Planning Path of Coordinated Development of Residential Building Design and Industrial Park Driven by Multi-dimensional Demand

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Abstract: Facing the problems of spatial separation and resource mismatch between residential buildings and industrial parks under the traditional planning mode, this article systematically analyzes the driving mechanism of multi-dimensional demand such as economy, society and environment for spatial coordination from the perspective of demand adaptation. By constructing a collaborative development framework including target system, spatial strategy, time sequence strategy and governance strategy, this article puts forward an evaluation index oriented to "inclusive development", a spatial reorganization model with "functional mixing" as the core, a time sequence coordination mechanism with "dynamic balance" as the key, and a governance innovation path with multi-party participation. Research shows that demand-adaptive collaborative planning can shorten commuting time by 20%-30%, improve the utilization rate of public service facilities by more than 15%, and reduce the intensity of carbon emissions. This study provides support and reference for solving the dilemma of "separation of production and city", and emphasizes that planning needs to change from "static control" to "dynamic response" to meet the new requirements of high-quality urbanization development.

1. Introduction

At present, the urbanization process in China has shifted from "scale expansion" to "quality improvement", and the urban spatial structure is undergoing profound changes [1]. However, the spatial separation between residential buildings and industrial parks is still prominent under the traditional planning mode. Industrial parks are often oriented to a single production function, with insufficient supporting living space or low quality, which leads to long-distance commuting, traffic congestion and a sharp increase in carbon emissions caused by the separation of occupation and residence. Due to the lack of industrial support, residential communities have gradually become "sleeping cities", lacking economic vitality at night and low utilization rate of community service facilities [2]. This separation of functions leads to waste of resources, which runs counter to the pursuit of a livable and suitable environment under the concept of "people's city".

From the demand side, the demands of urban development subjects (residents, enterprises and governments) have undergone structural changes [3]. Residents are no longer satisfied with "having a house to live in", but pursuing high-quality living space with convenient commuting, complete facilities and pleasant environment. Enterprises need a low-cost, high-efficiency industrial environment, and at the same time pay attention to the life satisfaction of employees to reduce the risk of brain drain. On the other hand, the government is faced with multiple challenges of land resource constraints, financial pressure and people's livelihood demands, and it is urgent to improve the comprehensive benefits of the city through spatial integration [4]. The existing planning system still takes "functional zoning" as the underlying logic, and the dynamic response ability to diverse needs is insufficient, which leads to the dilemma cycle of "separation in planning, disconnection in construction and contradiction after use" between residential and industrial space [5]. Traditional planning theory focuses on single function optimization, but pays little attention to function compounding and system coordination. Although the concepts of "integration of production and city" and "job-residence balance" have been widely discussed, there is a lack of in-depth analysis of

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demand-driven mechanism and an operable planning framework [6]. Especially in the background of digital economy and low-carbon transformation, industrial form and living mode are accelerating iteration, and how to realize the dynamic adaptation between them through planning means has become a theoretical proposition to be solved urgently.

Taking "multi-dimensional demand" as the breakthrough point, this study aims to break through the traditional functionalist planning thinking and build a theoretical system for the coordinated development of residential buildings and industrial parks. By deconstructing the demand dynamics of economy, society, environment, culture, technology and other dimensions, this article reveals the mechanism of demand change on spatial coordination, and then puts forward the planning path to meet the development requirements of the new era. This study is helpful to optimize the allocation of urban spatial resources, and is of great significance to promote the transformation of urban planning paradigm and realize the goal of "Better City, Better Life".

2. Demand deconstruction: the core power system to drive coordinated development

The coordinated development of residential buildings and industrial parks is essentially the projection and response of multi-dimensional demand in space [7]. These demands include both explicit material demands and implicit value pursuits, which together constitute the core power system that drives synergy. In the economic dimension, industrial upgrading puts forward higher requirements for housing facilities. The development of high-end manufacturing industry and modern service industry needs to attract high-quality talents, and the sensitivity of such people to living quality, commercial services and cultural facilities has been significantly improved [8]. If there is a lack of high-quality residential space around the industrial park, enterprises will face difficulties in attracting talents and rising operating costs, which will force the spatial integration of residential functions and industrial functions. In the social dimension, the needs of different groups of people for "job-residence balance" show differentiated characteristics. Young practitioners prefer short commuting and social vitality, while family groups pay more attention to the accessibility of education and medical resources. The elderly need a quiet living environment and convenient community services [9]. Planning needs to balance multiple demands and avoid marginalization of specific groups due to single function. Under the environmental dimension, ecological constraints and resource recycling have become the rigid requirements for coordinated development. Industrial activities are related to energy consumption and waste discharge in residential life in time and space. The spatial mixed layout can shorten the service radius of supporting facilities, reduce the cost of repeated infrastructure construction, promote the sharing and utilization of renewable energy, and maximize environmental benefits.

Cultural and technical dimensions promote synergy from the level of spiritual identity and tool support. The expression of regional cultural characteristics in space can enhance residents' sense of belonging, while intelligent means can provide technical support for functional compounding, making planning more forward-looking and adaptable.

3. Contradictory analysis: the coordination obstacles and mechanism defects of the traditional planning model

The traditional planning model takes "functional zoning" as the core logic, and realizes the standardized management of urban construction by defining land use and delineating spatial boundaries. In response to the demand for coordinated development of residential buildings and industrial parks, this model gradually exposes multiple contradictions such as spatial separation, time sequence dislocation, institutional conflict and cognitive deviation, which has become a key obstacle to system coordination.

3.1 Spatial contradiction: the dilemma of "separation of occupation and residence" caused by functional zoning

In traditional planning, residential and industrial functions are strictly separated, and spatial

control is realized through the circular layout of "industrial land-residential land-commercial land". This model effectively avoided the interference of industrial pollution on the living environment in the early stage of industrialization, but with the transformation of industrial form from labor-intensive to technology-intensive, its disadvantages became increasingly prominent. In order to control costs, industrial parks are often located on the edge of cities or traffic nodes, and a large number of employees are forced to commute long distances because of the lag in development timing or insufficient planning of supporting residential land. According to the Monitoring Report on Commuting in Major Cities of China, in 2022, the one-way commuting time of over 10 million urban residents exceeded 45 minutes, among which the imbalance of job-residence ratio around industrial parks was one of the main reasons. Due to the lack of industrial support, the residential community has gradually evolved into a "tidal" space: population outflow during the day, business is deserted, and public service facilities are overloaded after the return at night, resulting in inefficient allocation of resources in time and space (see Figure 1).

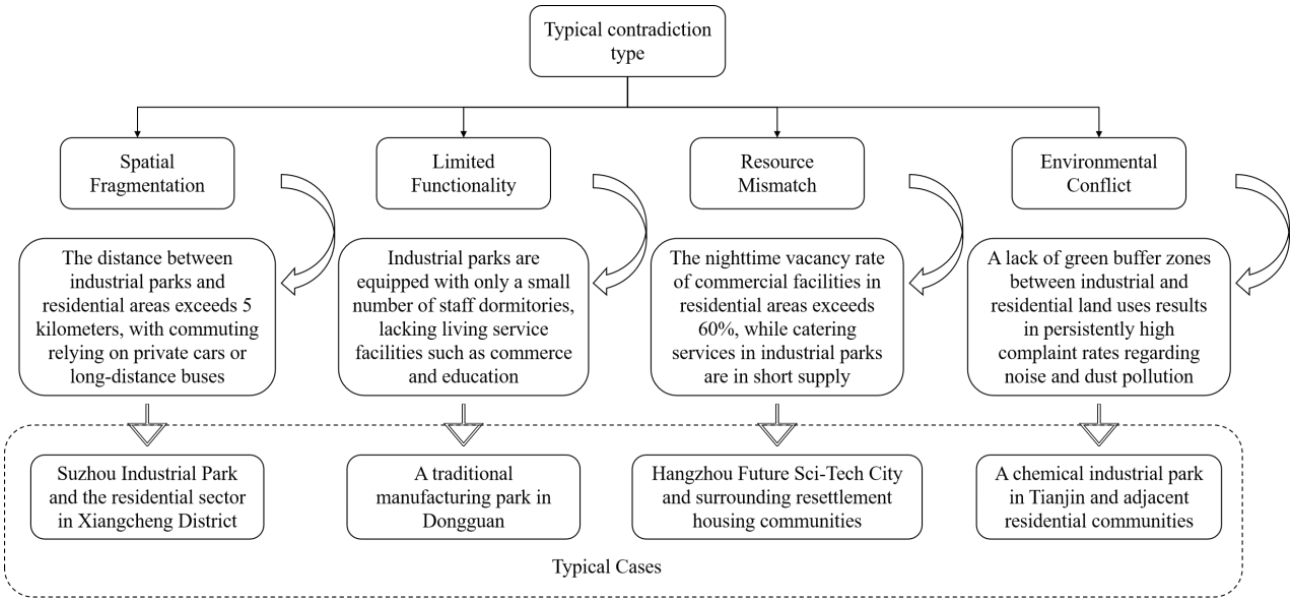

Figure 1 Typical Contradictions in the Spatial Allocation of Residential and Industrial Areas under Traditional Planning Models

3.2 Time series contradiction: the rhythm dislocation between industrial life cycle and residential renewal

The development of industrial parks has obvious life cycle characteristics: the initial stage focuses on attracting investment, the middle stage focuses on capacity expansion, and the mature stage turns to technological innovation and functional upgrading. However, the construction period of residential buildings is usually long, and it is difficult to match the industrial dynamics because of the constraints of land transfer and fund raising. Residential land was reserved in the planning of an emerging science and technology park. However, due to the rapid rise of the industry, the original five-year development cycle was compressed to two years, which eventually led to the brain drain due to the lagging supporting facilities. In other traditional industrial parks, after the industrial recession, the residential space is difficult to transform due to the solidification of land properties, which leads to the coexistence of "industrial hollowing out" and "residential aging".

3.3 Institutional contradiction: policy conflict between land control and mixed development

The current land management system in China is based on the principle of "single use", and there are significant differences between residential land and industrial land in terms of transfer conditions, plot ratio and tax policies. The price of industrial land is usually only 1/5 to 1/3 of that of residential land, and you can enjoy tax relief. This has led local governments to be more inclined to use land for industrial development and ignore residential facilities. At the same time, the development of mixed functions (such as "industry+commerce" and "residence+office") is often

shelved because of the difficulty in coordination among departments because it involves complex processes such as land property change and planning index adjustment. Some state-level development zones have tried to build talented apartments in industrial land, but due to the conflict of fire protection and sunshine, they were finally forced to adjust their design schemes, which increased the development cost and time.

3.4 Cognitive contradiction: interest game and value divergence of planning subject

The coordinated development of residential buildings and industrial parks involves many subjects, such as government, enterprises and residents, and there are significant differences in their interest demands and value judgments. Local governments pursue land finance and GDP growth, and pay more attention to the immediate benefits of industrial projects. Enterprises aim at reducing costs and improving efficiency, but their willingness to invest in housing facilities is limited. Residents give priority to the quality of living and the accessibility of public services. This differentiation of interests leads to the obvious tendency of "industry priority" in planning and decision-making, and the residential function is often marginalized. When a city was planning a new district, the enterprise opposed to reducing the proportion of industrial land from 60% to 50%, which eventually led to the distance between residential area and industrial area being too far, and the goal of job-residence balance failed.

4. Planning path: Construction of collaborative development framework based on demand adaptation

The contradiction of traditional planning mode lies in the lack of dynamic response to multiple demands, so it is necessary to build a collaborative development framework with "demand adaptation" as the core. This framework needs to give consideration to economic efficiency and social equity, balance short-term interests and long-term resilience, and realize the system integration of residential buildings and industrial parks through goal reconstruction, spatial reorganization, time sequence coordination and governance innovation.

4.1 Target system: the value shift from efficiency priority to inclusive development

The core goal of collaborative development is to build a "livable and suitable for business" spatial unit, and its evaluation criteria should shift from a single economic index to a multi-dimensional inclusive index (see Figure 2). The job-residence balance rate should consider the commuting needs of different income groups and avoid simplifying "close neighbors" to "the shortest geographical distance". The coverage rate of public services should be divided into basic and upgrading types to meet the needs of people in different life cycles. Environmental performance needs to quantify indicators such as carbon emissions and water resources recycling rate to ensure the sustainability of coordinated development.

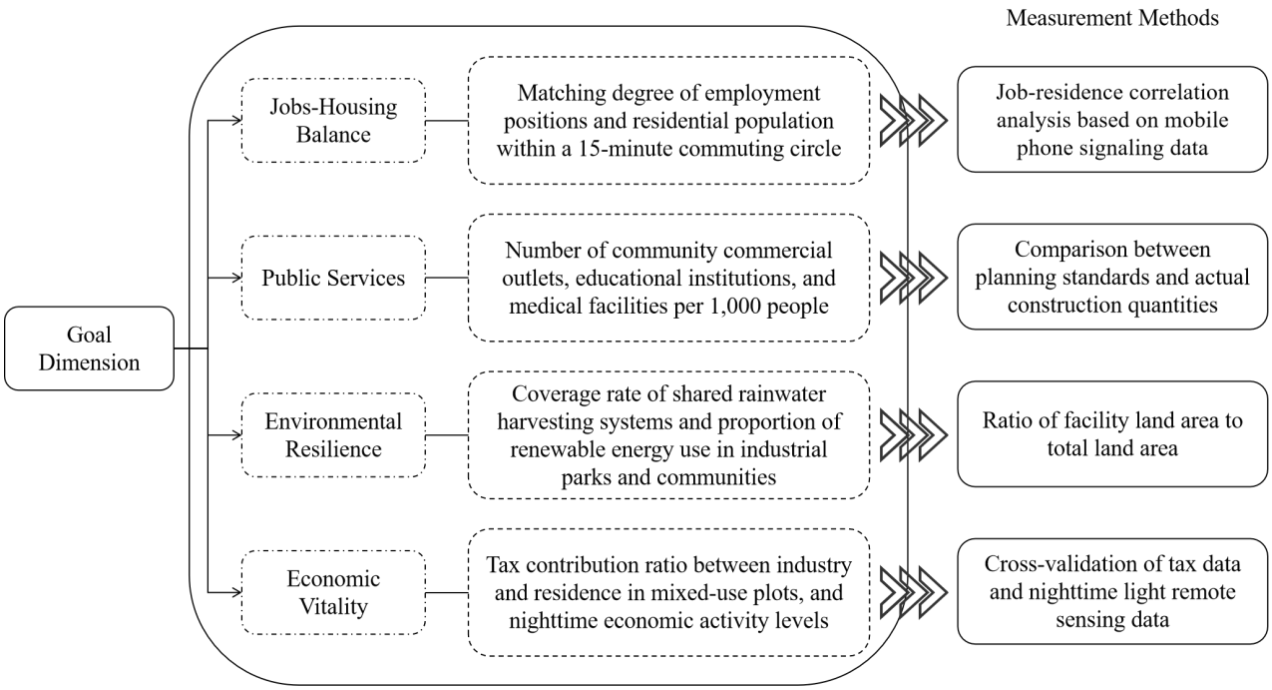

Figure 2 Dimensions and Indicators of the Collaborative Development Goal System

4.2 Spatial strategy: the combined design of functional mixing, density gradient and elastic blank space

Spatial reorganization needs to break the rigid boundary of "functional partition" and realize functional infiltration through "vertical mixing" (such as bottom business+upper residence) and "horizontal mixing" (such as embedding talent apartments in industrial blocks). A science and technology park in Shenzhen is equipped with 20% residential units in industrial land, and the service radius of commercial facilities is required to cover three surrounding communities, which effectively shortens the commuting distance. At the same time, it is necessary to construct a "core-transition-edge" density gradient: the industrial core area supports innovation and exchange with high-density development, the transition area balances population capacity through medium-density residence, and the marginal area reserves low-density ecological space to buffer environmental pressure. In addition, 10%-15% of "flexible land" is reserved to cope with future demand changes and avoid the cost of secondary renovation caused by functional solidification.

4.3 Timing strategy: the dynamic balance mechanism between industry and residence in phased development

The key to time series coordination is to establish a linkage mechanism of "industrial demand forecast-residential supply response". At the initial stage of planning, the type and scale of housing demand are predicted through the analysis of industry type, employment scale and talent structure. In the middle stage of development, the phased supply mode of "industry first, housing follow-up" is adopted. For example, temporary talent apartments will be built at the same time when industrial land is developed in the first stage, and the types of residential products will be adjusted according to the situation of enterprises in the second stage. In the operation stage, the residential function is prevented from being squeezed by excessive commercialization through land period adjustment and property right division and sales restriction.

4.4 Governance strategy: multi-party collaborative decision-making platform and flexible planning system

Governance innovation needs to build a "government-enterprise-residents" co-governance platform, such as setting up a joint Committee composed of planning departments, park management committees and community representatives to regularly review collaborative development plans. At the institutional level, the policy of "mixed land" can be piloted, allowing the

proportion of residential, commercial and office functions in the same plot to be dynamically adjusted; At the same time, a "demand response fund" will be established, which will be funded by the government and enterprises in proportion to subsidize the loss of public interests in the development of mixed functions. In addition, the mechanism of "planning implementation evaluation-dynamic revision" can be popularized, and indicators such as job-residence balance rate and public service coverage rate can be checked every three years, and planning strategies can be adjusted in time.

The construction of collaborative development framework needs to avoid the tendency of "idealization" and recognize the differences of resource endowments in different cities and parks. First-tier cities can focus on high-density mixed development, while third-and fourth-tier cities need to give priority to ensuring basic public service coverage. Only through continuous demand monitoring and strategy iteration can the real synergy between housing and industry be realized.

5. Conclusions

Through the analysis of the contradiction between the coordinated development of residential buildings and industrial parks, this article reveals the deep defects of traditional planning model in function separation, time sequence dislocation, system conflict and interest game, and constructs a framework of coordinated development based on demand adaptation. The core of this framework is to recognize the dynamics and complexity of diverse needs, and to extend the "job-residence balance" from the geographical concept to the comprehensive balance of social, environmental and economic dimensions through goal reconstruction, spatial reorganization, time sequence coordination and governance innovation.

The future research needs to be deepened and expanded in three directions: First, the accuracy of demand forecasting should be strengthened, and a more forward-looking demand dynamic simulation system should be built by combining population flow big data, industrial life cycle model and consumption behavior analysis. Second, explore the feasibility of institutional innovation, such as the landing rules of mixed land policy, the fault-tolerant mechanism of flexible planning, and the power distribution and responsibility definition of multi-party co-governance platform. Third, pay attention to the effectiveness of technology empowerment and study the specific application scenarios of intelligent means in reducing the cost of mixed development and improving the efficiency of spatial adaptation.

Collaborative development is a technical problem of spatial planning and a value choice of urban governance. It requires planners to go beyond the inertia thinking of "efficiency first" and find a balance between land resource constraints and people's livelihood demands, short-term economic goals and long-term social benefits. Only in this way can urban space truly become a container for a better life, rather than a cold functional container.

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