Research on Planning Method and Layout Design of International Logistics Node—— Focusing on International Logistics Park

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ABSTRACT

This paper mainly takes the international logistics park as an example to analyze the planning method and layout design of the international logistics node. First, it summarizes the planning methods of logistics parks at home and abroad, and points out the applicability of different methods. Secondly, systematically expounds the planning and layout methods of international logistics parks from the aspects of market analysis, strategic positioning, functional design, layout design and business plan. More importantly, by analyzing the layout design model, this paper further studies the layout design method of the logistics park and optimizes the layout of international logistics parks and nodes.

Keywords: International logistics node, International logistics parks, Planning methods, Layout design model

1 INTRODUCTION

The international logistics park is one of the important manifestations of international logistics nodes. The logistics park is defined in GB/T 18354-2021 "Logistics Terminology" as follows: A logistics park is planned by the government and managed by a unified main body, providing professional services for many enterprises to set up distribution centers or regional distribution centers here. Logistics industry agglomeration area that integrates logistics infrastructure and public services[1]. From the perspective of the types of logistics parks, logistics parks can be divided into different types according to geographical location, location conditions, service space scope and industrial objects. According to the size of the service space, it can be divided into international type, regional type and city type. According to their different functions, they can be divided into freight service type, production service type, business service type, port service type and comprehensive service type. This paper provides a reference for the planning of different types of international logistics parks by systematically studying the planning and layout methods of logistics parks.

2 COMPARISON OF PLANNING METHODS

The planning and layout methods of the material park are summarized as follows:

Table 1. Comparison of logistics park planning methods (Foreign)

Logistics Park Planning Method	Features	Scope of application
MSFLB Planning Methodology	The park planning is completed through five parts: market analysis, strategic positioning, functional design, layout design and business plan.	It is suitable for the planning and construction of most logistics parks, including international and regional types, and needs to be transformed according to the actual situation of the planning area.
Based on road transportation network planning method	The "two-stage" method is used to study the planning of the logistics park in the central city of the main highway hub. The first stage mainly adopts the "four-stage" theory in traffic planning; the second stage conforms to the principle of minimum logistics cost and road network expansion cost.	It is suitable for urban logistics park planning and can well optimize urban road transportation network.

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Table 2. Comparison of logistics park planning methods (Domestic)

Logistics Park Planning Method	Features	Scope of application
Planning method of logistics park based on industrial park	Planning and design are mainly based on functional positioning, design concept, planning and design concept, functional structure and project setting, and road traffic organization concept.	It is suitable for the construction of production logistics parks. The production logistics park is closer to the raw material area of the manufacturing industry. Using this method, various factors of the logistics park can be comprehensively considered.
Planning method of logistics park based on urban facilities	Apply the city's functional positioning, urban layout planning, urban transportation planning and a series of other special planning methods to the logistics park planning.	It is suitable for the construction of urban commerce and logistics parks.
The Planning Method of Regional Logistics Park Based on Weight Coefficient	The planning scheme in the regional logistics park is comprehensively evaluated by the weight coefficient method, the optimization scheme is evaluated, the optimization model is determined, and it is used in the actual logistics park planning project.	It is suitable for the construction of urban regional logistics parks. This method can comprehensively consider various alternatives and choose the best one.

3 PLANNING LAYOUT METHOD

3.1 Market analysis

The first step in logistics park planning is market analysis, which mainly includes an in-depth understanding of the market demand, social and economic development, infrastructure, and service competition in the surrounding areas of the logistics park; To conduct a comprehensive investigation and research on the regional economic structure, industrial layout, social environment, etc., so as to predict and analyze the development prospects of the logistics park[2]. Market analysis mainly includes two parts, one is data collection and research, which is usually done by means of telephone interviews and questionnaires; the other is data analysis, both qualitative and quantitative. Qualitative analysis usually uses SCP model, quantitative analysis REA model is usually adopted.

3.2 Strategic Positioning

After completing the first step of market analysis, planners should begin to analyze the advantages and disadvantages of the logistics park, what are the main challenges it faces, and what opportunities can be seized, that is, SWOT analysis[3]. Through these analyses, we can have a more accurate understanding of the internal and external environment of the logistics park. Based on this, we can propose the main mission, long-term goals and winning strategies of the logistics park, and then propose a more accurate strategic positioning to better achieve its strategic goals.

Typical winning strategies for logistics parks are: make full use of the functions of bonded logistics centers to achieve high efficiency in import and export customs clearance and administrative management; make full use of and expand existing logistics information systems to create a strong international logistics information platform; make full use of WTO and CEPA's international trade policy, establish a characteristic professional distribution center for European and American commodities, and expand international logistics business; make full use of the advantages of existing enterprises in the park and the characteristics of logistics needs, promote the competitiveness of the industry supply chain, gather the logistics of the industry, and realize the industry The formation and optimization of the chain; in accordance with the development requirements of the circular economy, with the goal of creating an ecological logistics park, firmly establish the scientific development concept, adhere to the equal emphasis on economic development and ecological protection, and commit to the cultivation and improvement of the ecological environment.

3.3 Functional design

The functional design of the logistics park usually adopts a top-down method. Generally, the planning principles of the logistics park planning must be clarified first, and then the core factors involved in the logistics function planning and the internal and external environment of the park are listed and analyzed[4]. A batch of cases of the most advanced logistics parks at home and abroad at that time summed up the most suitable experience for the logistics parks studied.

3.4 Layout design

The layout design of the logistics park refers to the entire process from the entry, assembly, processing, etc. of the goods to the delivery of the goods within the scope of the planned land use after taking into account the strategic positioning, business objectives, and production and management needs of each department of the logistics park. , Determine the land for various functions, including logistics area, warehouse, production area, administrative office area, etc., and strive to achieve the most reasonable distribution and the most efficient combination of the space required by personnel, equipment and materials, so as to obtain the best economic benefits.

The site selection and planning of various building facilities in the logistics park should adopt scientific quantitative methods, such as: some optimal location methods in operations research, shortest path method, minimum cost maximum flow method, effective material entry and exit table method, Handling system analysis method, fuzzy comprehensive evaluation method in fuzzy theory, optimal decision-making method, etc. The rationality of logistics park planning and facility layout can also be tested through animation simulation.

The planning goals of the logistics park can be considered from two aspects: material flow and inter-departmental relationship flow. The flow analysis mainly considers the flow of materials, while the activity correlation analysis refers to considering the logistics relationship at the same time, not only for the production department, but also for the office, service facilities, etc. can be analyzed according to the correlation between each other to determine the ideal planning Location. Mainly set goals from the following points:

Reasonable use of space.

Try to consider the characteristics of the goods entering and leaving the international logistics park, so that the logistics operation cost is small.

It conforms to the order of logistics and freight operations, so that the entry and exit of goods are orderly, and repeated operations are avoided as much as possible.

Muther[5] proposed a set of correlation degree scoring system, each system is represented by a letter, and the reason code for the corresponding evaluation level is given. The correlation factor degree level table is as follows:

Table 2. Correlation factor degree scale scale value

Degree of correlation		**Related factors**		**Extreme value (V_{ij})**
Code	Proximity Description	Reason code	Reason	
A	Absolutely necessary	1	Frequent material flow	8
E	Especially important	2	Share the same space	6
I	Important	3	Common facilities	4
O	Ordinary important	4	Organization and management	2
U	Unimportant	5	Easy access to personnel	0
X	Closeness undesirable	6	Convenient information and transportation	-2
		7	Increase work efficiency	
		8	Work Environment Considerations	
		9	……	

Among them, the score of comprehensive correlation degree between functional areas should be quantified based on the influence degree between factors (for example, A corresponds to 7, E corresponds to 5, I corresponds to 3, etc.), and then according to the weight recommended by experts, the final score of comprehensive correlation degree between functional areas should be obtained according to the following formula:

$$T_{ij} = \beta_1 M_{ij} + \beta_2 N_{ij} + \beta_3 H_{ij} + \beta_4 K_{ij} + \beta_5 L_{ij} + \varepsilon\beta_6 P_{ij} \tag{1}$$

Among them:

T_{ij} ——the comprehensive score between functional areas i and j;

β_1 ——weight of logistics relationship, M_{ij} ——score of logistics relationship between functional areas i and j.

β_2 ——weight of management relationship; N_{ij} ——score of management relationship between functional areas i and j.

β_3 ——process relationship weight, H_{ij} ——process relationship score between functional areas i and j.

β_4 ——weight of operational relationship, K_{ij} ——score of operational relationship between functional areas i and j.

β_5 ——environmental relationship weight, L_{ij} ——environmental relationship score between functional areas i and j.

β_6 ——weight of other special relationships; P_{ij} ——score of special relationships between functional areas i and j.

ε —— parameter, when ε =0 there is a special relationship between functional areas; When ε =1 no special relationship exists in the functional area.

The objective function is

$$F = maxTPD = max\sum_{i=1}^{n-1}\sum_{j=j+1}^{n} T_{ij} z_{ij} \tag{2}$$

Ensure that the area layout does not overlap, X_i and Y_i are the coordinate values of the centroid of the i area in the X and Y directions, where 1, 2..., n.

$$\begin{cases} |X_i - X_j| \geq \frac{(M_{xj}+M_{xj})}{2} \\ |Y_i - Y_j| \geq \frac{(M_{yj}+M_{yj})}{2} \end{cases} \tag{3}$$

Ensure that the layout is carried out within the set area, where h and g are the length and width of the logistics center in the X and Y directions, respectively.

$$\begin{cases} 0 < X_i < h \\ 0 < Y_i < g \end{cases} \tag{4}$$

Converting the definition of "adjacent" functional area i and j into a mathematical expression, the judgment condition of z_{ij} is obtained.

When functional area i and functional area j have adjacent sides, and the adjacent sides are parallel to the Y axis, then

$$\begin{cases} |X_i - X_j| = \frac{(M_{xi}+M_{xj})}{2} \\ |Y_i - Y_j| = \frac{(M_{xi}+M_{yj})}{2} \end{cases} \tag{5}$$

Similarly, when functional areas i and j have adjacent sides, and the adjacent sides are parallel to the X axis, then

$$\begin{cases} |X_i - X_j| < \frac{(M_{xi}+M_{xj})}{2} \\ |Y_i - Y_j| = \frac{(M_{yi}+M_{yj})}{2} \end{cases} \tag{6}$$

If z_{ij} satisfies (5) or (6), then z_{ij} =1, otherwise z_{ij} =0.

3.5 Evaluation of the layout design

Generally, the program is evaluated from qualitative and quantitative aspects. The selected evaluation method should reflect these two aspects as much as possible.

(1) Advantages and disadvantages enumeration method

List the relevant factors in each plan and compare the pros and cons. This method is suitable for small single planning projects.

(2) Analytic Hierarchy Process (AHP)

AHP is mainly to decompose the indicators or factors related to decision-making into different levels, usually divided into goal level, criterion level and scheme level[6]. The final score is obtained by the weighted sum of the factors at each level through the comparison matrix, and the scheme with the highest score is selected. This method is subjective to some extent.

(3) Weighted factor analysis

This method is mainly by dividing the problem into many elements to be analyzed one by one, and finally to each factor given weight and one by one evaluation to the score, the final sum. The best solution is the one with the highest score.

3.6 Business plan

The main content of the business plan is to provide the park's investors and managers with the business model, management model and development model of the park system design, mainly including: the organizational structure and responsibilities of the logistics park management park, income forecast, business model, investment income, Business analysis such as park sales and marketing strategies, customer analysis, etc[7].

The development of logistics parks is generally carried out in stages. Staged development will be easier to implement than the overall one-step development, and the latter stage can learn from the experience of the previous stage, while further adjusting and optimizing the marketing strategy and other details of the next step. Typical business models of logistics parks include property support, construction support, financial support, human resources support, environmental support, safety support, quality support, equipment support and other services.

In terms of logistics park marketing, it is recommended to adopt an integrated marketing method that uses a combination of publicity brochures, user magazines, attendance at promotion conferences and trade fairs, visual image design, Internet, investment guides, and advertisements to achieve expected results.

4 CONCLUSION

International logistics plays an important role in international economy and trade. As an important hub node in international logistics and an important link in international trade, the ineffective use of international logistics park will surely reduce the efficiency of the whole international trade. Therefore, the scientific and rational planning and layout of the international logistics park in this study is of great significance to maintain the smooth flow of international logistics and maintain the stable development of international supply chain.

REFERENCES

[1] Li H., Yan Z.G., Zheng J.H. Analysis on the Planning and Construction Characteristics of Bonded Logistics Park. China Storage and Transportation, 2022, No.257(02):170-171.

[2] Li S. Research on two-stage layout planning optimization method of functional blocks in logistics parks. Chongqing Jiaotong University, 2019.

[3] Xu Q. The method and practice of logistics park planning. Jiangxi Building Materials, 2016, No.196(19):15+18.

[4] Yan J.D. Research on the planning method and practice of logistics park and countermeasures for the development of logistics industry. Xinjiang Normal University, 2016.

[5] Chen Z.J. Research on regional logistics park planning method based on economic development correlation mechanism. Nankai University, 2012.
[6] Zhou R.H. Research on Planning and Construction of Logistics Park. Science and Technology Information, 2011, No.388(32):428.
[7] Sun Y., Wang J. International Logistics Park Planning Method and Its Application. Journal of University of Science and Technology Beijing (Social Science Edition), 2010, v.26; No.86(04):110-116.