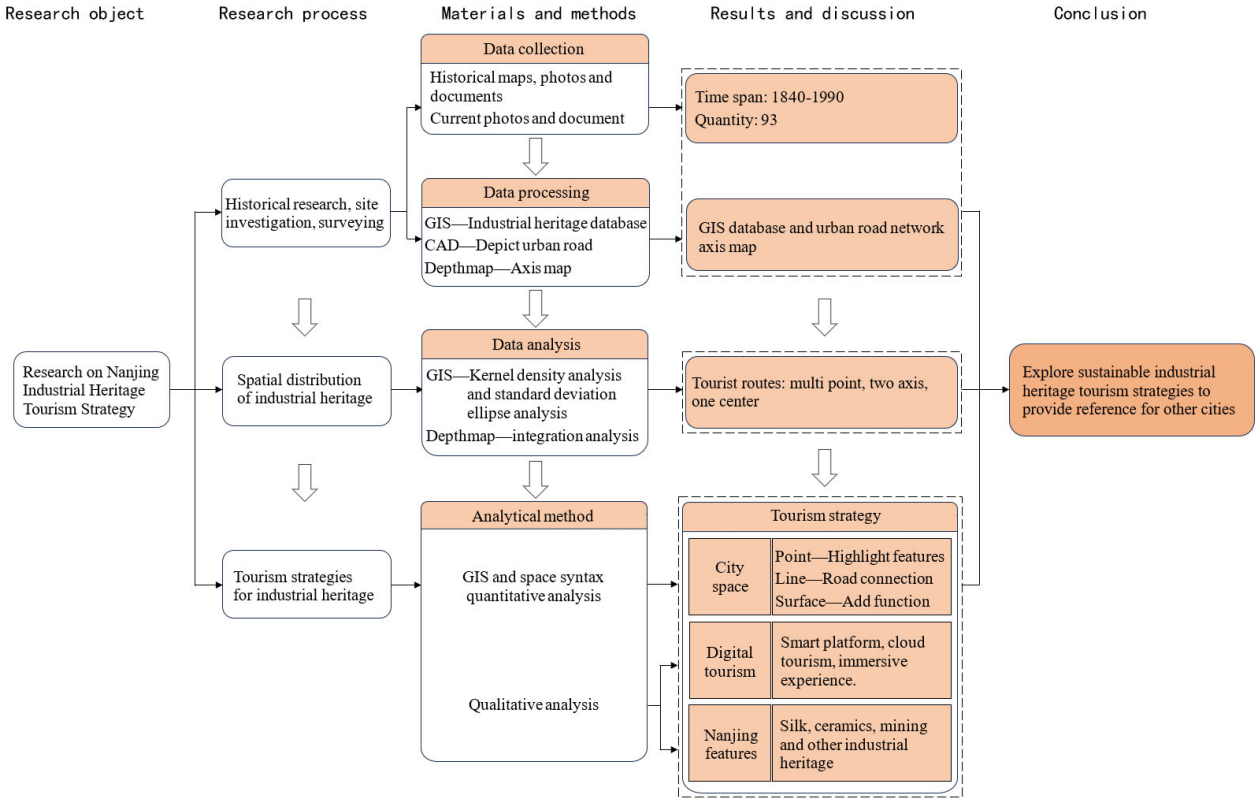


Figure 2. Research framework.

4. Results and Discussion

4.1. Industrial Heritage Statistics and Analysis

4.1.1. Industrial Heritage Statistics

Through historical research and on-site investigation, combined with the Industrial heritage type historic building protection list issued by the Nanjing Municipal Government, there are 93 industrial type historic buildings heritage sites (Table 1). A total of 80 of them were announced in the "Reply to Proposal No. 0063 of the Fifth Session of the 14th CPPCC" [45], and 10 of them were included in the "Municipal Government's Announcement of the Third and Fourth Batch of Historical Building Protection Lists in Nanjing" [46] were publicized, and 3 were publicized in the "Municipal Government's Announcement of the Fifth Batch of Historical Building Protection List in Nanjing" [47].

Table 1. Nanjing Industrial Heritage Statistics Table.

Industrial Heritage Protection Documents	Heritage Statistics	Industrial Heritage Name	Number	Address
		Capital Water Plant of the National Government	5	No. 7 Beihekou Shuichang Street, Gulou District
		Jinling Shipyard	5	No. 168 Yanjiang Road, Gulou District
		Nanjing Turbine Motor Factory	7	No. 80 Zhongyang North Road, Gulou District
		Nanjing Shuguang Machinery Factory	2	No. 205 Shogunfu East Road, Yaoshang Village, Gulou District
		Nanjing Film Machinery Factory	2	No. 9 Bancang Street, Xuanwu District

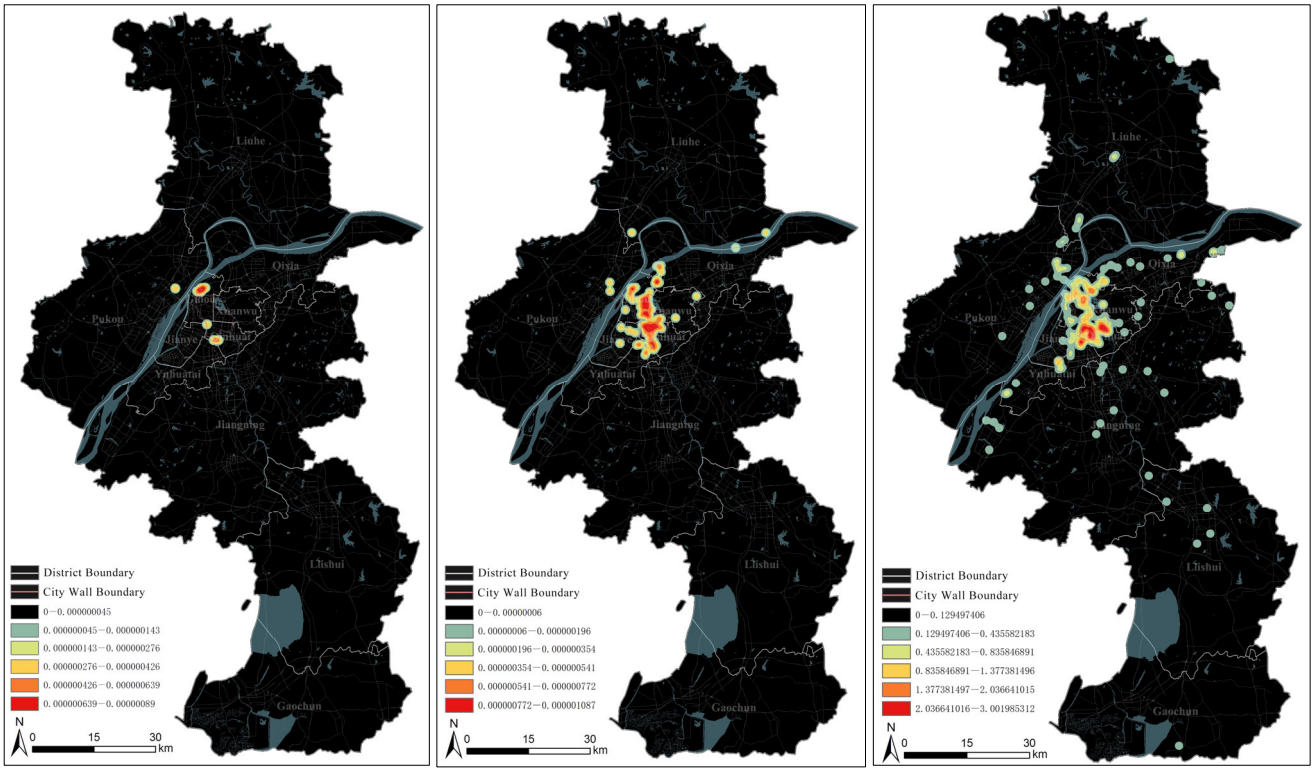
Table 1. *Cont.*

Industrial Heritage Protection Documents	Heritage Statistics	Industrial Heritage Name	Number	Address
Reply to Proposal No. 0063 of the Fifth Session of the 14th CPPCC Municipal Committee	80	Nanjing Optical Instrument Factory	6	No. 39 Tianshan Road, Xuanwu District
		Nanjing Watch Factory	4	The south side of Sifang City outside Zhongshan Gate in Xuanwu District
		Nanjing Oil Pump Nozzle'Factory	4	No.302 Central Road, Xuanwu District
		Jinling Machine Manufacturing Bureau	1	No. 1 Zhengxue Road, Qinhuai District
		Nanjing No.2 Machine Tool Factory	3	No. 66 Lingjiao City, Laifeng Street, Qinhuai District
		Nanjing Hongguang Airborne Equipment Factory	5	No. 1 Hongguang Road, Longpan South Road, Qinhuai District
		Nanjing Process Equipment Manufacturing Plant	6	No. 329 Mochou Road, Qinhuai District
		Nanjing Marine Auxiliary Equipment Factory	1	Banqiao outside Zhonghuamen in Yuhuatai District
		Nanjing Compressor Plant	1	Yuhuatai District small walking road
		China Cement Plant	4	No. 185 Cement Factory Road, Qixia District
		Xinlian Machinery Factory	1	Qixia District and 439 Yan Road
		Nanjing Coal Mining Machinery' Factory	4	No. 25 Maqun Street, outside Zhongshan Gate, Qixia District
		Ohashi Machine Factory	2	No. 61 Shuanglong Avenue, Jiangning District
		Yeshan Iron Ore	5	No. 300 Yingshan Village, Yeshan Town, Liuhe District
		Other heritage	12	
Notice on Announcing the Third and Fourth Batch of Nanjing Historic Building Protection List	10	Former Dajiaochang Airport	3	No. 1 Dajiaochang Road, Qinhuai District
		Former Nanjing Chenguang Machine Factory	1	No. 1 Zhengxue Road, Qinhuai District
		Former State-Owned 307 Plant	2	No. 1 Zhengxue Road, Qinhuai District
		Former Nanjing Compressor Factory	3	No. 1 Youjiawu, Yuhuatai District
		Former Xinlian Machinery Factory Auditorium	1	Qixia District and 439 Yan Road
Notice of the Municipal Government on Announcing the Fifth Batch of Historical Buildings Protection List in Nanjing	3	Former Xinlian Machinery Factory	3	Qixia District and 439 Yan Road
Total	93		93	

4.1.2. Spatial Distribution of Industrial Heritage

1. Evolution rules of Nanjing industrial buildings

(1) GIS was used to conduct kernel density analysis of industrial buildings in Nanjing in various modern periods (Figure 3). Red areas represent areas with dense industrial buildings.



(**a**) (**b**) (**c**)

Figure 3. (**a**) Kernel density distribution of industrial buildings in Nanjing from 1840 to 1911; (**b**) Kernel density distribution of industrial buildings in Nanjing from 1912 to 1949; (**c**) Kernel density distribution of industrial buildings in Nanjing from 1950 to 1990.

From 1840 to 1911, industrial buildings were mainly distributed outside the city walls and along the river, mainly concentrated along the Qinhuai River and near Xiaguan Avenue (Figure 3a).

From 1912 to 1949, industrial buildings began to develop in large numbers within the city walls. Not only were they distributed along rivers and lakes, but urban roads also became the main consideration in the location selection of industrial buildings. During this period, there were two core areas where industrial buildings gathered, namely the south of the city with a dense road network and the Central Road area in the north of the city (Figure 3b).

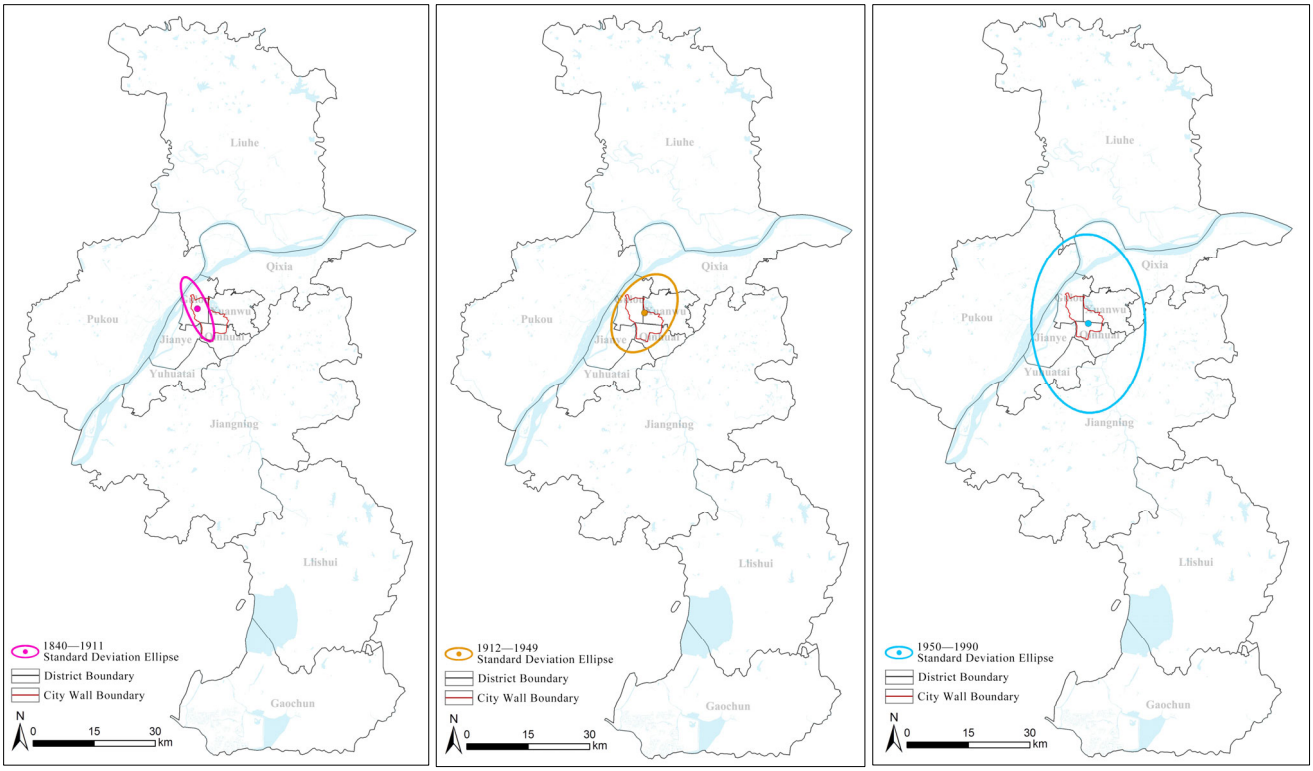
From 1950 to 1990, from the founding of the People's Republic of China to the early stage of reform and opening up, industrial buildings developed in large numbers, spreading from the area near the city wall to the entire city of Nanjing. Generally speaking, it still follows the characteristics of distribution along the water and along the main road. The core area where industrial buildings gather is the southern area of the city with a dense road network (Figure 3c).

To sum up, the location selection of modern industry in Nanjing is affected by production resources and urban planning. Under the combined effect of the two, the spatial layout of modern industrial buildings in Nanjing is ultimately formed. Convenient transportation is the main influencing factor in the location selection of industrial buildings.

(2) Use ArcGIS10.8 to analyze the mean center and standard deviation ellipse of industrial buildings in various periods of modern times in Nanjing (Figure 4).

The standard deviation ellipse and the mean center show a movement pattern in which the area gradually increases and the center of gravity of spatial distribution gradually moves southward. The coverage area of the ellipse increases, indicating that the distribution range of modern industrial buildings in Nanjing gradually expands. Although the center of gravity of spatial distribution gradually moves southward, it was always within the scope

of the Nanjing city wall. In these three stages, the development of industrial buildings started from the central city and spread to the entire city, but the core area was always the main city area (within the city wall).



(**a**) (**b**) (**c**)

Figure 4. (**a**) Mean center and standard deviation ellipse of Nanjing industrial buildings from 1840 to 1911; (**b**) Mean center and standard deviation ellipse of Nanjing industrial buildings from 1912 to 1949; (**c**) Mean center and standard deviation ellipse of Nanjing industrial buildings from 1950 to 1990.

2. Spatial distribution of Nanjing's industrial heritage

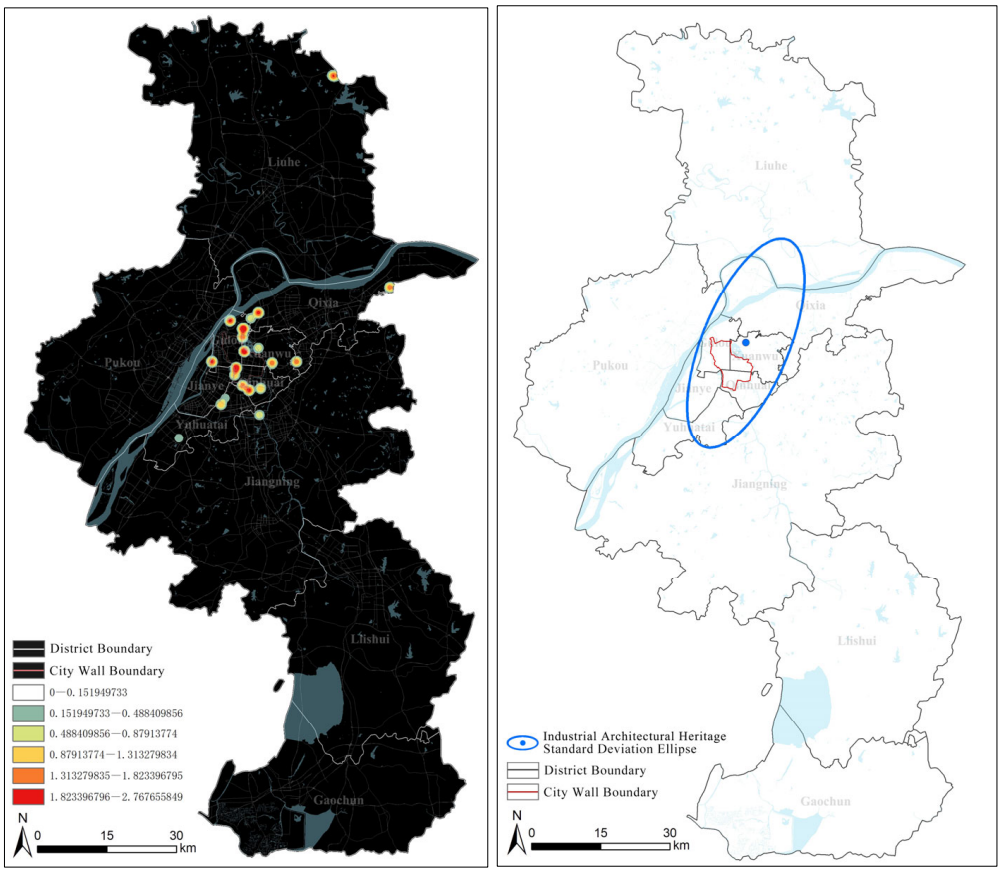
Use GIS to conduct kernel density analysis, mean center, and standard deviation ellipse analysis on Nanjing's industrial heritage.

It can be seen from the kernel density analysis chart that the red areas represent areas with dense industrial buildings. The remaining industrial buildings are mainly distributed outside the Nanjing city wall and still have the characteristics of being distributed along the Yangtze River, the ancient canal-Qinhuai River, and urban arterial roads (Figure 5a).

It can be seen from the analysis of the mean center and standard deviation ellipse that the distribution center of Nanjing's industrial heritage is no longer within the Nanjing city wall, but has shifted outside the city wall. The decline in the number of industrial buildings within the city walls has led to a shift in the center of gravity of the spatial distribution (Figure 5b).

The mean centers and standard deviation ellipses of the three historical stages and industrial heritage are superimposed to create a center of gravity migration diagram (Figure 6). The spatial scope of the shift of the center of gravity over time is concentrated near the Nanjing City Wall. In the three periods from 1840 to 1980, the distribution center of gravity of industrial buildings was within the city wall, showing a gradual southward trend. This is because in the initial period of industrial development, the core area where industrial buildings are distributed is along the river near Xiaguan [48]. With the opening of new roads, the industrial center of gravity began to gradually move south. In contemporary

times, due to the needs of urban development, the number of industrial buildings within the city walls has declined [49], causing the spatial distribution center of industrial buildings to shift outside the city walls.

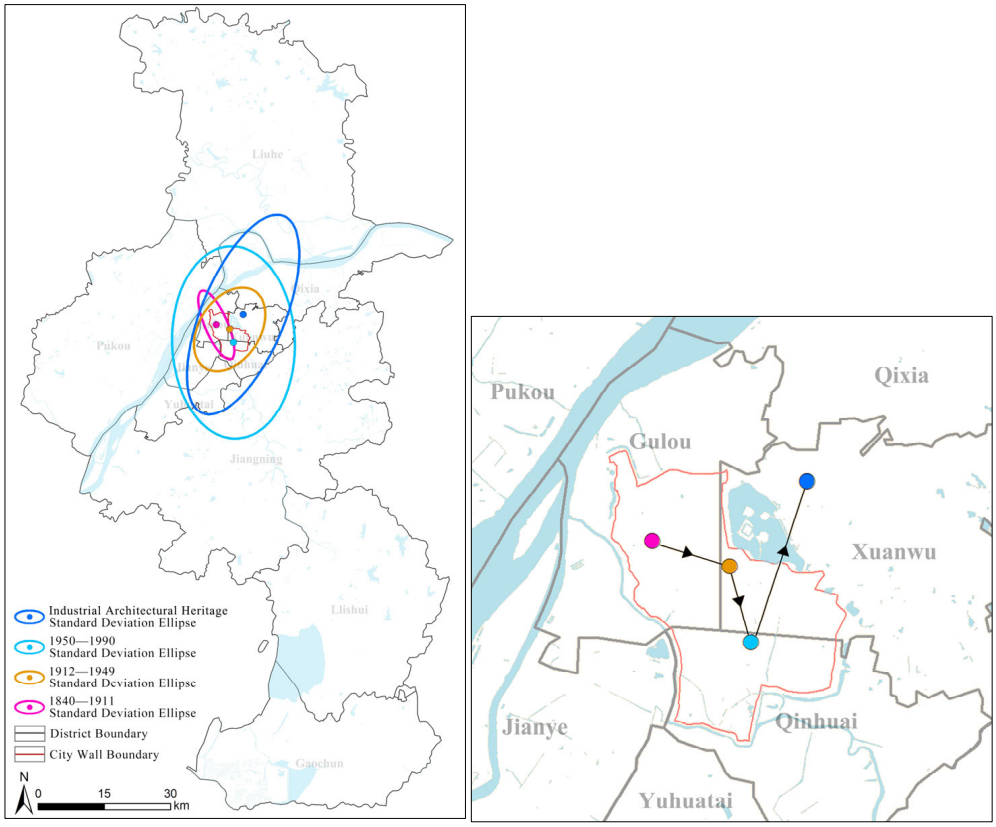


(**a**) (**b**)

Figure 5. (**a**) Industrial architectural heritage kernel density distribution; (**b**) Industrial architectural Heritage Mean Center and Standard Deviation Ellipse.

According to the rotation angle, shape area, major axis length, and minor axis length of the standard deviation ellipse (Table 2), in the two historical periods from 1840 to 1949, the major axis length, minor axis length, shape length, and area of the ellipse were all small, indicating that the distribution concentration of industrial buildings is high and the distribution range is small. From 1950 to 1990, the long axis length, short axis length, shape length, and area of the ellipse were all larger, indicating that industrial buildings were distributed over a large area and gradually spread from small-scale gathering areas to the entire city.

In summary, based on GIS kernel density analysis (Figure 5a), it can be concluded that Nanjing's industrial architectural heritage is distributed at multiple points throughout the city, located in all areas within the Nanjing Ring Expressway, along the Yangtze River, the Ancient Canal-Qinhuai River, and urban arterial roads. Therefore, this article summarizes it as "multiple points (i.e., multi-point distribution), two axes (i.e., the two axes of the Yangtze River, the Ancient Canal-Qinhuai River), and one center (i.e., all areas within the Nanjing Ring Expressway) "Spatial distribution characteristics; this is also the tourism path of industrial heritage, which provides a reference for the construction of industrial heritage tourism strategy below.



(**a**) (**b**)

Figure 6. (**a**) Ellipse analysis plots of mean center and standard deviation for 1840–1911, 1912–1949, 1950–1990 and industrial architectural heritage; (**b**) 1840–1911, 1912–1949, 1950–1990 and the shifting center of spatial distribution of industrial architectural heritage.

Table 2. Parameters of mean center and standard deviation ellipses by period.

Historic Stage	Areal Coordinates	Directional Angle	Long Axis (km)	Short Axis (km)	Shape Length	Oblateness	Shape Area (km^2)	Moving Direction	Moving Distance (km)
1840–1911	118.755° E 32.071° N	151.39°	16.87	5.13	37.05	0.70	67.96		
1911–1949	118.782° E 32.063° N	45.37°	20.74	13.78	54.77	0.34	224.42	Southeast	3.16
1949–1990	118.790° E 32.040° N	177.04°	43.92	27.73	113.98	0.37	956.30	Southeast	3.12
Industrial heritage	118.810° E 32.088° N	27.49°	48.50	18.89	111.01	0.61	719.26	Northeast	6.74

4.2. Industrial Heritage Tourism Strategy

According to the "Jiangsu Province's 14th Five-Year Plan for Cultural and Tourism Development", industrial heritage tourism is mainly coordinated by the government, develops digital tourism, and adheres to sustainable development. Therefore, this article discusses tourism strategies from the aspects of urban space, digital tourism, and highlighting Nanjing's industrial characteristics.

The industrial heritage that this study focuses on, especially the 11 industrial heritages listed as Class I in the "Nanjing Industrial Heritage Protection Plan", are the core assets for the development of Nanjing's industrial heritage tourism. These industrial heritages have obvious spatial distribution characteristics along water systems and transportation arteries, providing unique geographical advantages for tourism development. However,

the current status of these heritages is not entirely optimistic. On the one hand, they face the problem of balancing protection and development; on the other hand, how to combine these historical sites with contemporary tourism needs to achieve sustainable development is an important issue currently facing us.

4.2.1. Build Travel Routes

Based on the "multiple points, two axes, and one center" distribution characteristics of industrial heritage summarized above, this article constructs a tourism strategy of "point prominence, linear links, and surface darning" from the urban spatial level. Details are as follows:

Point: It is to carry out small-scale transformation of the industrial heritage itself to highlight its own industrial tourism value, which can quickly promote the development of industrial heritage tourism in local areas. The point heritage analyzed in this article is all Category I industrial heritage classified in the "Nanjing Industrial Heritage Protection Plan" [50], a total of 11 sites.

Line: It links industrial heritage through urban roads to form an industrial heritage tourism path. This article uses Depthmap software and uses the axis analysis method in space syntax to link the scattered Class I industrial heritage in the city into industrial heritage tourism paths based on quantitative analysis, so that the development of industrial heritage tourism is not limited to local areas but can run through the entire city.

Surface: It is to supplement the tourism elements that are lacking in the core area of industrial heritage tourism, improve tourism supporting service facilities, and create characteristic tourism projects. This article uses ArcGIS10.8 to conduct a kernel density analysis of tourism elements in the area surrounding the industrial heritage tourism route. Based on the analysis results, it supplements tourism supporting facilities and provides the necessary conditions for tourism activities, such as shopping, catering, accommodation, transportation, entertainment, etc., transforming old industrial areas into high-quality industrial heritage tourism areas.

1. Highlight important heritage

Highlight 11 key heritage sites. Based on the "multi-point, two-axis, one-center" industrial heritage distribution characteristics analyzed by GIS above, and combined with the tourism development pattern proposed in the "Nanjing Municipal Government's "14th Five-Year Plan" Cultural and Tourism Development Planning Notice" [51] (Figure 7a), this article constructs The tourist route consists of "multiple points (multiple industrial heritage attractions), two axes (two riverside scenic belts of the Yangtze River, Grand Canal, and Qinhuai River), and one center (all areas within the Nanjing Ring Expressway)" (Figure 7b).

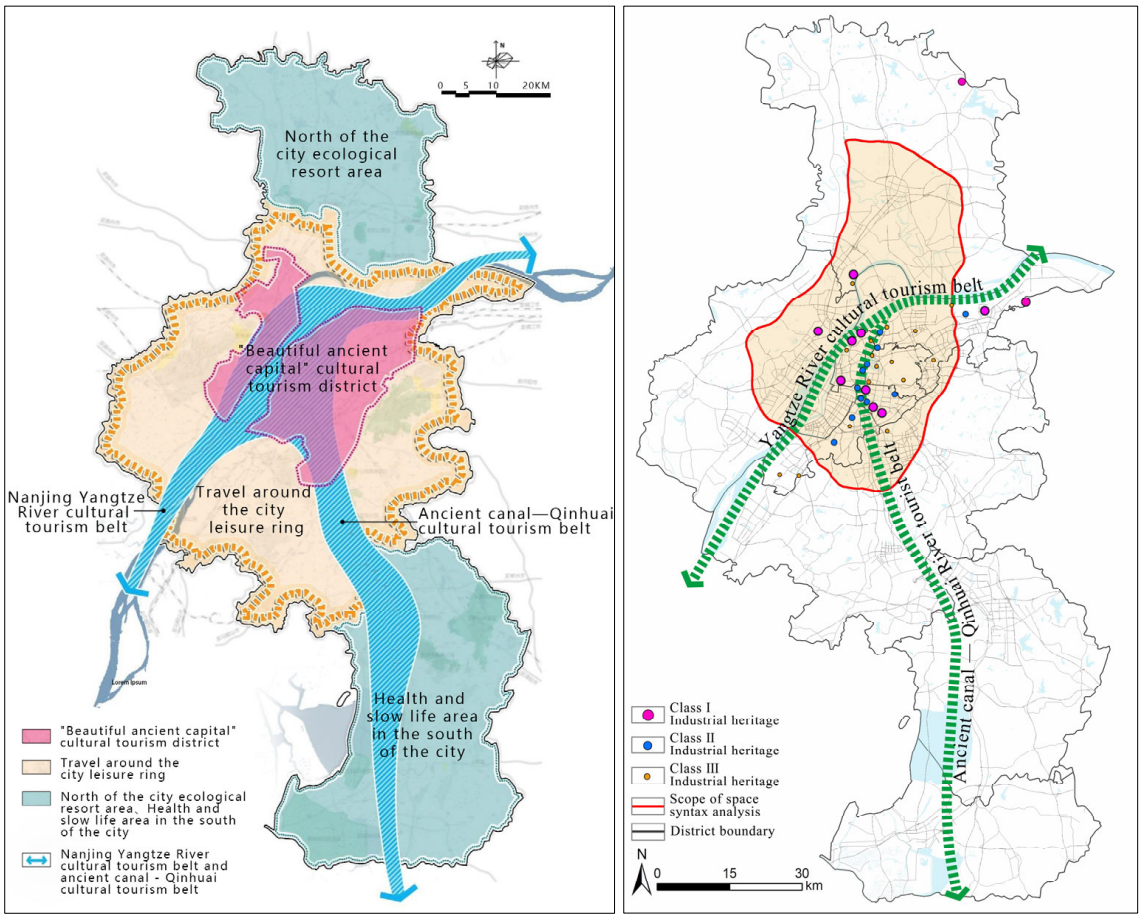
According to the classification of industrial heritage in the "Nanjing Industrial Heritage Protection Plan", all Class I industrial heritage (11 sites, all national key cultural relic protection units) will be developed as the focus of industrial heritage tourism. According to the characteristics of the heritage itself, the heritage will be highlighted in Features (Table 3).

2. Linear link

The Depthmap software of space syntax was used to conduct an integration analysis on the roads within the Nanjing Ring Expressway. The scattered industrial heritage was linked through urban roads with a high degree of integration (that is, high accessibility and easy for people to congregate) to construct two Riverside tourist belts. We perform this in the following ways:

(1) Select industrial heritage sites along the river. As shown in the figure (Figure 8a), Nanjing's industrial heritage is concentrated in the main urban area within the city wall, especially in the Gulou District and nearby areas, and is distributed along the water system. Therefore, this article selects all Class I industrial heritage sites that are no more than 1 km away from the Gulou District and no more than 1 km away from the water system as industrial heritage link points. They are Jinling Shipyard (Figure 8b), Hutchison & Co. (Figure 8c), Jinling Machinery Manufacturing Bureau (Figure 8d), and Nanjing Second

Machine Tool Factory (Figure 8e). They are linked by highly integrated roads and water systems to build two riverside tourist belts and form a core industrial heritage tourist area.



(**a**) (**b**)

Figure 7. (**a**) The cultural and tourism development pattern of Nanjing during the "14th Five-Year Plan"; (**b**) Tourist path with multiple points, two axes, and one center.

Table 3. Nanjing Class I Industrial Heritage Tourism Strategy.

Name	Current Photo	Location	Construction Years	Heritage Number	Heritage Tourism Strategy
Jinling Machinery Manufacturing Bureau		Yingtian Street, Qinhuai District	1865	1	Increase tourist supporting facilities and build a cultural and creative park
Nanjing Second Machine Tool Factory		Laifeng Street, Qinhuai District	1896	3	Silk Culture Museum

Table 3. *Cont.*

Name	Current Photo	Location	Construction Years	Heritage Number	Heritage Tourism Strategy
Puzhen Vehicle Factory		Puzhu Middle Road, Pukou District	1908	Many industrial heritage	Industrial historical area
Hutchison Matheson		Baotaqiao West Street, Gulou District	1913	7	Commercial complex
China Cement Factory		Cement Factory Road, Qixia District	1921	4	Industrial Culture Exhibition Hall
Republic of China Capital Water Works		Water Factory Street, Beihekou, Gulou District	1929	5	Industrial Culture Exhibition Hall
Yongli Chemical Factory		Fenghuang South Road, Dachang Street, Liuhe District	1934	Many industrial remains	Cultural and Creative Park
Jiangnan Cement Factory		Leshan Town, Qixia District	1935	Many industrial heritage	Republic of China style street
Nanjing Hongguang Airborne Equipment Factory		Hongguang Road, Qinhuai District	1951	5	Tourist attractions

Table 3. *Cont.*

Name	Current Photo	Location	Construction Years	Heritage Number	Heritage Tourism Strategy
Jinling Shipyard		Yanjiang Road, Gulou District.	1952	5	Industrial characteristic riverside scenery belt
Yeshan Iron Mine		Yingshan Village, Yeshan Town, Liuhe District	1957	5	Mining Culture Theme Park

Figure 8. (**a**) Industrial heritage distribution map; (**b**) Photos of the current situation of Jinling Shipyard; (**c**) Photos of the current situation of Hutchison matheson; (**d**) Photos of the current situation of Jinling machinery manufacturing bureau; (**e**) Photos of the current situation of Nanjing Second Machine Tool Factory.

(2) Choose the path with high integration.

The urban space within the Nanjing Ring Expressway is analyzed using global integration and local integration, respectively. The purpose is to more comprehensively and accurately reflect the core areas of Nanjing's urban space integration and then select the streets with the highest accessibility to build travel routes. In the integration analysis diagram, the closer to red, the higher the integration, the higher the road accessibility, and the easier it is to gather people [52].

The global integration analysis when R = n (Figure 9a) represents the difficulty of reaching the road within the entire Nanjing Ring Expressway [53]. The core area of global integration in this region is within the Nanjing City Wall. The main roads with the highest accessibility are Central Road, Zhongshan Road, Zhongshan North Road, Zhongshan East Road, Beijing West Road, Beijing East Road, and Hanzhong Road.

Figure 9. (**a**) Global integration analysis when R = n, red roads are roads with high accessibility; (**b**) Local integration analysis when R = 3, red indicates roads with high accessibility.

The local integration analysis when R = 3 (Figure 9b) indicates the difficulty of reaching the road within the three-step topological distance [54], reflecting the core integration degree of the small-scale area. The core area of local integration is distributed at multiple points, which is different from global integration. Within the Nanjing City Wall, the urban arterial roads with the highest accessibility are Central Road, Zhongshan Road, Zhongshan North Road, Zhongshan East Road, Beijing West Road, and Beijing East Road.

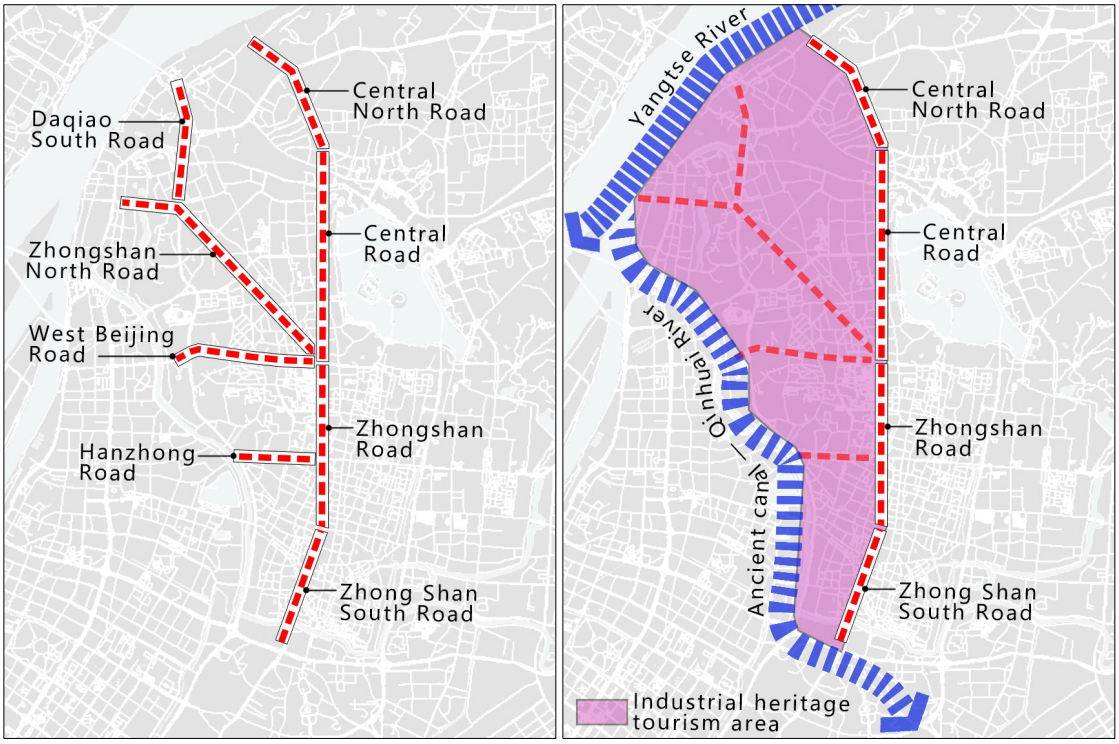
Therefore, when connecting scattered industrial heritage sites, first choose the urban trunk roads with the highest global accessibility and local accessibility: Central Road, Zhongshan Road, Zhongshan North Road, and Beijing West Road. Secondly, choose the roads with the highest accessibility near the industrial heritage site. The urban arterial roads with the highest accessibility, such as Zhongshan South Road, Hanzhong Road, and Daqiao South Road. Finally, based on the analysis of global integration and local integration, combined with the spatial location of industrial heritage sites, we can infer that the roads with the highest accessibility for industrial heritage tourism (where crowds are most likely to gather) are Central Road, Central North Road, Zhongshan Road, Zhongshan South Road, Zhongshan North Road, Beijing West Road, Hanzhong Road, and Daqiao South Road (Figure 10a).

Therefore, a core industrial heritage tourist area is formed consisting of Central Road, Central North Road, Zhongshan Road, Zhongshan South Road, the Yangtze River, the ancient canal, and the Qinhuai River (Figure 10b).

(3) Select roads with a high degree of integration to connect point-like heritage to form two riverside tourist belts.

For example (Figure 11), four Class I industrial heritage sites in Gulou District and nearby areas are distributed along the Yangtze River and the ancient canal-Qinhuai River. These four important point-shaped industrial heritage tourist attractions are connected to the Yangtze River and the Qinhuai River through highly integrated urban roads. The ancient canal-Qinhuai River link forms the core industrial heritage tourist area in the main

urban area (Figure 10b), and focuses on building two riverside industrial heritage tourist belts (Figure 11).



(**a**) (**b**)

Figure 10. (**a**) Highly accessible roads related to industrial heritage tourism; (**b**) An industrial heritage tourist area surrounded by roads and water systems.

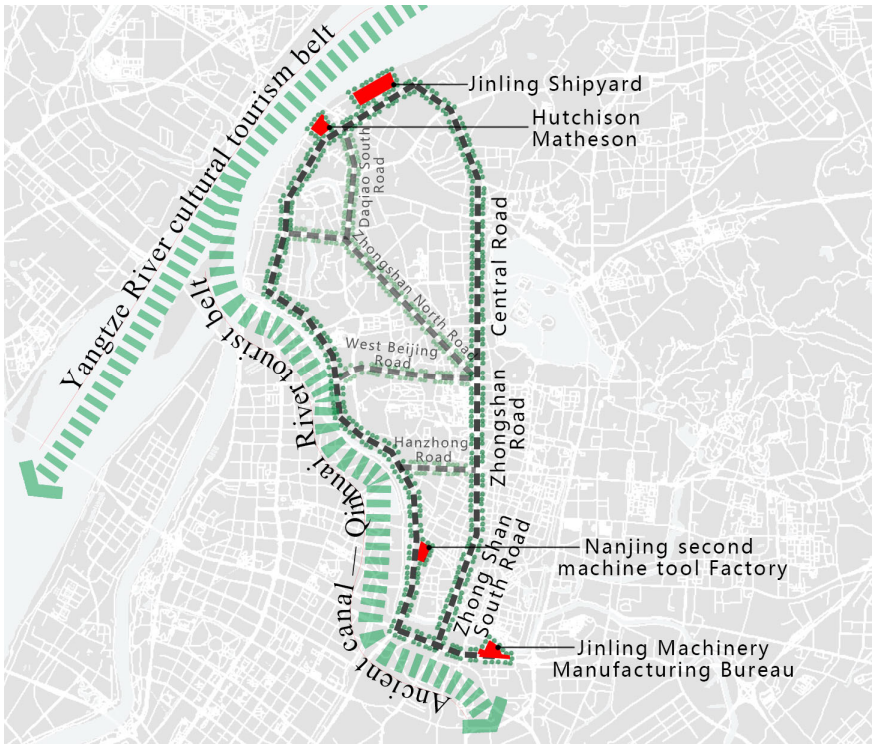


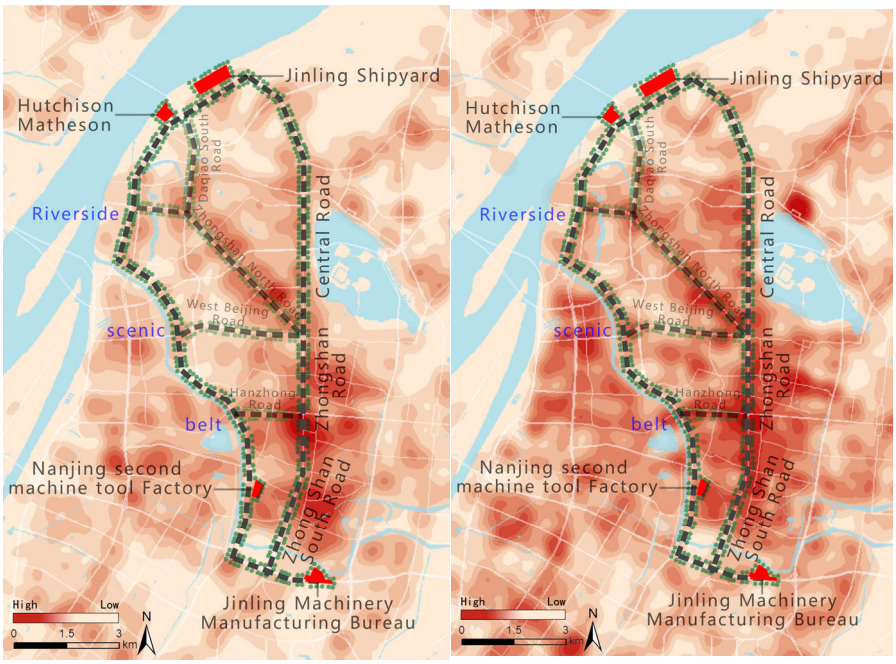
Figure 11. 2 riverside industrial heritage tourism belts.

3. Surface darning

This article only conducts a quantitative analysis of the tourism elements of the core industrial heritage tourist area (Figure 10) in the main urban area. The GIS kernel density analysis method is used to select five types of tourism elements closely related to tourists' needs: shopping, dining, accommodation, transportation, and entertainment, and to supplement the supporting facilities in the lacking areas (it is like a facial darning). It increases the vitality of tourism and forms a cultural, leisure, and tourism place, integrating cultural experience, leisure vacation, ecological sightseeing, business entertainment, and other functions.

(1) Distribution characteristics of tourism elements

In the kernel density analysis chart, the red area represents the area where tourism elements are concentrated. The distribution of all tourism elements (Figure 12a) is mainly concentrated in the Zhongshan South Road and Zhongshan Road areas. There is the Xinjiekou commercial district at the junction of Zhongshan Road and Hanzhong Road, and the Confucius Temple commercial district is on the east side of Zhongshan South Road. Both of these places have very developed businesses. The distribution of transportation tourism elements (Figure 12b) basically covers the entire industrial heritage tourism area and is mainly composed of public transportation and parking lots to facilitate tourists' travel.



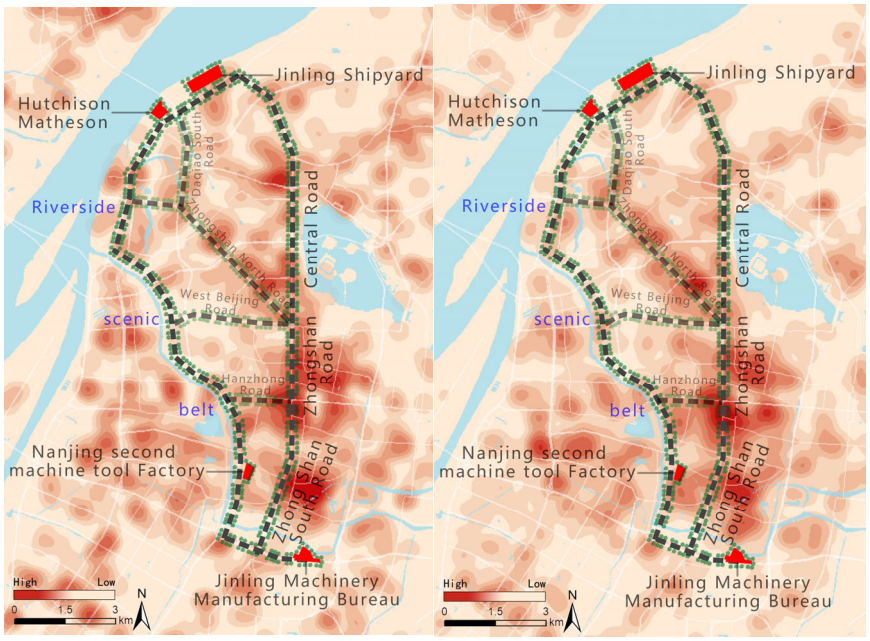
(**a**) (**b**)

Figure 12. (**a**) Kernel density analysis chart of all tourism elements superimposed; (**b**) Kernel density analysis chart of transportation and tourism elements.

The core density distribution of shopping and dining is similar (Figure 13). The distribution range basically covers the entire tourist area, with Xinjiekou and Confucius Temple business districts as the core areas. However, there is a lack of shopping and dining facilities in the northern sections of the two riverside scenic belts of the Yangtze River and the ancient canal-Qinhuai River.

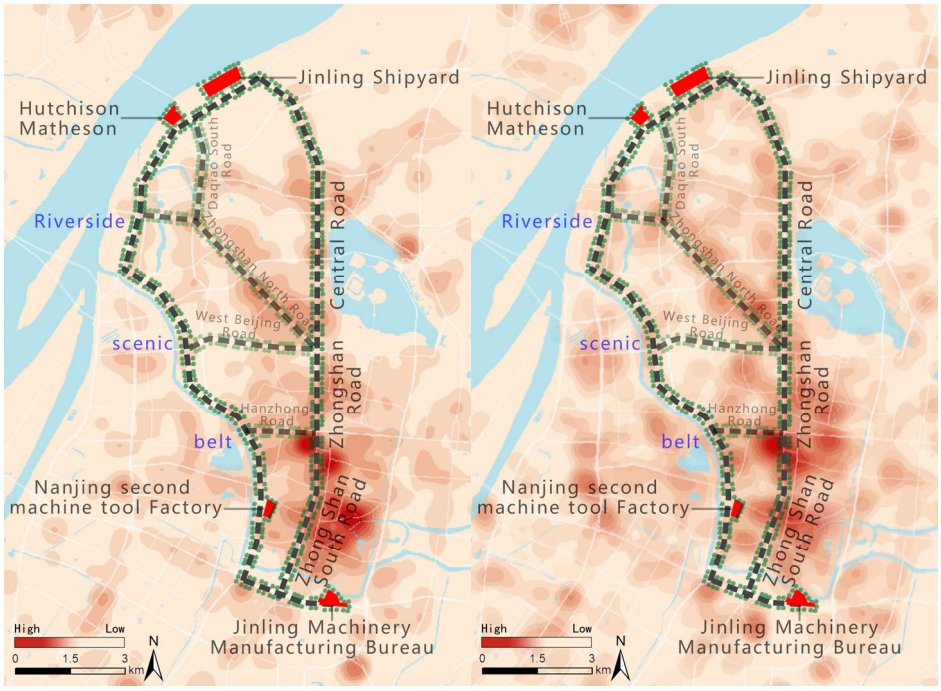
Accommodation is mainly concentrated in the southern part of the industrial heritage tourist area (Figure 14a), and convenient transportation and commerce attract the gathering of accommodation. However, in the northern part of the industrial heritage tourist area, such as Beijing West Road, Zhongshan North Road, and Central Road, the distribution of accommodation tourism elements is relatively small, and some tourists need to travel a long distance to reach their accommodation. Although entertainment facilities are also

located in the Xinjiekou business district and Confucius Temple business district as the core area (Figure 14b), they are distributed along roads with high accessibility and need to be supplemented near the two riverside scenic belts.



(**a**) (**b**)

Figure 13. (**a**) Kernel density analysis chart of shopping tourism elements; (**b**) Kernel density analysis chart of catering tourism elements.



(**a**) (**b**)

Figure 14. (**a**) Kernel density analysis chart of accommodation tourism elements; (**b**) Kernel density analysis chart of entertainment tourism elements.

(2) Travel Features Darning Advice

When supplementing tourism supporting service functions, give priority to roads with high accessibility. For example, according to the integration analysis at the global scale and the local scale, the Central Road, the Zhongshan North Road, and the Beijing West Road all have high accessibility, but the tourism supporting services are not complete enough. Properly supplementing these roads with different types of tourism elements and taking advantage of their high accessibility can attract more tourists. This article recommends creating characteristic industrial heritage tourism projects based on the distribution characteristics of different types of tourism elements.

According to (Figure 12a), the areas where all tourism elements are concentrated are Zhongshan South Road and Zhongshan Road, while the areas that are lacking are the northern part of Riverside District. Therefore, it is necessary to create nighttime cultural tourism consumption gathering areas in areas where all tourism elements are concentrated to promote the development of the nighttime cultural tourism industry and form a cultural tourism brand. For riverside areas lacking all tourism elements, supporting tourism service facilities should be supplemented to provide convenience for tourists.

According to (Figure 12b), the transportation and tourism elements in the region are fully covered, indicating convenient transportation. For example, Hanzhong Road is the most integrated road linking the riverside industrial heritage tourism routes. Building Hanzhong Road into a walking tour channel between the riverside belt and the commercial center will promote the integration of culture, tourism, and commerce and form the characteristics of the Yangtze River industrial cultural tourism, creating a tourist and leisure neighborhood with industrial characteristics.

According to (Figure 13), shopping and dining facilities are widely distributed in the region. However, there is a lack of shopping and dining facilities near the four important industrial heritage tourist attractions along the river in the figure. The author recommends that, based on industrial heritage, increase shopping, dining, leisure, and other tourism elements and develop shopping streets and snack streets with industrial characteristics.

According to (Figure 14), accommodation and entertainment facilities are concentrated on Zhongshan South Road with the two major business districts of Confucius Temple and Xinjiekou, but these are lacking in the riverside tourist belt. The author recommends improving the quality and upgrading of the existing B&Bs in the Confucius Temple business district to create a B&B gathering area with Nanjing's local characteristics and sufficient entertainment projects to create a famous tourist B&B brand and increase the length of stay of tourists. For the riverside area that lacks accommodation and entertainment facilities, the main focus is to supplement entertainment elements, set up riverside greenways, and improve recreational facilities. For example, through government and public participation in the development of activities such as the Industrial Road Marathon and the Qinhuai River Dragon Boat Race, a number of self-driving tour bases and RV campsites will be built to expand the influence of Nanjing's industrial tourism. In addition, service facilities such as parking lots, visitor centers, and tourist toilets will be further improved.

In summary, by improving tourism elements and increasing tourism vitality, traditional tourism activities focusing on sightseeing will be expanded into industrial heritage and cultural experience tours that integrate leisure vacations, ecological sightseeing, entertainment, and shopping.

4.2.2. Develop Digital Tourism

Build a comprehensive cultural and tourism management service platform in Nanjing, build an industrial culture and tourism industry database, and realize network integration and symbiosis of industrial heritage tourism business.

Promote digital technology application scenarios. Create "cloud tourism" scenes around representative industrial heritage sites such as Jinling Shipyard, Hutchison Company, Nanjing Second Machine Tool Factory, and Jinling Machinery Manufacturing Bureau, and create a number of "cloud tourism" scenes such as online live broadcasts and virtual

VR scenery viewing. Create "cloud exhibitions" to promote cooperation between industrial heritage and digital culture enterprises and launch online cultural products such as online exhibitions, online classes, and online live broadcasts. Create a "cloud craft" scene, combine craft processes with digital technology, and develop immersive experience projects such as holographic interactive projection and immersive craft experience. Create a "cloud consumption" scenario and develop new cloud consumption models such as live streaming, online group buying, and cloud MALL to innovate the consumption experience and increase tourism revenue [55].

4.2.3. Highlight the Characteristics of Nanjing's Industrial Heritage Tourism

As the ancient capital of six dynasties and the capital of the Republic of China, Nanjing's ceramics, silk, and mining industries have lasted for thousands of years and are uniquely famous in China and even the world. This article focuses on displaying these industrial cultures and forming an industrial tourism brand with Nanjing characteristics [56].

The integration of ceramic culture and industrial heritage tourism allows tourists to immerse themselves in the entire process of designing, firing, baking, and listing a set of exquisite porcelain. For example, in addition to displaying ceramic culture, the Gaochun Ceramics Museum in Nanjing also opens the ceramic production line. Visitors can witness with their own eyes the entire process of ceramics from clay to out of the kiln (Figure 15a). In addition, a ceramics experience area has been added. Under the guidance of professional teachers, visitors can personally experience the production processes of drawing, kneading, trimming, glazing, and painting porcelain and feel how the clay becomes a blank and then transforms into ceramic. Beautiful ceramics. The Ceramic Museum focuses on ceramic culture and utilizes industrial heritage to create an industrial tourism destination that integrates sightseeing, science popularization, and experience.

Figure 15. (**a**) Ceramic production process display; (**b**) Textile craft experience (**c**) Iron ore remnants of railroad tracks and trains; (**d**) Night water tour.

The integration of silk culture and industrial heritage tourism allows tourists to immerse themselves in the entire process of silk manufacturing. Nanjing plays an important role in Chinese silk culture. During the Ming and Qing Dynasties, the Jiangning Weaving House, the leader of the "Three Weavings in Jiangnan" (Nanjing, Suzhou, and Hangzhou),

was located in Nanjing; Nanjing Yunjin is a fine silk product; the famous Maritime Silk Road also has Nanjing as an important node. At present, the Jiangnan Silk Culture Museum, built on the site of the Nanjing Second Machine Tool Factory, not only displays precious collections of silk cultural relics, varieties, patterns, and cultural and historical materials with the characteristics of Jiangnan Silk Culture, but also displays real objects, replicas, simulated scenes, text displays, and modern technological means such as multimedia interaction that allow tourists to experience textile crafts immersively (Figure 15b) and deeply feel China's colorful silk culture.

The combination of mining culture and industrial heritage tourism allows tourists to immerse themselves in the entire process of mining resources from development to utilization. The Yeshan Iron Mine in Nanjing has a long history, dating back more than 3000 years. Currently, the Yeshan Mine Park is built with the mining heritage of the Yeshan Iron Mine as the main landscape, and experiential tourism is developed using industrial relics such as narrow-gauge railways, steam trains (Figure 15c), underground tunnels, underground mining levels, and mineral processing relics. The project allows tourists to learn resource utilization knowledge during the tour and promote ecological and environmental protection more effectively.

Night cultural tourism and industrial heritage tourism are combined. The Qinhuai River in Nanjing and the "Qinhuai Lights" in the Confucius Temple area are world-famous. With the Confucius Temple business district as the core, we will create a nighttime cultural tourism consumption gathering area and then develop a number of nighttime cultural tourism consumption gathering areas along the Yangtze River, the Grand Canal-Qinhuai River Riverside Sightseeing Belt, and provide tourists with immersive night tours on the water (Figure 15d), forming tourist routes such as "night shopping, night eating, night accommodation, night tours, night entertainment, night reading, and night exercise" to create a multi-level tourism experience for tourists.

4.3. Sustainable Use of Industrial Heritage

Under the current green and low-carbon goals, combined with the tourism sustainable development goals proposed by the United Nations in Making Tourism More Sustainable: A Guide for Policy Makers (2005), this article combines industrial heritage The sustainable development model of tourism is summarized as "taking into account cultural integrity, environmental protection, and economic development".

4.3.1. Culturally Sustainable

The United Nations proposed in "Transforming Our World: The 2030 Agenda for Sustainable Development" that culture is both a driving force and an enabler of sustainable development [57]. In this context, the notion of cultural sustainability extends beyond merely the preservation of material culture; it also encompasses the inheritance and advancement of spiritual culture. Serving as the confluence of history and contemporary reality, industrial heritage represents not just a legacy of material form but also a vessel for the spirit of the era and cultural heritage. For example, Jinling Machinery Manufacturing Bureau and Jinling Shipyard are important historical buildings that demonstrate China's transformation from a traditional agricultural society to an industrial society and have important cultural status. By maintaining the integrity of industrial heritage and industrial culture, we transform it into an industrial heritage tourism education base, forming a new industrial heritage tourism experience that integrates research, learning, and tourism and can better spread industrial culture.

The integration of industrial heritage and cultural industries is not only aimed at awakening the dormant cultural genes of industrial heritage but also deeply reflects the concept of cultural sustainability. Focusing on "art and innovation", it introduces diversified modern formats such as cultural creativity, sports, and animation industries, creating a series of unique industrial heritage tourism products. This integration is not only the reuse of old resources but also the in-depth excavation and creative transformation of the

cultural connotation of industrial heritage. For example, the abandoned factory buildings are transformed into swimming pools and ice rinks. By maintaining the historical facade of the industrial heritage while introducing functional innovation, it becomes a contemporary venue that showcases both industrial culture and the spirit of sports.

The embodiment of cultural sustainability lies not only in the protection and revitalization of heritage at the material level but also in the cultural inheritance and innovation at the spiritual level. This practice of combining historical culture with modern lifestyle not only enhances the public's understanding and respect for industrial heritage but also achieves a win-win situation for culture and economy by creating new social and economic value, providing sustainable impetus for the future development of industrial heritage.

4.3.2. Ecologically Sustainable

Industrial heritage tourism based on ecological environmental protection is an environmentally friendly sustainable development model. Seize the opportunity of China's promotion of "carbon peaking and carbon neutrality" development and develop industrial heritage from the perspective of eco-tourism. For industrial plants with high energy consumption and high pollution, we adopt on-site transformation and environmental restoration methods to build an eco-tourism space integrating industrial ecological culture, industrial tourism theme park, and industrial production experience, so as to achieve environmentally friendly and sustainable development.

Taking the Nanjing Yongli Chemical Factory as an example, it is planned to transform the original factory area into an industrial ecological and urban leisure landscape park. We can carry out ecological transformation of its original pollution systems, such as canals and pools, introduce plants with water purification functions, such as water lilies and irises, and build a healthy water ecosystem. In addition, the polluted environment will be comprehensively managed, including replacing toxic soils and planting plants that absorb harmful substances to promote the ecological restoration of the soil.

Through these measures, not only can the ecological environment around the industrial heritage be restored, but also a leisure and tourism area integrating ecotourism and industrial experience can be created. This transformation model not only embodies the principle of ecological sustainability but also provides tourists with a unique experience of getting close to nature and understanding industrial history, while also promoting the harmonious development of the regional economy and ecological environment.

4.3.3. Economically Sustainable

The restoration of industrial heritage requires funds. The income obtained from industrial heritage tourism is not only used for the daily maintenance and operation management of industrial heritage but also can promote the comprehensive development of the regional economy, thus forming a benign and sustainable development of heritage protection and tourism development.

5. Conclusions

Based on historical research and on-site investigation, this article summarizes the development characteristics of modern industrial buildings in Nanjing. Specifically, the author constructed a database of modern industrial architectural heritage in Nanjing, and then used GIS to analyze the spatial distribution characteristics, aggregation characteristics, and spatial directionality characteristics of industrial heritage in the city. In addition, GIS and space syntax were used to analyze the relationship between heritage and urban space, and an industrial heritage tourism strategy of "point-like highlighting, linear linking, and surface darning" was constructed. The conclusion is as follows:

1. There are 93 industrial heritage type historic building sites in Nanjing, which are distributed along the Yangtze River, the ancient canal-Qinhuai River, and urban arterial roads, showing a significant clustering distribution. They are gathered in Gulou District, Xuanwu District, Jianye District, Qinhuai District, Yuhuatai District, and Qixia District,

and the gathering direction is from southwest to northeast. High-density industrial heritage areas are located near the Nanjing City Wall, with the largest number in the Gulou District.

2. Based on the spatial distribution characteristics of industrial heritage, the author uses space syntax and GIS to conduct quantitative analysis from the urban spatial level. The author constructs an industrial heritage tourism path with "multiple points, two axes, and one center". "Multipoint" refers to the 11 Class I industrial heritage sites listed in the "Nanjing Industrial Heritage Protection Plan". The "two axes" are the Yangtze River, the ancient canal, and the Qinhuai River riverside sightseeing belt. "One Center" refers to the area within the Nanjing Ring Expressway.

As a result, the industrial heritage tourism strategy of "point protrusion, linear links, and surface darning" was put forward. Point protrusion: The strategy focuses on building 11 Class I industrial heritage sites into industrial heritage tourism demonstration sites. It is proposed to use the Urban Acupuncture approach to "inspire" and drive the renewal of surrounding areas through the renewal of the heritage itself. Linear links: By using the Depth map software of space syntax, based on quantitative analysis, the scattered industrial heritage in the city is linked into two riverside industrial heritage tourism paths along the Yangtze River, the ancient canal and the Qinhuai River. Area darning: Managers can use the kernel density analysis method of GIS to quantitatively analyze the tourism elements of the industrial heritage tourism routes and surrounding areas by improving shopping, catering, accommodation, transportation, entertainment, and tourism supporting service facilities to increase tourism vitality.

3. Highlight the industrial heritage tourism characteristics of the ancient city of Nanjing. Nanjing's silk industry, ceramics industry, and mining industry are uniquely famous in China and even the world. These can be used to create unique industrial tourism products in Nanjing. For example, using industrial heritage to build a silk culture museum can help popularize special culture. Another example is introducing tourists to the ceramic production line to observe the porcelain production process or making pottery. Mining ruins can also be used to build a mining park to protect the ecological environment. . . In addition, the two riverside sightseeing belts of the Yangtze River and the Ancient Canal-Qinhuai River will be equipped with night lights to form a water night tour to attract more tourists.
4. According to the sustainable tourism goals proposed by the United Nations Environment Program and the World Tourism Organization, a sustainable development model for industrial heritage tourism is proposed from the aspects of cultural inheritance and innovation, environmental restoration, and economic development.

Due to space limitations, this article only conducts a systematic study on Nanjing's modern industrial heritage. In the future, regional linkage and multi-modal tourism strategies for Nanjing and surrounding cities can be created from the perspectives of regional linkage and cloud tourism. In addition, the impact of tourists on destinations is also an area worthy of further exploration. Other types of specialized heritage tourism can also be developed to attract tourist groups with different interests and needs.

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