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Integrated sustainability assessment and renewal of old industrial areas: A case study on Changzhou

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Abstract

With the acceleration of China's industrialization process, quite a lot of developed cities have come to the watershed towards a post-industrial stage. The constant urgrading of their traditional industries has brought about an urgent need to redevelop the old industrial areas with a more scientific and realistic urban strategy.

This paper takes Changzhou city as an in-depth case study of industrial land renewal from a perspective of sustainable development. In Changzhou, textile and electronic industries have constitued its economic base for decades, which occupied the majority of its industrial land throughout the city. However, in the following years, these urban industries will be moved out of the downtown area, and the formed lands be transferred into commercial, business, public service, cultural industry and residential use mainly. Based on the analysis of the current situation of the old industrial areas, this paper proposed three constructive views on how to improve these areas on the aspects of basic theory research, redevelopment mode, and planning methods. Secondly, it analyses the factors which affect the renewal of old industrial areas, and proposes the integrated and comprehensive sustainability assessment system that combines the economic, social, environmental and regional development. Finally, this paper focuses on and puts forth urban renewal strategies such as enhancing urban centre functions, regenerating land resources, optimizing the use of urban land resouces.

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1. Introduction

There have been successful and failed cases in the practice of old industrial area renewal so far, such as Tiexi Industrial Area of Shenyang City (Zhang Xiaoyun, 2001; Chen Baichao et al.,2003), Ruhr Industrial Base (Wang Jianguo et al., 2003). These cases provided experiences for China's planning practice in urban renewal. But among them, the reasons for some of the mistakes include the lack of scientific and holistic assessment of the present features of the old industrial areas. The failure to assess the "present situation – goal-setting – policy-making" during the process of renewal and transformation of the city's old industrial areas resulted in the lack of understanding of the areas' value, the lack of diversity in transformation methods, subjectivity and arbitrariness, as well as the emphasis on economic profit and the neglect of social, cultural and environmental benefits. As a result, studying the assessment systems and methods for renewing old industrial areas will assist in guiding future renewal practices. It will provide a scientific method framework of implementing old industrial area renewal in China. By making the planning and policy-making process of old industrial area renewal more systematic and scientific, it will promote the comprehensive, coordinate and sustainable development of the old industrial areas' renewal.

The main objective of the study is to establish an assessment system and method for the renewal of old industrial areas that have practical and guiding significance. This includes two main points: first, how to understand past integrated assessment system from the socio-economic level into the level of old industrial area renewal, thereby establishing a set of assessment index specific to the renewal of old industrial areas; second, how to establish an assessment method framework, through which the assessment index system can be integrated with various types and levels of old industrial area renewal. Only the establishment of a comprehensive assessment method framework can enable the effective application of the assessment system at the socio-economic level in the practice of renewing old industrial areas.

2. General Situation of Changzhou's Old Industrial Areas

The object of this study is Changzhou's old industrial areas. Changzhou's old industrial areas, which include industries within the scope of Changzhou's central group, have undergone development since beginning of the 20th century. They include the earliest national industries from the 30s, large-scale industrial construction from the early days of the Peoples Republic of China as well as a large number of township enterprises that emerged after reform and opening up. Having experienced the surge in industrial construction that never occurred in many other Chinese cities, these areas are highly representative and typical.

The old industrial areas refer to the industrial lands in the old city of Changzhou. It reaches as far north as the main road north of the city, as south as Guihua Canal, as west as Longjiang Road, and as East as Qingyang Road, occupying a total land area of 77.35 square miles. These areas are situated in the center and old city of Changzhou, with relatively earlier and higher quality urban industrial development.

The old industrial areas currently have approximately 337 industrial enterprises. There are 102 textile, printing and dyeing, and clothing industrial enterprises, representing 30.26% of the total enterprises, 143 machinery processing industries, representing 42.43% of the total enterprises, 17 electronic industrial enterprises, representing 0.51%, 21 chemical industries, representing 6.2%, 6 pharmaceutical industries, representing 1.7%, and 38 other enterprises, representing 11.3%.

These industrial enterprises occupy a total land area of 985.97 hectares. Among them, textile, printing and dyeing clothing enterprises occupy 197.99 hectare which represent 20.08% of the total land area, machinery processing industries occupy 500.85 hectares which represent 50.8%, electronic industries occupy 39.4 hectares which represent 3.99%, chemical industries occupy 80.74 hectares which represent 8.18%, pharmaceutical industries occupy 11.38 hectares which represent 1.15%, food industries occupy 40.34 hectares which represents 4.09%, and other industries occupy 112 hectares which represent 11.36% of the total land area. From the number of land size of the industrial enterprises in the old city, the machinery processing industry has a clear advantage, followed by the textile, printing and dyeing industry. Electronic and chemical industries also represent a significant proportion.

The machinery and textile industries have a long history. Among them, factories relatively large in size were mostly built in the first half of the 20th century, representing the origin of Changzhou's national industries. As time went on, products continued to optimize and the industrial chain continued to extend upstream. Based on textile and

machinery industries, electronic and chemical industries started developing around the 60s. By the late 70s, the four main industries of machinery, textile, electronics and chemical industry co-existed in the old city. With subsequent technological and scientific developments, industries including bio-technology, electronic information, new material and new energy emerged in new industrial areas outside of the old city.
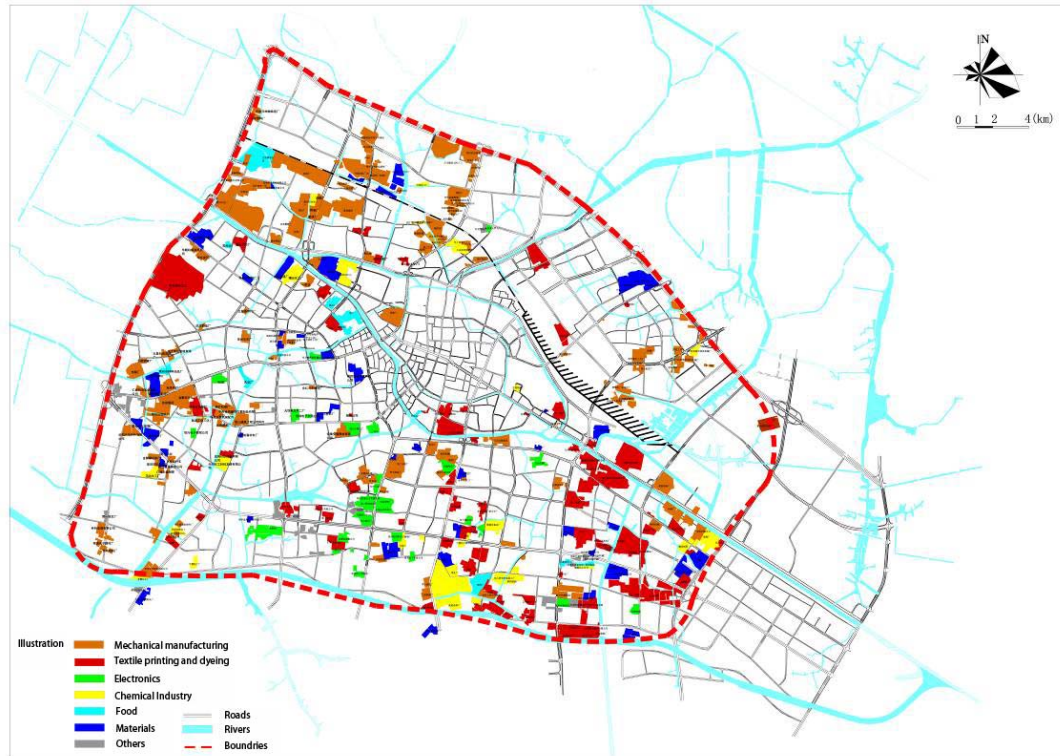

Fig. 1. Layout of industries in Changzhou's old industrial areas

3. Integrated assessment of the renewal of Changzhou's old industrial area

3.1. Integrated assessment of the renewal of old industrial areas

3.1.1 Integrated Assessment Objectives for the Renewal of Old Industrial Areas

The integrated assessment specific to the renewal of old industrial areas is based on the present situation of old industrial areas and aims to achieve optimal benefits in every aspect of industrial area renewal. The time sequence and renewal strategy for the renewal of old industrial areas will be proposed according to this assessment. The objective is to establish an integrated assessment system that considers ecological environment, economic development, as well as social and cultural aspects of renewing old industrial areas. It uses the target-achievement matrix method which integrates quantitative and qualitative methods to establish a "present situation – assessment – strategy" assessment model. Based on the analysis and assessment of all aspects of the old industrial areas' present situation, it proposes the corresponding time sequence and strategy for renewal, eventually forming an integrated renewal method for old industrial areas.

3.1.2 Integrated Assessment Principles for the Renewal of Old Industrial Areas

(1) The principle of scientificity

Policy-making regarding old industrial areas is frequently influenced by subjective factors. The relocation sequence is often determined according to the enterprise's own situation and from the perspective of environmental pollution, neglecting social and cultural considerations. The integrated assessment system of old industrial areas demonstrates its scientificity and objectivity. Placing each old industrial area in a uniform assessment system can

avoid the influence of subjective human factors and reflect the present situation, advantages and shortcomings of the old industrial areas under assessment with relative scientific accuracy. The structure selection and hierarchy of the assessment index must be on the basis of science; they cannot be speculative. A scientific assessment system is the foundation of the objective and comprehensive assessment of old industrial areas.

(2) The principle of comprehensiveness

The renewal of old industrial areas impacts every aspect of urban development. It is an integrated adjustment and renewal process. The corresponding assessment index system should be a multivariate framework involving the economy, society and environment, all of which are essential elements. A comprehensive assessment system is conducive to conducting fairly comprehensive research and study of sophisticated, intersecting urban issues, thus reflecting all aspects of the issues pertaining to old industrial areas' renewal.

(3) The principle of effectiveness

The principle of effectiveness has two levels of significance. First, the assessment index must possess discriminability, that is, the index must have the ability to distinguish the differences in features of assessment objects. Secondly, the assessment index should be comparable during different periods and among different areas, which requires the index to employ relative, proportional, index and average numbers as much as possible.

(4) The principle of operability

The principle of operability requires each index in the index system to be operable. It must be able to collect accurate data in a timely manner. It first requires the index itself to be as simple as possible and to avoid repetition; the collection of basic data should also be simple and feasible.

3.2. Integrated assessment system construction for the renewal of old industrial areas

3.2.1 Integrated assessment system construction for the renewal of old industrial areas

The integrated assessment system for the renewal of Changzhou's old industrial areas can be divided into three levels. The top level is the objective level, the middle is the criteria level, and the bottom is the index level. Through relevant research and data processing as well as the analysis of factors influencing the renewal of Changzhou's old industrial areas, the final index system for the renewal of old industrial areas includes two levels and four aspects, including ecological environment, economic development, society and culture, and regional environment (Table 1).

Table 1 Integrated Assessment Index System for the Renewal of Changzhou's Old Industrial Areas

Objective level	Criteria level	Index level	Assessment factors
Integrated benefits of old industrial area renewal	Ecological environment benefits	Level of environmental pollution	Mainly inspect the current pollution situation of each factor such as air pollution, water pollution, and solid waste pollution.
		Risk of industrial pollution	Mainly inspect the risk level of industrial pollution; for instance, whether ecological restoration is required.
	Economic development benefits	Economic benefits to enterprises	Inspect economic benefits to enterprises, including the market share and growth rate of the annual output value.
		Land location value	Mainly inspect the land location value of each industry through the ring structure and price distribution of industrial land.
		Land use intensity	Inspect the land use intensity of land plots through the plot ratio distribution of various industrial lands.
	Socio-cultural benefits	Historical and cultural value	Inspect industrial heritage architectures such as officially protected cultural relic sites to determine their historical and cultural value.
		Urban industrial development	Inspect the distribution and function of electronic information, textile and clothing, and related urban industries within the scope of the old city, especially their contribution to the employment of workers.
	Integrated regional benefits	Large project construction	Inspect the relationship between Changzhou's major infrastructure construction and old industrial areas.
		Relevant planning of industry distribution	Inspect the industrial distribution requirements of existing industrial layout adjustment plans.

3.2.2 Meaning of the integrated assessment index for the renewal of Changzhou's old industrial areas

(1) Ecological Environment Index

The degree of environmental pollution refers to air pollution, water pollution and various solid waste pollution that result during the process of factory operation. On this issue, each factory should prevent and treat timely according to its own characteristics to ensure that all environmental quality indexes reach national environmental protection standards. Particular attention should be paid to certain high pollution and high energy-consumption enterprises. They should relocate in the near future to control effectively the surrounding environmental pollution and to restore the surrounding ecological environment to excellence.

The risk of industrial pollution mainly refers to pollution that cannot be restored in a short time period produced by certain special industrial categories. The renewal of these old industrial areas usually takes a step by step approach. Use can resume only after land environment management using ecological restoration methods. Development into low-density parks is more suitable for these industries.

(2) Economic Development Index

The economic benefits to enterprises index mainly investigates future economic development potential by organizing and calculating each enterprise's market share and growth rate of annual output value. It provides the basis for classifying Changzhou's strong and weak industrial groups and for proposing relevant development strategies. The study uses the BCG matrix to analyze the development characteristics of Changzhou's existing secondary industries. The size and growth rate of the industry are main assessment factors for measuring the competitiveness of the existing industry, thereby optimizing economic benefits in the renewal.

The value of urban land varies according to its location. Typically, the closer the land is to the city center, the higher its value. This is demonstrated by the rent of same-sized land as well as the variation in land yield in relation to its distance from the city center. Tertiary industry has the highest demand on land location, followed by residential areas, while industrial lands are the least sensitive. In general, for renewal of old industrial areas located in the city center and adjacent to major public service facilities, the large-scale economic development model can give full play to the location advantage of the city center. In comparison, old industrial areas on the periphery of the city are more suitable for sustainable development using methods such as optimizing the types of industrial development and constructing new urban industries.

The land use intensity index is connected to the plot ratios of various industrial lands. Higher plot ratio indicates higher land use intensity for that plot of land. The plot ratios of the various industries differ accordingly. For example, industries such as electronic equipment manufacturing tend to have relatively high plot ratio and use land more intensively, whereas industries such as metal smelting and chemical engineering have relatively low plot ratio as well as low land use intensity.

(3) Socio-cultural Index

Changzhou's industrial heritage in the old city was mainly formed in the first half of the 19th century. Boasting a long history and distinct features, it has been well-maintained and has high historical and cultural value. During the process of adjusting and renewing old industrial areas under the backdrop of rapid urbanization, it needs to be proactively protected and reused to bolster the unique position of Changzhou's industrial heritage as well as to enrich the historical and cultural significance of the city.

Urban industry is a light, micro, environmental and low-consumption new industry connected to traditional industries. Relying on social resources typical of large cities such as information flow, logistics, talent flow, capital flow and technology flow for support, it uses product design, technological development, processing and manufacturing, marketing and management, and technical services as its main body, and industrial parks and premises as carrier for its activities. It is well-positioned to survive and thrive in downtown districts and central regions of the city.

(4) Integrated Regional Index

With the gradual implementation of old city transformation, Changzhou's old city gradually demonstrates the characteristic of using large projects as a catalyst for renewal. Therefore, related large project construction will have a vital role in the adjustment and renewal of old industrial areas and effect an important influence on the time sequence and intensity of renewal. For analysis, this paper divides large projects into lot reconstruction, flagship

project construction, and large infrastructure project. It discusses their respective impact on the old industrial areas' renewal time sequence and strategy.

Adjustment planning for industrial layout is the main basis for the adjustment and renewal of old industrial areas in most Chinese cities. It sets out certain regulations for both the renewal principles and renewal time sequence of old industrial areas. In addition, overall urban planning, space layout planning for the manufacturing industry, and industrial heritage protection planning all impose various requirements on the renewal of old industrial areas from their own perspectives. It is necessary to combine and organize related planning to provide guidance to the renewal of old industrial areas.

3.3. Conclusion of the Assessment of Changzhou's Old Industrial Areas

The renewal direction of Changzhou's old industrial areas is tightly connected to each old industrial area's ecological environment, economic development, socio-cultural, and regional benefits. A renewal strategy specific to the situation is proposed according to the "present situation – assessment – strategy" evaluation model (Table 2).

Table 2 Conclusion of the assessment of Changzhou's old industrial areas and renewal direction

	Assessment of ecological environment benefits	Assessment of economic development benefits	Assessment of socio-cultural benefits	Assessment of regional benefits	Renewal direction
Northwest district	Currently, there is a relatively high degree of pollution as well as certain industrial pollution risks. Pollution control and gradual ecological restoration management are required.	Advantage industries are concentrated in distribution, generating high economic benefits. They can be combined with large project construction and developed in clusters for full relocation of used lands and industry upgrade.	Traditional machinery industries are distributed in this area. Old industries have certain public sentimental value, which should be considered in the renewal process.	Create industrial history and culture as well as characteristic waterfront sceneries. Should be developed in conjunction with large ecological residential districts nearby such as the Machinery Village.	Guided by the improvement of ecological environment, develop large landscape residential areas with industrial history and culture as well as characteristic waterfront sceneries.
North district	Currently there is serious environmental pollution and very high industrial pollution risks. Construction of green park space is required to restore the damaged ecology.	Relatively low economic benefits. Can relocate in the near future to achieve function replacement and industry upgrade as soon as possible	Relatively high distribution of old industrial enterprises. Has certain historical and cultural value and public sentimental value, which should be considered in the renewal process.	The five industries that have recently relocated to the main urban area and the seven industrial areas on the periphery should engage in large-scale, clustered development in accordance with the industrial development classification.	Guided by the improvement of ecological environment, create waterfront urban open space in conjunction with surrounding residential areas and develop scenic parks with industrial characteristics.
Northeast district	Both the pollution level and pollution risks are relatively low. Should focus on reducing pollution discharge and reinforcing pollution control in the near future.	Industries are relatively small in size and scattered in distribution. Should combine with peripheral project construction to relocate in the interim to achieve industry upgrade.	They are mostly scattered small industrial enterprises, with both low historical and cultural value and low social benefits.	The five industries that have recently relocated to the main urban area and the seven industrial areas on the periphery should engage in large-scale, clustered development in accordance with the industrial development classification.	Guided by the improvement of human settlement, develop urban functions such as residential, park, and commercial community service functions in conjunction with surrounding residential communities.

4. Renewal strategy for Changzhou's old Industrial areas

4.1. Renewal Objectives for Changzhou's Old Industrial Areas

As part of urban renewal, the renewal of old industrial areas is inevitably guided by the ideas of enhancing urban function, optimizing urban function, improving urban structure, and promoting urban civilization. From the assessment of the various aspects of Changzhou's old industrial areas, the renewal objectives for old industrial areas include multifaceted requirements such as ecological improvement, promotion of human settlement, social improvement, economic development, and historical and cultural protection.

(1) The Objective of Ecological Improvement

The objective of ecological improvement is mainly suitable for areas that currently have relatively serious industrial pollution and need to use bioremediation technology to purify soil pollution. The improvement of ecological environment includes multifaceted renewal objectives such as ecological environment, landscape environment, and architectural environment, comprising an important part of the sustainable development strategy. Centred on environmental protection in its essence, it aims to achieve a positive development model that satisfies the dual objectives of economic development and ecological sustainability.

(2) The Objective of Human Settlement Improvement

The objective of human settlement improvement is suitable for industrial lands that will be used for residential purposes after the renewal. As the main renewal method for the city's old industrial areas, the improvement of human settlement is not only demonstrated by the improvement of living environment. Through the construction of new models of residential buildings, the completion of infrastructure and the enhancement of traffic conditions, the government meets the needs of the new lifestyle and promotes community development. In addition, the government reinforces the development of the local employment market and improves local security conditions as well as supporting facilities by creating employment and providing employment training.

(3) The Objective of Social Improvement

The objective of social improvement is suitable for "stopping and optimizing the secondary industry" and for industrial lands undergoing transformation into urban industries. Urban industries are mostly high-efficiency, environmental, and labor intensive industries. The technical threshold for employment is not high, but relatively high labor investment and experienced labor skills are required. Employees in these industries can mainly be community residents, which is a significant contribution to the re-employment of the great number of experience workers that emerged in the process of industry restructuring in the urban area.

(4) The Objective of Economic Development

The objective of economic development is one of the most important objectives in the renewal of old industrial areas. It includes renewal methods such as the transformation of industrial lands into business offices, commercial and leisure, and cultural and entertainment functions. This development model mostly focuses on the market and emphasizes factors such as the economic benefits, development intensity, and price of land use. The objective of economic development is not limited to regional economic development brought about by land development; more importantly, it focuses on the resulting optimization and enhancement of urban core functions as well as the increase in the city's overall competiveness.

(5) The Objective of Historical and Cultural Protection

The objective of historical and cultural protection is mostly suitable for industrial heritage with certain historical and cultural value, such as cultural relic protection units, protected architecture and historical architecture. Historical and cultural protection is not only demonstrated in protecting the value of the industrial heritage itself, but more emphasizes history and culture as important urban resources, that is, using culture and art to drive the revival of old industrial areas in decline, thereby promoting the balance between protection and development and achieving coordinated and sustainable social development.

4.2. Integrated Renewal Strategy for Changzhou's Old Industrial Areas

According to the integrated assessment of Changzhou's old industrial areas, we have divided the old industrial areas' renewal and adjustment direction into five categories, each corresponding to an objective of old industrial area renewal: renewal and adjustment direction guided by ecological environment improvement, renewal and adjustment direction guided by human settlement improvement, renewal and adjustment direction guided by economic development, renewal and adjustment direction guided by social improvement, and renewal and adjustment direction guided by historical and cultural protection.

First, the old industrial areas are generally divided into three rings. The inner ring is the city's core ring, where commercial and trade functions are concentrated at the city centre. It requires intensive development and high benefit level, precluding the suitable development of industrial functions. The middle ring falls within secondary industry's land price range. This area presently bears most of the city's residential functions and is the preferred region for future expansion and extension of urban core functions. It should restrict the development of industrial functions other than that of some intensive, high-efficiency new urban industries. The outer ring is the region for industrial optimization, integration and adjustment. The creation of industrial landscape parks, improvement of human settlement, and development new urban industries are all in the zone of the outer ring. In addition, an industrial heritage corridor directed by historical and cultural protection will run through the entire old city area, with industrial heritage located along both sides of the canal in point distribution. Urban development driven by culture and art will enrich the city's historical and cultural significance. (Fig.2)
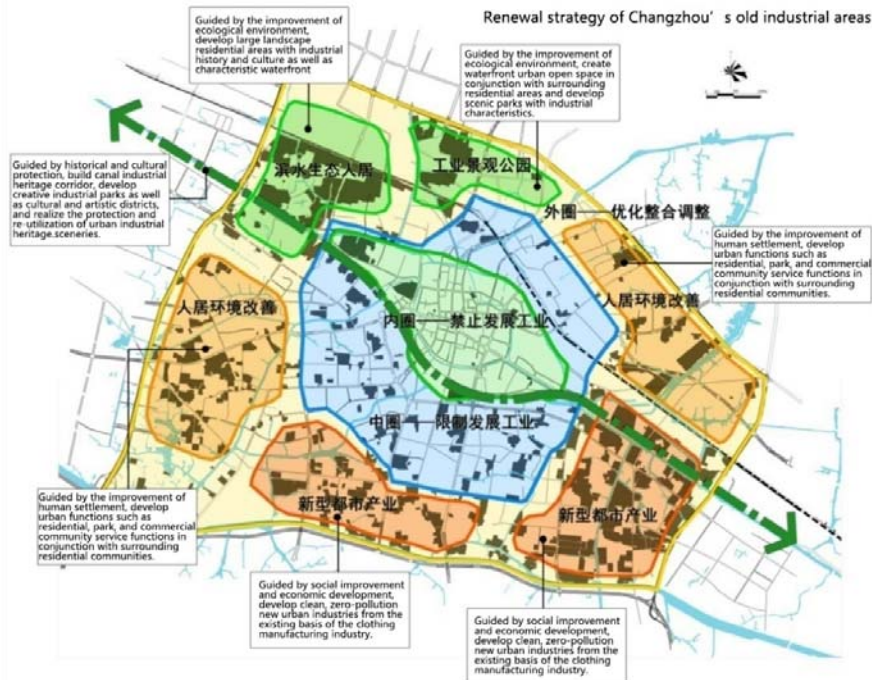

Fig. 2. Renewal strategy of Changzhou's old industrial areas

According to the integrated assessment of old industrial areas, the key area for industrial optimization, integration and adjustment is the outer ring, outside of the old city. Furthermore, it can be divided into six zones with different development directions, corresponding to the six industrial districts.

The northwest and north development districts are guided by the improvement of ecological environment. Presently, industrial pollution is serious in the northwest district. While engaging in ecological restoration, natural bodies of water can be used to develop large landscape residential areas with industrial history and culture characteristics. This method not only achieves the goal of remedying pollution, but also improves human settlement

as a landscape condition, rendering unique industrial landscape characteristics to the residential neighbourhood. Industrial pollution risks are relatively high in the north district at the moment, requiring microbial remediation and plant remediation technologies for pollution purification. Combined with the surrounding residential areas, we can create waterfront urban open space and develop large landscape parks with industrial characteristics.

The northeast and southwest development districts are directed by human settlement improvement. Industries in these two areas are small in size and scattered in distribution. Their functions can be transformed and upgraded to improve the environment of surrounding residential communities, for example, by building new residential buildings, completing infrastructure, and improving traffic conditions. Meanwhile, it can develop in conjunction with production and consumer services in the region, and can maintain and develop some urban industries, thereby forming high-quality residential communities and parks as well as a community-level commercial services functional zone.

The south and southeast development districts are guided by social improvement and economic development. Among these, the south district can rely on the existing advantageous electronic equipment manufacturing industry as a basis for integrating the peripheral related industrial categories and developing clean, zero-pollution new urban industries. The southeast district can use the existing clothing manufacturing industry as the basis and the industrial parks as the carrier for developing new urban industries, while developing industrial creative design centres in conjunction with large urban projects.

5. Conclusion

The focus of the study is to explore an assessment index system and assessment method for old industrial areas that has certain practical and guiding significance. Based on the integrated assessment of old industrial areas to determine the renewal direction and propose suitable renewal strategies specific to each old industrial area.

(1) Introduce relevant content of the integrated assessment system into the adjustment and renewal level of old industrial areas. During this process, attention is paid not only to the comprehensiveness of the assessment system covering aspects such as ecological, economic, cultural and regional benefits of old industrial areas, but also to the operability of the assessment system, that is, to ensure this system is suitable for most cities that are currently undergoing or plan to undergo the renewal of old industrial areas.

(2) Studied the integrated assessment methods for the renewal of old industrial areas. During this process, attention is paid to setting an assessment standard to ensure that every index has a corresponding assessment standard. Every assessment standard divides assessment objects into various levels and categories, with different scores assigned to each. Final assessment results are compiled to determine the renewal direction of old industrial areas.

(3) Connect assessment results with the renewal method for old industrial areas, thus enabling the entire integrated assessment to, directly guide the renewal strategy for old industrial areas and to propose situation-specific renewal strategies.

(4) As the renewal of old industrial areas is highly complex and involves many aspects of social life, the assessment system only covers the main aspects influential to the renewal process. It is lacking in its study of deep dynamic mechanism and relevant social factors in the renewal and transformation of old industrial areas. More in-depth research is needed.

References

[1] J.Q. Yang & M.W. Wu. Modern Urban Renewal [M]. 1999. Nanjing:Southeast University Press.

[2] J.G. Wang. The Protection and Renewal of Industrial Architecture Heritage in the Post-Industrial Age [M]. 2008. Beijing:China Building Industry Press.

[3] B.Y. Liu & K. Li. Initial Exploration of the Assessment Method for Beijing's Industrial Heritage [J]. 2008 (12). Journal of Architecture.

[4] Southeast University School of Architecture. Study on the Renewal Planning of Changzhou's Old City[A]. 2008.

[5] X.Y. Zhang /Shenyang old industrial base transformation research group. Investigation report on vega industrial zone in shenyang overall transformation [J]. 1993(65). China Industrial Economy:60-65. (In Chinese)

[6] B.C. Chen, Y.F. Zhang. Cultural value of Tiexi industrial zone in Shenyang [A]/ China surveying and mapping society. Building A well-off society in an all-round way: the history of Chinese science and technology workers responsibility - China association for science and technology in 2003 academic essays (bottom) [C]. 2003(2). Institute of surveying and mapping: in China. (In Chinese)

[7] J.G. Wang, F. Wei. Environmental benefits of "Micro climate shell" - some enlightenment from the renovation project of Germany Ruhr-nice moncef mining area [J]. 2003(12). Journal of architecture:63-66. (In Chinese)