Optimization of Industry City Integration Evaluation Based on Planning and Wuhan Practice

Pan Qisheng, Jiao Hongzan, Liu Xuejun, Zheng Zhenhua, He Hao, Wang Wenwen

Abstract: As one of the important issues in urban planning in China, the integration of industry and city has received widespread attention in academic research and planning practice. However, the existing research on the integration of industry and city is disconnected from planning practice, making it difficult to effectively integrate into planning and implementation. Based on the compilation needs of different levels of national spatial planning, propose a new approach for optimizing the evaluation of industry city integration combined with planning compilation; And for the two levels of zoning planning and control planning, an evaluation system for integrated production city units and control planning units will be constructed and applied to Wuhan Economic and Technological Development Zone. Research has found that the integration evaluation of industrial space, urban space, and human perception in the Economic Development Zone is not ideal, and the process of industry city integration lags behind. The main reason is that the existing evaluation guidance and control mechanisms have not been effectively implemented in planning practice. Research suggests that the evaluation of industry city integration requires in-depth planning and practice to serve the planning and adjustment process. Based on the evaluation results of the two spatial units, optimization suggestions are proposed for the zoning planning and control planning adjustment of the Economic Development Zone, providing strong support for its goal of integrated development of industry, city, and people.

Keywords: integration of industry and city; Evaluation optimization; Planning and preparation; Integrated production city unit; Control and regulation unit; Wuhan Economic and Technological Development Zone

The concept of industry city integration is closely related to the development and evolution of China's development zones. From the beginning of the reform and opening up to the 1990s, the concept of economic and technological development zones was first introduced and sprouted in coastal port cities. Between 1990 and 2000, the construction of development zones rapidly advanced, especially after the implementation of the tax sharing system in 1994, economic zones and development zones at all levels emerged like mushrooms after rain [1-2]. However, during this period, cities also faced problems of extensive expansion and inefficient development, resulting in lagging urbanization development, insufficient integration between development zones and cities, and the formation of isolated economic systems. Since the 12th Five Year Plan, government policies and academic research have gradually emphasized the importance of industry city integration, in order to solve the problems faced by development zones during the transformation and upgrading period, such as single functions, separation of work and housing, and insufficient supporting infrastructure. In 2015, the National Development and Reform Commission issued the "Guiding Opinions on the Construction and Management of Industry City Integration Demonstration Zones", and subsequently planned to build 58 demonstration zones. In 2016, the number of Chinese literature related to CNKI reached 235, and then increased at an average annual rate of 185. These fully reflect the recognition of the government and academia on the integration of industry and city as a key strategy for regional coordinated development. The establishment of an evaluation system for the integration of industry and city is the

foundation for achieving the development of industry city integration.

However, the comparison of existing literature reveals that there is a certain disconnect between the evaluation research and planning practice of the integration of production and city, manifested in the disconnection between evaluation methods and planning or implementation, and the evaluation system only focuses on a top-down professional perspective, ignoring the true feelings and needs of the core participants of the city - people.

Therefore, this study first clarifies that the integration of industry and city refers to the organic integration of industrial space, urban space, and human perception, which requires the construction of a top-down and bottom-up evaluation loop; Next, we will construct an optimization framework for evaluating the integration of industry and city based on planning, and take the two levels of zoning planning and control planning as examples to analyze the evaluation system for the corresponding integrated unit of industry and city and control planning unit. Finally, taking Wuhan Economic and Technological Development Zone (hereinafter referred to as "Economic Development Zone") as an example, a comprehensive evaluation is conducted to propose an industry city integration optimization strategy that serves planning and adjustment, and improves the adaptability and scientificity of the evaluation.

1 Overview of Research on Industry City Integration

The integration of industry and city has become a key concept for urban development and regional transformation in China, especially for the transformation and upgrading of development zones. According to data from China National Knowledge Infrastructure, research on the integration of industry and city has grown rapidly since 2010, and research hotspots have evolved over time. Before 2014, research mainly explored the connotation of industry city integration; After 2014, the focus shifted to the construction and application of evaluation systems. In recent years, with the increase of practical projects, the disconnect between the research on industry city integration evaluation and planning practice has become increasingly apparent. How to make industry city integration evaluation an "effective tool" to promote high-quality integration between industry and city has become a new research focus.

1.1 Connotation of Industry City Integration

The connotation of industry city integration includes two levels: broad and narrow. Broadly speaking, it refers to the integration of industrialization and urbanization in various aspects such as society, economy, culture, and industry; Narrowly defined, it focuses on the integration of industries and urban areas [2,6-8]. If divided from the time dimension, there are two stages: the initial focus is on "industry and city", with the core being spatial integration, structural coordination, and facility improvement [9-11]; Introduce the element of "human" in the later stage, emphasizing people-oriented, functional complexity, and demand matching. This study suggests that the integration of "people" in the integration of industry and city should not be limited to the theoretical assumptions of planners. The real users of the city should be given the right to speak, that is, the integration of "industry, city, and human perception", to ensure that human needs are effectively reflected.

1.2 Evaluation System and Optimization Strategies for Industry City Integration

The evaluation system for the integration of industry and city covers two aspects: evaluation methods and indicator selection. Due to differences in research perspectives and objectives, evaluation methods, dimensions, and sub indicators vary. Common methods include Analytic Hierarchy Process, Factor Analysis, Entropy Method, Grey Relational Analysis, Comprehensive

Weighting, and Four Quadrant Method [4,6,12-14]. The evaluation dimensions and indicators cover multiple aspects such as industrial development, urbanization level, urban functions, land use structure, policy support, population and spatial integration, and environmental protection [6, 12, 13]. Due to the varying availability of data, there is no unified standard for the number and selection of indicators.

Based on the evaluation results, research proposes optimization strategies for "industry, city, and people". At the industrial level, attention is paid to resource integration and land use control [15]; At the urban level, emphasis is placed on spatial structure, infrastructure support, ecological and cultural environment [11,16]; At the human level, emphasis is placed on humanism and diversity of needs [5,9]. In addition, the optimization strategy for the integration of industry and city should also consider regional characteristics and development stages to avoid the disorderly expansion of urban land and supporting facilities [17].

1.3 Current Problems in the Evaluation of Industry City Integration

There are currently two major problems in the research of industry city integration evaluation: the disconnect between the evaluation system and different levels of national spatial planning, and the separation of evaluation and planning practice, which leads to the inability to effectively integrate with planning formulation and implementation work.

Existing research mostly focuses on the selection and quantity of evaluation indicators, neglecting the structure, adaptability, and application of the evaluation system in planning and development. It is often limited to a single spatial level of evaluation and is not combined with the multi-level objectives and scales of national spatial planning [18]. In addition, evaluation research has remained at the theoretical guidance stage and has not been transformed into practical planning strategies [19], resulting in difficulties in effectively implementing evaluation systems and indicators.

This study suggests that the evaluation and optimization of the integration of industry and city should reflect the guiding role in planning formulation, and be combined with the national planning process and key control content to propose evaluation and spatial optimization strategies that are conducive to planning practice [20]. Strategic optimization strategies can be proposed in conjunction with the overall planning or zoning planning, such as strengthening the optimization of regional industrial structure; Adopting a diversified land use strategy to promote work residence balance; And promote the balanced distribution of public service facilities and infrastructure. Specific control measures, including road traffic, land use, population distribution, employment distribution, and intensity zoning, can also be proposed in conjunction with the indicators formulated for regulatory planning.

2. Evaluation ideas for the integration of industry and city based on planning and development

2.1 Evaluation Approach

2.1.1 Three evaluation dimensions of industry, city, and human perception

The evaluation of the integration of industry and city is mostly based on the professional perspective of planners, and quantitative comparisons of indicators are conducted from top to bottom, often ignoring the actual feelings and real needs of the core participants of the city - people. This study suggests that evaluating the integration of industry and city should not be limited to quantitative indicators, but should focus on residents' satisfaction with urban life and work. Therefore, in addition to evaluating the basic elements of industry and urban space, this study also includes a bottom-up resident satisfaction questionnaire survey for comprehensive

evaluation.

Finally, the study identified three evaluation dimensions: industrial spatial integration, urban spatial integration, and human perception integration. The integration of industrial space emphasizes economic benefits and innovation capabilities; Urban spatial integration focuses on land use, ecology, transportation, and facility construction; The integration of human perception refers to the results of a questionnaire survey, reflecting the diverse needs of residents, emphasizing employment balance, commuting convenience, and mixed community functions.

2.1.2 Evaluation Framework System

The evaluation of industry city integration should be closely linked with the formulation of national spatial planning. Firstly, it needs to be combined with the planning hierarchy; Secondly, clarify which staffing levels require evaluation of industry city integration; Once again, determine appropriate evaluation units based on the spatial scale of the evaluation hierarchy; Finally, based on the understanding of the connotation of industry city integration, appropriate evaluation dimensions are selected for comprehensive evaluation. Refer to Figure 1.

Planning practice has shown that the issue of industry city integration is more common in urban industrial new areas, such as the far urban areas or new urban areas of mega cities and super large cities, as well as new industrial areas of large and medium-sized cities. In the preparation of national spatial planning, there are two levels of zoning planning corresponding to super large, super large, and large cities, as well as detailed control planning for all cities. Therefore, this study focuses on exploring new ideas for optimizing the evaluation of industry city integration at the level of zoning and regulatory planning.

The basic spatial units for evaluating the integration of industry and city at the zoning level and control planning level are the integrated unit of industry and city and the control planning unit, respectively. At different unit scales, evaluate the current situation in three dimensions: industrial space, urban space, and human perception. Based on the evaluation results, propose planning suggestions and feedback them to the formulation or adjustment of control detailed planning, zoning planning, and overall planning, forming new planning schemes. If necessary, secondary evaluation or multi scheme evaluation simulation can be conducted after adjusting the regulations to obtain planning optimization schemes guided by the integration evaluation of industry and city.

2.2 Evaluation System for Industry City Integration at the Level of Zoning Planning

2.2.1 Define the integrated unit of industry and city

The evaluation of the integration of industry and city at the zoning planning level is based on the integrated unit of industry and city, which is generally determined by the scale of work residence balance and commuting efficiency [22]. Based on relevant research and practices in cities such as Chengdu, Shanghai, and Guangzhou [10,22], the scale of the integrated production city unit should be 20-30 km ², serving a population of 200000 to 300000. In terms of commuting efficiency, the commuting distance in the unit should be less than the average commuting distance in the study area [23]. In foreign studies, the commuting distance is usually 3-10 miles (4.8-16.9 km) [24,25]. The 2012 China New Urbanization Report issued by the Chinese Academy of Sciences proposed that the commuting distance is about 5-12 km [9]. Therefore, the commuting distance of the integrated production city unit should be controlled within 5-12 km, with a maximum of 17 km.

The scope of this study includes Dunkou Street, Shamao Street, and some Junshan Street in

Wuhan Economic Development Zone, with a current population of approximately 357000 people, expected to increase to 960000 people by 2035. Based on the suggestions of administrative divisions and planning departments, the research area will be divided into four integrated production and urban units: Zhuankou, Junshan West, Junshan East, and Shamao.

2.2.2 Evaluation indicators for integrated production city units

This study uses the Analytic Hierarchy Process to evaluate the degree of integration between industry and city, dividing it into target layer, criterion layer, and indicator layer. At the target level, based on the three elements of "industry, city, and people", three major goals have been established: industrial spatial integration, urban spatial integration, and human perception integration. Industrial spatial integration focuses on the "quantity" of industrial output and the "quality" of transformation and upgrading; Urban spatial integration involves four basic elements: land use, ecological environment, transportation system, and infrastructure; The fusion of human perception is combined with satisfaction surveys, focusing on three criteria: balanced employment, convenient commuting, and mixed functions. See Figure 2.

This evaluation system combines the rational evaluation of planners from top to bottom with the intuitive evaluation of urban users (residents, employees, enterprises, etc.) from bottom to top, forming a complete evaluation loop

2.3 Evaluation System for Industry City Integration at the Level of Controlled Detailed Planning

2.3.1 Defining the Integration of Industry and City Control Units

This study further refines the integrated unit of industry and city, and proposes an integrated control and planning unit that serves the preparation of control and planning. The scale of this unit refers to the 15 minute community living circle and the travel radius of people, combined with boundary factors such as administrative divisions, urban roads, rivers, and mountains, covering an area of about 3-4 km ^{2} (equivalent to a walking distance of about 1 km in 15 minutes). In Wuhan Economic Development Zone, the four integrated production city units are subdivided into 51 integrated production city control and planning units. Each unit is divided into five categories based on land use ratio and supporting facilities: industrial production, residential life, commercial services, urban recreation, and education and research (industrial production unit: industrial land area/residential land area>3, or only industrial land; residential life unit: residential land area/industrial land area>1, or only residential land, and public service facility land ratio>5%; commercial service unit: commercial service facility land ratio>20%; urban recreation unit: green space and square land ratio>20%; education and research unit: education and research land ratio>60%).

2.3.2 Evaluation indicators for regulatory units

Given the small scale of regulatory units, it is not realistic to control macro industrial indicators. Therefore, evaluation indicators focus more on "urban space and human perception", with a focus on ecology, transportation, and facility support. At the same time, referring to the residents' concern about the walkability of service facilities within the 15 minute community living circle in the questionnaire survey, this evaluation criterion is added to the "human perception" evaluation. See Figure 3.

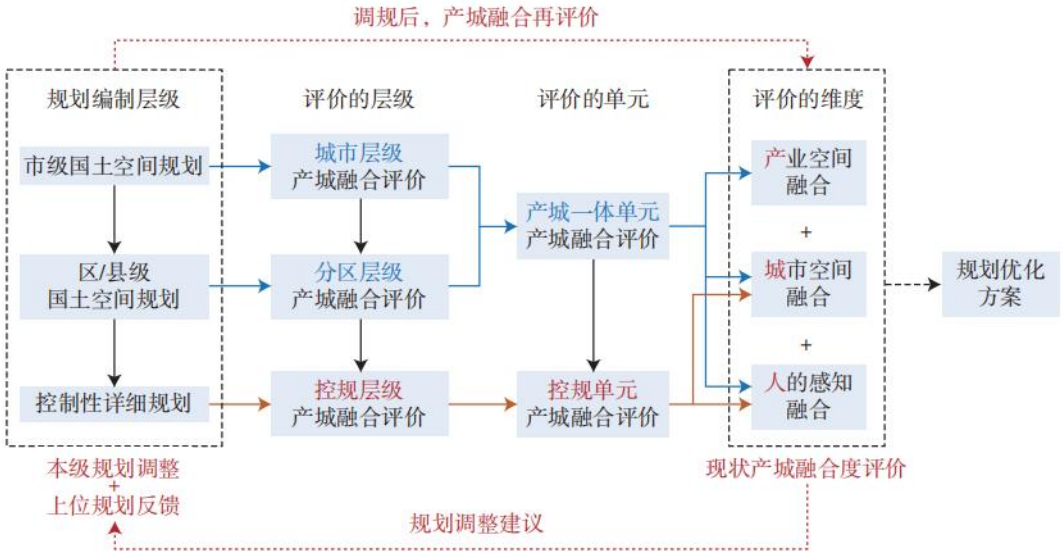

Fig.1 Evaluation framework for city-industry integration aligned with plan comp

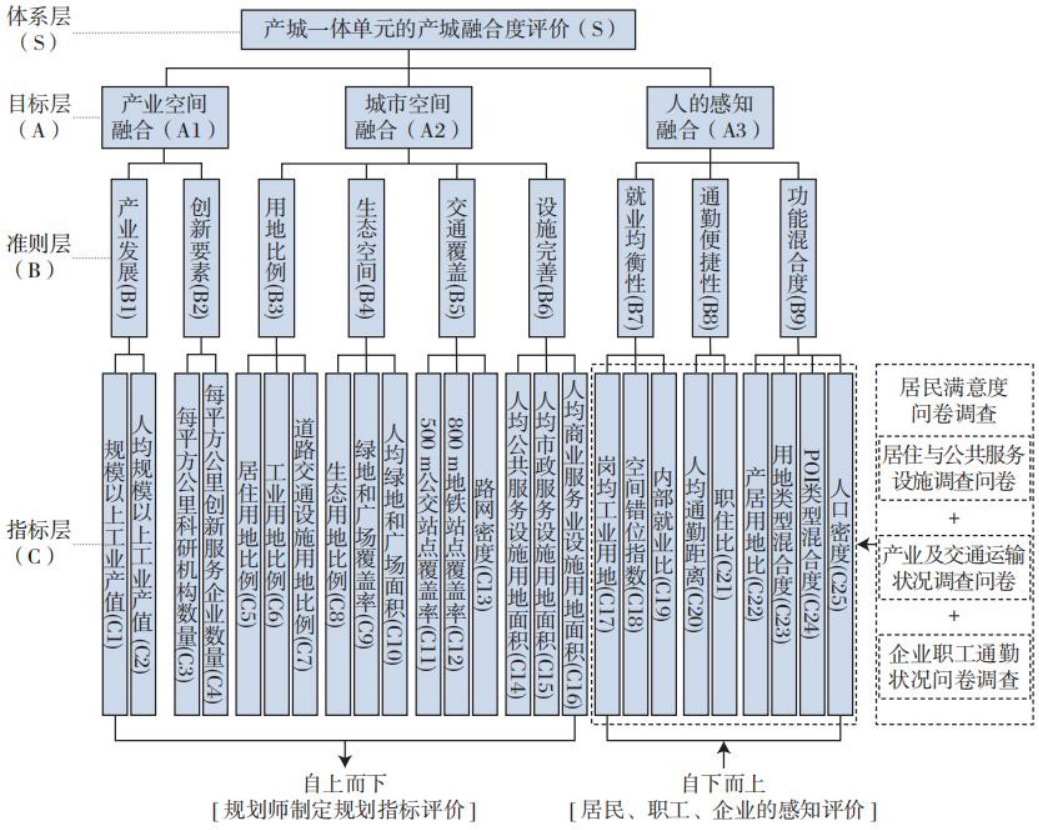

Fig.2 Evaluation system for industry-city integration units

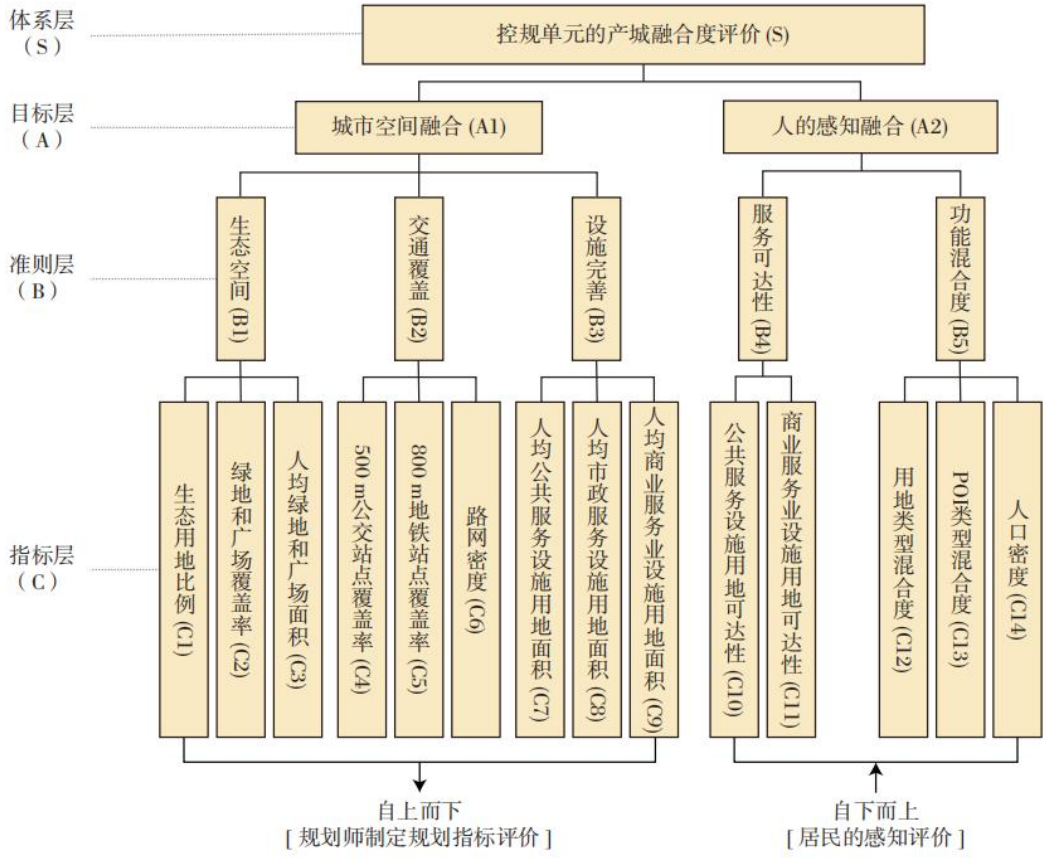

Fig.3 Evaluation system of industry-city integration for regulatory detailed planning units

3 Comprehensive evaluation of the integration of industry and city in Wuhan Economic Development Zone

3.1 Zoning planning hierarchy - evaluation of industry city integration of integrated units

3.1.1 Evaluation of Industrial Space Integration

In the evaluation of industrial spatial integration, the Zhuankou unit leads in industrial development and innovation factors, ranking first in terms of total scale, per capita, and per capita indicators. Although the hat unit has advantages in industrial land and population size, its per capita industrial output value ranks last. However, the performance of the Shandong and Western military units in terms of industry and innovation is relatively weak.

3.1.2 Evaluation of Urban Spatial Integration

The four integrated production city units exhibit different performances in the four dimensions of urban spatial integration (Table 1). In terms of land use ratio, based on the "Standard for Urban Land Classification and Planning Construction Land" (GB 50137-2011) (hereinafter referred to as the "Standard"), the residential land ratio of each unit has not met the standard requirements; In terms of industrial land, the proportion of land used by the Shandong military unit is too low; Among the land for road traffic facilities, only the Dunkou unit meets the basic requirements. The overall land use structure of the four units is not ideal.

In the evaluation of ecological space, the Junshan East unit performed well due to its good natural ecological conditions and low population size, but the green space and square coverage of the four units did not meet the standards, and the per capita green space and square area of

the Shamao unit were even insufficient.

In terms of transportation coverage, the Dunkou unit leads in all indicators and is the only unit currently accessible by subway; In contrast, the traffic conditions of the hat unit are poor and there are obvious shortcomings. The road network density is only over 8 km/km ² for the Dunkou unit, and only 3.54 km/km ² for the Shamao unit.

In the evaluation of facility completeness, the per capita facility land area in Junshan West and Junshan East is relatively high, while the silk hat unit is at the lowest level. Overall, the hat unit is at a disadvantage in the evaluation of urban spatial integration and needs significant improvement, while the other three units have their own strengths and weaknesses in different evaluation dimensions.

	用地比例			生态空间			交通覆盖			设施完善		
	居住用地比例(C5)	工业用地比例(C6)	道路交通设施用地比例(C7)	生态用地比例(C8)	绿地和广场覆盖率(C9)	人均绿地和广场面积(C10)	500m公交站点覆盖率(C11)	800m轨道交通站点覆盖率(C12)	路网密度(C13)	人均公共服务设施用地面积(C14)	人均市政服务设施用地面积(C15)	人均商业服务业设施用地面积(C16)
沌口单元	0.15	0.23	0.12	0.28	0.05	11.57	0.68	0.16	8.60	15.95	2.46	13.37
军山西单元	0.09	0.26	0.07	0.44	0.03	60.04	0.55	0.00	6.78	40.83	28.23	26.00
军山东单元	0.15	0.01	0.03	0.53	0.02	45.31	0.30	0.00	6.40	40.07	14.46	170.41
纱帽单元	0.15	0.18	0.05	0.50	0.02	8.15	0.21	0.00	3.54	11.01	1.89	2.22
合理值	0.25–0.4	0.15–0.3	0.1–0.25	—	≥0.1	≥10	——	——	——	——	——	——

Tab.1 Evaluation indicators for urban spatial integration

3.1.3 Perception Fusion Evaluation of Individuals

In the evaluation of human perception fusion (Table 2), the hat unit performs excellently in terms of employment balance and commuting convenience. However, the average industrial land per post in all four units far exceeds the reasonable range, indicating that the utilization rate of industrial land needs to be improved. The matching degree between residential and employment in Junshan East and Junshan West units is poor, with unsatisfactory spatial displacement index and internal employment ratio. In terms of commuting convenience, the average commuting distance per person in all four units is less than 4 km (Euclidean distance, about 5.4 km after excluding mobile signaling data from the same base station for residence and work), which is lower than the average travel distance in Wuhan city (8.3 km). However, from the data of work to residence ratio, there is a significant imbalance between work and residence in Junshan West and Junshan East.

In the evaluation of functional mix, the land use type mix and population density of the Zhuankou unit are the highest; The land use ratio for the production and residence of the hat unit is the only reasonable one, but the POI type mix is relatively low; The military Shandong unit has a high degree of POI type mixing, but the lack of industrial land and population leads to unsatisfactory other indicators; The proportion of residential land in the military Shanxi unit is relatively low, and the ratio of production to residential land exceeds the reasonable value by about one time.

3.1.4 Comprehensive evaluation of industry city integration at the zoning planning level

Taking into account the integration evaluation of industrial space, urban space, and human perception (Figure 4), the degree of integration between industry and city in the four integrated units is divided into four categories: highly integrated (85-100), well integrated (70-85), generally integrated (60-70), and lacking integrated (0-60). Overall, the degree of integration between industry and city is not ideal, with only the chaotic mouth unit (71.82) achieving a good integration type, while the other three units are all lacking in integration type.

3.2 Control detailed planning hierarchy - evaluation of industry city integration of control planning units

3.2.1 Evaluation of Urban Spatial Integration

In the evaluation of ecological space, the control and planning units with a high proportion of ecological land are mainly concentrated in Junshan East and Shamao, with some units accounting for more than 65%. The high proportion of green space and square land in Zhuankou reflects its relatively complete urban construction and supporting facilities. The per capita green space and square land area are greatly affected by population, with high-value distribution in all four units.

The evaluation of traffic coverage shows that the high coverage and road network density of 500m bus stops and 800m subway stops are mainly distributed in Zhuankou, which is consistent with the evaluation results of the integrated unit of industry and city, demonstrating its transportation advantages. In addition, although Shamao has the second highest population density, its road network density is relatively low and urgently needs improvement.

The evaluation of facility completeness covers three per capita facility indicators. The evaluation results of various control units in military mountains with lower population are higher. If comparing the types of regulatory units, it is found that the per capita land use for public and commercial service facilities in industrial production units is generally low. High value per capita public service facility land is often located near areas with good ecological conditions, while the per capita commercial service facility land area for commercial services and residential living units is relatively high.

	就业均衡性			通勤便捷性		功能混合度			
	岗均工业用地 / (m^2/人) (C17)	空间错位指数 (C18)	内部就业比 (C19)	人均通勤距离/ m (C20)	职住比 (C21)	产居用地比 (C22)	用地类型混合度(C23)	POI类型混合度 (C24)	人口密度/ (人/km^2) (C25)
沌口单元	292.99	0.43	0.84	3531.65	1.30	1.60	1.73	0.95	3973.13
军山西单元	1140.20	0.62	0.57	3370.45	2.18	2.80	1.28	1.00	480.76
军山东单元	327.91	0.68	0.66	3731.56	1.72	0.06	1.13	1.16	448.89
纱帽单元	154.96	0.22	0.86	3253.43	1.16	1.21	1.27	0.81	2211.26
合理值/最佳值	39.97–79.94	0	1.00	3000.00	0.8–1.2	1.0–1.5	——	——	——

Tab.2 Evaluation indicators for human perception integration

3.2.2 Perception Fusion Evaluation of Individuals

The evaluation of service accessibility shows that high-value units of public service facility land accessibility are mainly located in the southern part of Junshan and Dunkou, while

high-value units of commercial service facility land accessibility are concentrated in the eastern part of Junshan. The overall accessibility of facilities for the hats is relatively weak, especially in the southern region. The evaluation of functional mix reveals that the high-value units of POI type and land use nature mix are not completely consistent, that is, a high mix of land use types does not necessarily mean that the mix of POI types is also high, and vice versa. The areas with high population density are concentrated in the middle of Zhuankou and Shamao, while the population density of various control units in Junshan is generally lower.

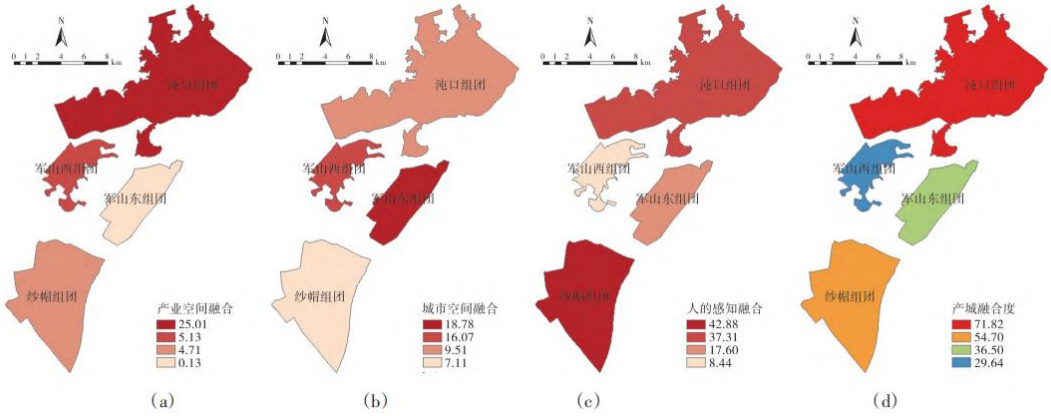

Fig.4 Comprehensive evaluation of industry-city integration at the district planning level

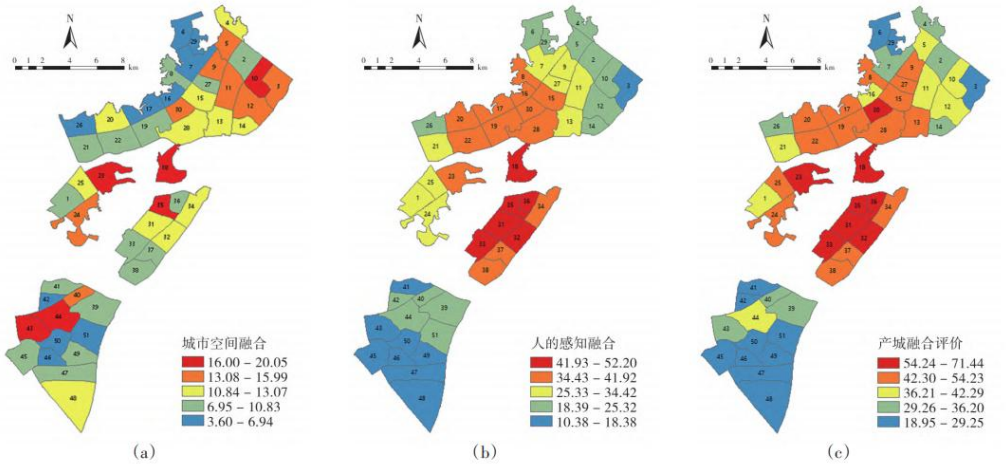

Fig.5 Comprehensive evaluation of industry-city integration at the regulatory detailed planning level

3.2.3 Comprehensive evaluation of industry city integration at the regulatory level

In the evaluation of urban spatial integration at the regulatory level (Figure 5), although the evaluation values of regulatory units did not show significant clustering, lower values are usually concentrated in certain residential and living units in Shamao and Zhuankou. In contrast, human perception fusion evaluation shows a clustering phenomenon, with high values mainly concentrated in the eastern part of Junshan and the southern part of Dunkou, while low values are concentrated in the hat unit. In the comprehensive evaluation of industry city integration, only 4 units belong to the general integration type (with an industry city integration degree exceeding 60, units 31/32/18/35), and the remaining 47 are lacking in integration type, indicating

the industry city integration in the study area.The level of integration needs to be improved.

4 Adjustment of planning formulation based on the evaluation of industry city integration in Wuhan Economic Development Zone

This study effectively integrates the evaluation results of the integration of industry and city in Wuhan Economic Development Zone into the planning practice of Wuhan. At the level of zoning planning, the evaluation results of the integrated production city unit have been integrated into the "Wuhan Economic and Technological Development Zone Spatial Planning (Preliminary Plan)" (referred to as the "Spatial Planning"), which is used to optimize development strategies and land layout. At the level of detailed control planning, as the new round of national spatial planning in the Economic Development Zone is currently in the preparation stage, the planning management department will adjust the existing control planning according to actual needs. The evaluation results of the integration of industry and city at the control planning level in this study will be directly applied to the control planning adjustment work of relevant land parcels.

4.1 Evaluation Results of Integrated Production City Units and Suggestions for Zoning Planning

4.1.1 Reduce the proportion of inefficient and scattered industrial land, optimize the layout of industrial parks, and promote the construction of M0 new industrial land

Some industrial land in the Economic Development Zone has problems of extensive development and low production efficiency, manifested as a high proportion of industrial land (except for Junshan East), exceeding the standard of industrial land per post, and a mismatch between industrial land and the number of posts. The optimization strategy includes two aspects: one is to integrate inefficient and scattered industrial parks and promote key industries

Cluster construction. The "Spatial Planning" will adjust the existing industrial land and build six major industrial clusters, including the upgrading zone of traditional industries in Zhuankou, the emerging industry cluster zone in Junshan, and the new material industry cluster zone in Shamao [Figure 6 (a)], to support the "3335" modern industrial system. The second is to adopt the "cage for bird" strategy in areas where land integration is difficult, converting some industrial land into new industrial land (M0), increasing innovative industrial functions such as research and development, creativity, and design, and tapping into the potential of existing industrial land.

4.1.2 Seize the strategic opportunity, adjust the industrial structure through "optimizing the second and advancing the third", and increase the number of scientific research institutions and innovative enterprises

In the Economic Development Zone, the density of research institutions in the Zhuankou unit is relatively high, about three times the total of the other three units, but the number of innovative service enterprises is insufficient. Other units need to be strengthened in terms of research institutions and innovative service enterprises, with densities below 7/km ^{2} and 0.2/km ^{2}, respectively.

Taking advantage of the opportunities presented by higher-level plans such as the 14th Five Year Plan and the 2035 General Plan, the Economic Development Zone should adjust its industrial structure and enhance its scientific research and innovation capabilities in conjunction with industrial transformation strategies such as "optimizing the second and entering the third". The "Spatial Planning" proposes that the "Chegu Central City" should focus on incremental development, with a focus on core functions such as smart innovation and scientific research and development. Taking advantage of the opportunity of "building the Chegu Industrial Innovation

Corridor", it should develop high-end industries such as new energy and intelligent connected vehicles. As a sub center of the city, Junshan Unit should rely on the "Chegu Central City" strategy to plan high-end service core areas and innovation and entrepreneurship areas, aiming to increase technology-based enterprises and innovative service enterprises.

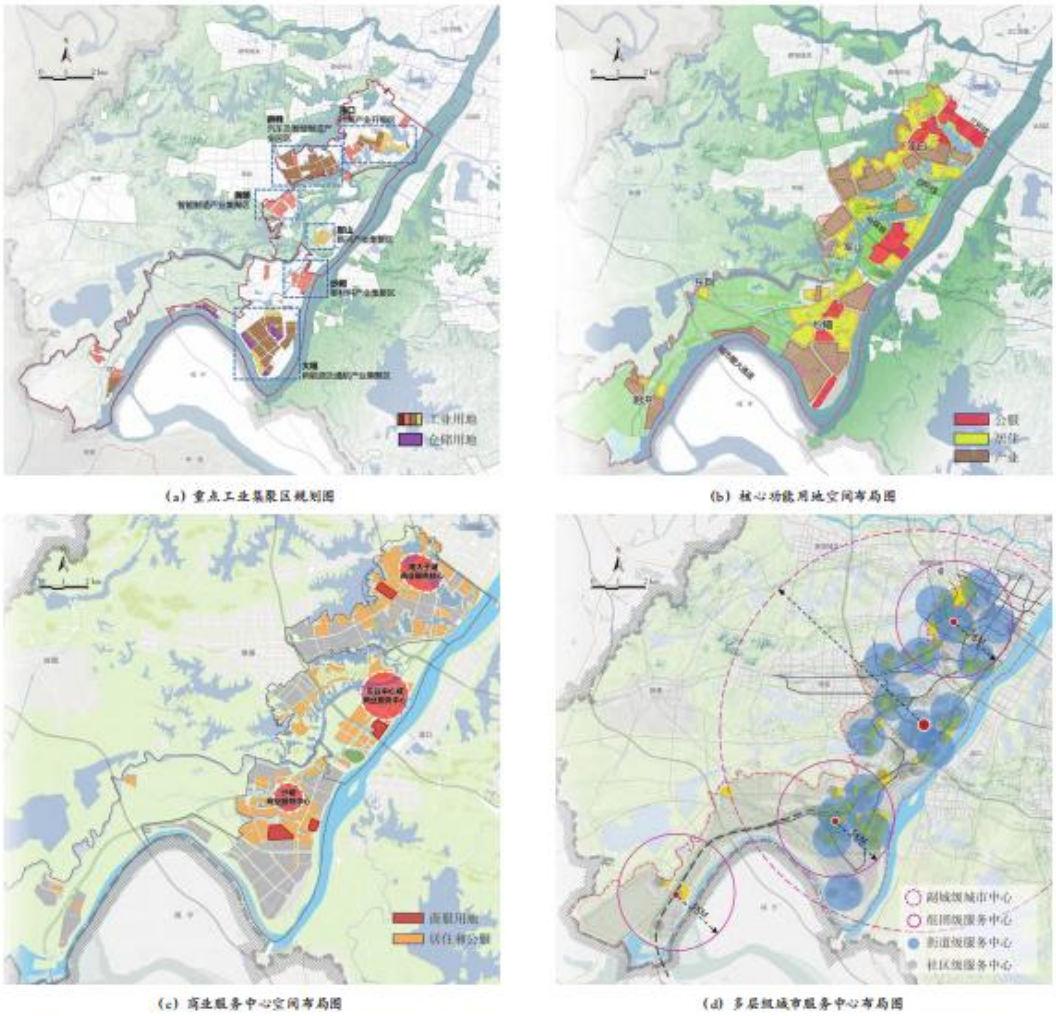

Fig.6 Partial illustration of the Preliminary Spatial Plan for Wuhan Economic and Technological Development Zone

4.1.3 Adjusting land use structure to increase employment balance

The land use structure in the Economic Development Zone is unbalanced, presenting a situation of "one high and two low" where industrial land is too high and residential and road transportation facilities are insufficient. Although the proportion of industrial land mostly complies with the "Standard" (except for Military Shandong), from the perspective of functional land balance, its proportion is relatively high.

The spatial planning adjusts the land layout of the four integrated production and city units, reducing industrial land and increasing residential and public service land, emphasizing balanced layout; Build a fully functional residential community, improve convenient services, complete basic facilities, and enrich public spaces. We plan to provide diversified residential products, including international communities, quality housing, talent apartments, and rental housing, to meet the needs of different groups of people and ensure that talents can "enter and stay" [Figure

6 (b)].

4.1.4 Improve the coverage of green spaces and square facilities, and increase the land area for service facilities

The four integrated production and city units in the Economic Development Zone exhibit varying degrees of facility completeness. In terms of ecological facilities, although the proportion of ecological land is relatively high, the coverage of green spaces and squares has not reached the standard, which is about half of the reasonable value. Among the per capita green space and square area, the gauze hat unit did not meet the standard, and the chaotic mouth was slightly higher than the "standard". Therefore, it is necessary to strengthen the construction of green spaces and square facilities while maintaining the proportion of ecological land. In terms of land for service facilities, Dunkou needs to increase the land for municipal service facilities, Junshan West needs to increase the land for municipal and commercial service facilities, Junshan East needs to increase the land for municipal service facilities, and Shamao needs to increase the land for public services, municipal services, and commercial service facilities at the same time.

The "Spatial Planning" proposes to improve the level of commercial services, including the planning of the South Taizi Lake Commercial and Service Agglomeration Area in Zhuankou, the Military Shandong Municipal Commercial Service Center, and the Shamao Commercial and Cultural Tourism Comprehensive Service Center [Figure 6 (c)]. In addition, the plan will establish a cultural, educational, and health service system at four levels: sub city level, group level, street level, and community level, covering basic education, medical services, and high-level fitness facilities [Figure 6 (d)].

In terms of ecological protection, the Spatial Planning focuses on the use of natural resources such as the mudflat and woodlands of the Yangtze River, strengthening water governance and ecological restoration, regulating river and lake shorelines, and creating urban ecological habitats of the Yangtze River. Plan the Tongshun River urban ecological green corridor, combining it with lake chain wetlands such as Zhushan, Wanjia Lake, Nantaizi Lake, Zhongshan Lake, and Dajunshan, to construct an ecological spatial framework of river lake harmony and urban water symbiosis.

In addition, the "Spatial Planning" proposes the construction of the Dunkou Jiangtan Cultural Park, Xiaojunshan Smart Technology Theme Park, Dajunshan Natural Park, and Shamao Jiangtan Park, etc., to build a multi-level urban park system, showcase natural ecology, modern industrial culture, and the history of the old city, and enhance the public functions of the riverside.

4.2 Evaluation Results of Control and Regulation Units and Suggestions for Control and Regulation Adjustment

In 2023, the Wuhan Municipal Government launched the "Urban Renewal Year" campaign, particularly promoting the "retreat of two industries into three" and urban renewal work within the Fourth Ring Road of Wuhan Economic Development Zone. In order to optimize land use and enhance the urban functions and landscape image along Dongfeng Avenue, the Natural Resources and Planning Bureau of the Economic Development Zone plans to prioritize industrial transformation and urban renewal in areas with mature conditions, and initiate local land use control and planning modification work.

The proposed regulation area is located within the area enclosed by roads such as the Fourth Ring Road, Dongfeng Avenue, and Checheng Avenue, with a total area of approximately 75.96 hectares. Currently, it is mainly used for industrial and road transportation purposes [Figure

7 (a)]. According to the "Research on the System and Use Control of Main Functional Zones in Wuhan City" (draft for comments), this area is located in the Da Peninsula Living Unit of the Zhuankou Living Area, and its main function is residential living.

The land belongs to the 16th regulatory evaluation unit, and the evaluation results show a lack of integration. The scores for indicators such as ecological land proportion, green space and square coverage, per capita green space and square area, per capita land area for three types of service facilities, accessibility of commercial service facility land, and land type mix are all relatively low. Based on the evaluation results and higher-level planning, it is recommended to optimize the living functions, improve the quality of the industry, and shape the image along Dongfeng Avenue. The plan involves relocating second-class industrial land, optimizing the layout of commercial land, adjusting the northern public service land to the central area, and improving accessibility and land use mix. Increase residential land, improve public service facilities and green space. Consider supplementing the land for educational facilities such as primary and junior high schools based on the size of the service population and the enrollment needs of eligible children. According to the requirements of the 15 minute living circle, public spaces and supporting facilities such as culture, medical care, fitness, and elderly services will be set up. After adjustment, the integration of industry and city on the land will be significantly improved [Figure 7 (b)].

(a) 调整前控规一张图　　(b) 调整后控规一张图

Fig.7 "One Drawing" of regulatory detailed planning

5 Conclusion

This study proposes a new approach to optimizing the evaluation of the integration of industry and city based on planning, which supplements and improves the existing evaluation research mainly based on the integration of industry and city units, and explores a new path to integrate the concept and methods of industry city integration into different levels of national spatial planning. This study takes an open stance in the selection of evaluation indicators, not limited to their completeness and uniqueness. Different studies may have differences in the selection of evaluation indicators due to different perspectives, goals, regions, and data availability. However, different indicator systems should ultimately serve the planning and implementation.

Future evaluation research should emphasize the consistency between evaluation indicators and planning objectives, and value the interaction and adaptability between evaluation results and planning formulation. Especially to integrate the perception and evaluation of urban users - people, in order to deepen the integration of the concept and practice of industry city integration. At the same time, the evaluation of industry city integration should be developed into a dynamically adjustable system, establishing a cyclic feedback mechanism of "current situation evaluation - preparation adjustment - monitoring feedback - re evaluation", and enhancing the forward-looking and scientific nature of planning through data analysis and model simulation, ensuring that industry city integration becomes a "practical tool" to promote urban sustainable development.

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