

Research on location selection of Jingdong warehouse & distribution center based on multi-objective programming

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Abstract: The logistics and courier industry is the carrier of urban life. In order to pursue a more convenient life, online shopping has become an important way for many people to obtain living materials, and the logistics industry has made a huge research contribution to solve the "last mile". As a leading company in the logistics industry, Jingdong is relying on national and regional policy support to vigorously develop unmanned logistics services. It has established Asia No.1 Logistics Park in Baqiao District, Xi'an, and built a highly intelligent and unmanned aerospace e-commerce distribution logistics center in the Space Base. Located in Xi'an International Port, the Xi'an Jingdong Asia No.1 Logistics Park is the largest and most highly automated intelligent logistics center in the northwest. Its three-dimensional stacking and storage technology, automated sorting system and unmanned warehouse technology are leading in China. Its location is of strategic importance to the development of the logistics industry and the development of Xi'an.

1. Introduction

It is understood that in the landing of global logistics headquarters, Jingdong Group uses technology, airspace and talent resources, which are provided by Xi'an Space Base, to build an intelligent logistics industry center, which includes warehousing, distribution, settlement, big data, cloud computing and other modern logistics business; in the landing of unmanned system industry center, Jingdong Group set up an unmanned system research and development team at the end of 2017, and gradually built Jingdong At the end of 2017, Jingdong Group set up a research and development team for unmanned systems and gradually built an integrated testing system for "unmanned aircraft, unmanned vehicles and unmanned warehouses", which was put into use at Xi'an Space Base. In addition, the Jingdong Cloud Operation Center will build a new infrastructure platform of cloud computing + big data, construct an intelligent city ecology supported by cloud technology and driven by big data, and create four systems of platform, data, ecological and network ^[1]. Relying on the general-purpose airport of the Space Base, Jingdong will build the Jingdong Global Logistics Headquarters, the Jingdong Unmanned Systems Industry Center, the Jingdong Cloud Operation Center and the aerospace e-commerce distribution and logistics center in the Space Base. The whole research ideas is shown in the following Figure 1.

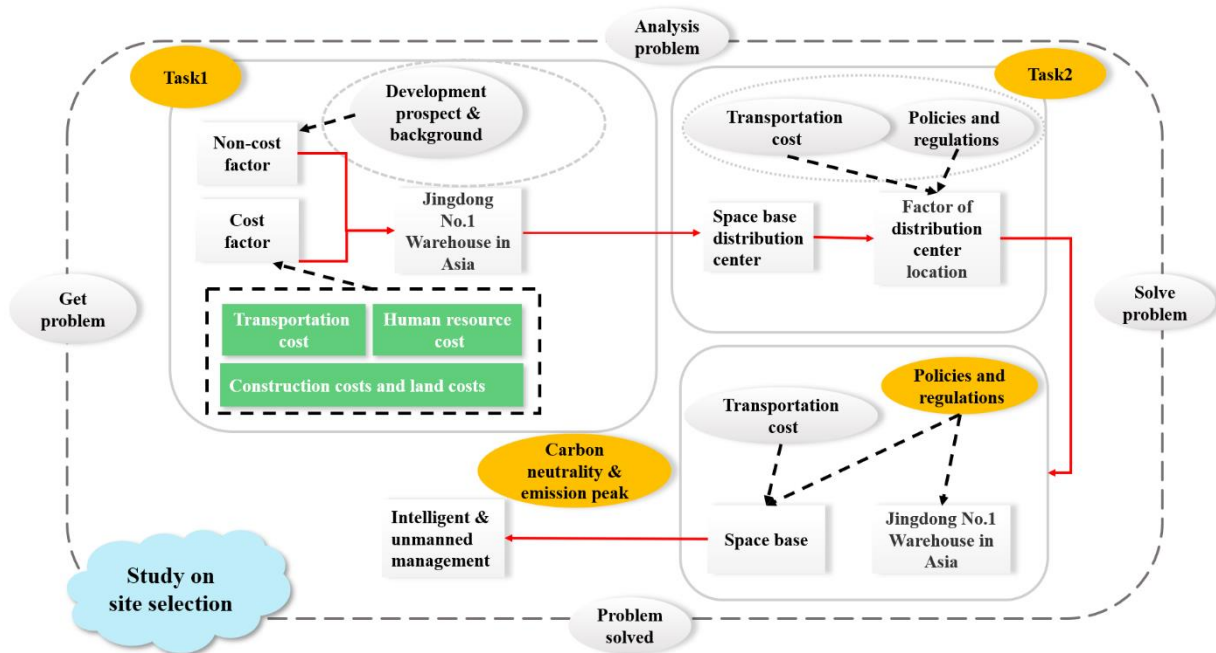


Figure 1 Research ideas

2. Model building and solving

2.1 Study of the factors for siting the Jingdong Asia No.1 Warehouse

In general, when making site selection decisions, the influencing factors can be divided into cost and non-cost factors. Cost factors are directly related to costs, while non-cost factors can influence the future development of a business. Here is the main cost factors:

(1) Transportation costs. For many years, transport costs have been high and a problem for logistics enterprises. The National Development and Reform Commission and the China Federation of Logistics and Purchasing jointly released the "National Logistics Operation Bulletin 2021"^[2] shows that China's logistics transportation costs are 9 trillion-yuan, accounting for about 54% of logistics costs.

(2) Raw material supply costs. By locating warehouses and distribution centers close to where the raw materials are supplied, you can not only ensure a safe and timely supply of raw materials, but also reduce transport costs.

(3) Human resource costs. Labour levels vary considerably from region to region and the share of human resource costs in logistics costs needs to be taken into account when making site selection decisions.

(4) Construction costs and land costs. Different site options have different requirements for land acquisition, construction and therefore different costs.

2.2 Non-cost factors

(1) Operating environment. Site selection should take into account factors such as the local business environment, the business climate and the relationship between government and business.

(2) Policies and regulations. Site selection should take full account of local government policies and regulations. For example, the city of Xi'an supplies land for logistics construction projects in accordance with industrial land concessions and land levels.

(3) Natural environment. Some commodities must be stored within a specific temperature and humidity range and therefore require specific geographical conditions.

(4) Time-influencing factors. Fast response and quick delivery is one of the important factors for competition between logistics companies.

3. Evaluation of Model

We mainly consider transport costs, human resource costs, construction costs and land costs among the cost factors, as well as the impact of policies and regulations on the location of Jingdong Asia No.1 Warehouse among the non-cost factors.

3.1 Transport costs

Only with the transport distances of each distribution center in mind, we simulate the site selection. The center of gravity method does not lead to an optimal solution, so we choose the multi-objective planning method and optimize it with the help of the fminmax function in MATLAB.

3.1.1 Determine the location of distribution centers and distribution points

Once the latitude and longitude of the distribution centers have been obtained from the map, they need to be converted to the projected coordinate system.

We assume that the roads in Xi'an are perpendicular to each other and that the objective of the optimization is to minimize the distance to the distribution center furthest from the warehouse, which can be achieved with the fminmax function in MATLAB.

Calculate the distance from the warehouse to the distribution center with the following formula:

$$d = \sqrt{[x_1 - x'(i)]^2 + [x_2 - x''(i)]^2} \quad (1)$$

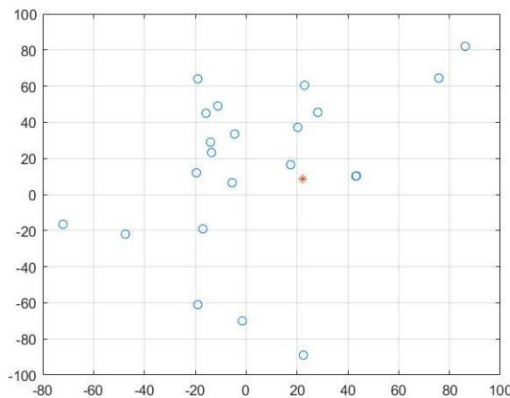


Figure 2 Location of Asia No.1 Warehouse only considering transportation cost

From figure 2, we can see that when transport costs are taken into account alone, Asia No.1 Warehouse should have been established in the city center, which is clearly the opposite of the truth. We therefore speculate that transport costs were not taken into account when selecting the location for the Asia No.1 Warehouse.

3.1.2 Construction costs and land costs

There is a large stock of land near the port area of Xi'an, and in 2015, when the warehouse was

officially opened, the average price of dry land in Xi'an was \$8 million per acre. The land situation in Xi'an is shown in Figure 3 and 4.

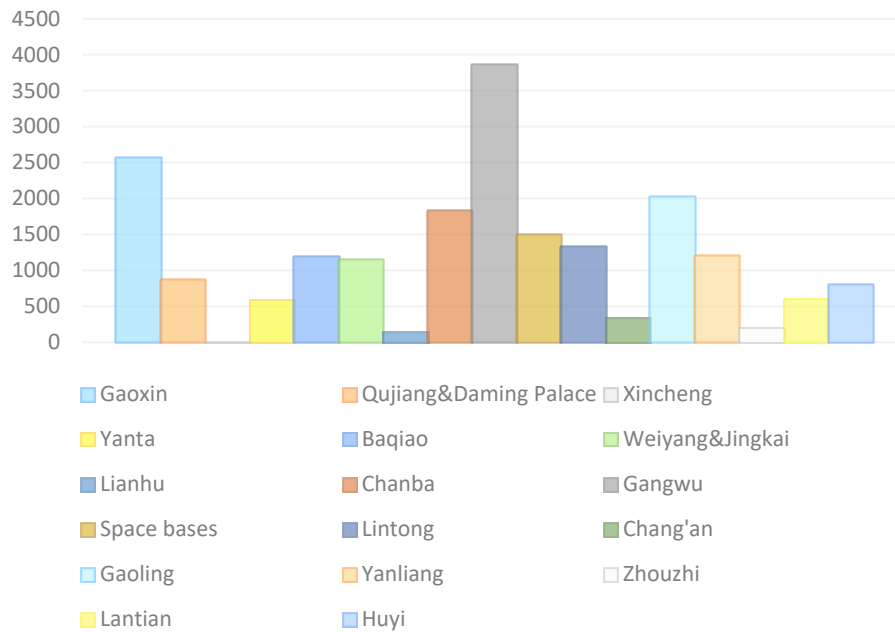


Figure 3 Land stock in all districts of Xi'an in 2015 (unit: mu)

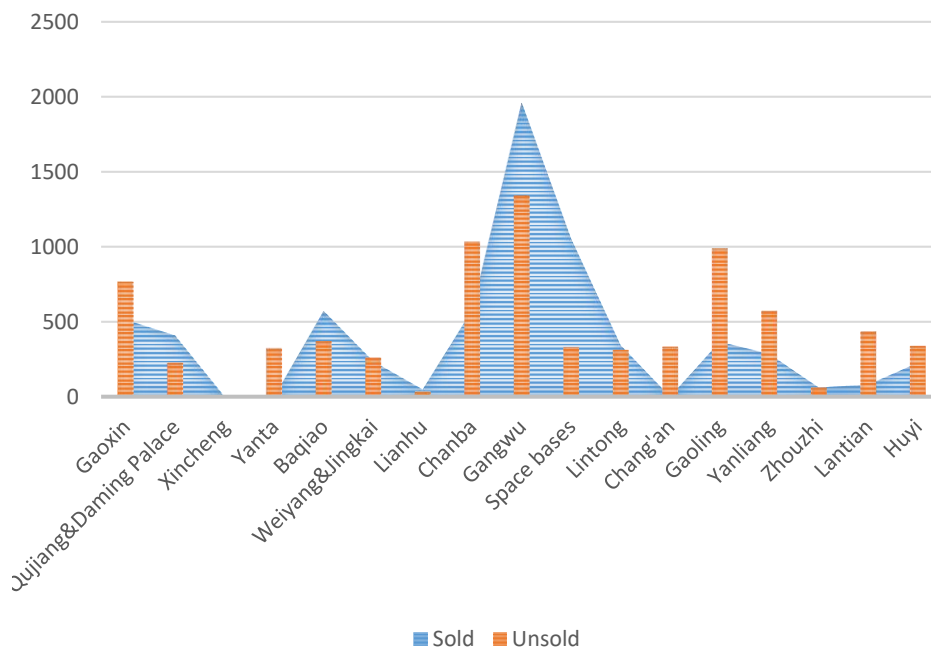


Figure 4 Sold land area and unsold land area in all districts of Xi'an in 2015 (unit: mu)

3.2 Human resource factors

Asia No.1 Warehouse is located in the suburban area of Xi'an. The operation of the warehouse requires a large amount of labour, which can effectively solve the employment problem of the surrounding residents. According to data provided by the China Federation of Logistics and

Purchasing, the average monthly salary for those working in the logistics industry in Xi'an is 7.0k in 2017. Xi'an is the city that has reached the national average salary level for the logistics industry. The villages surrounding Xi'an Asia No.1 Warehouse are shown in Figure 5.

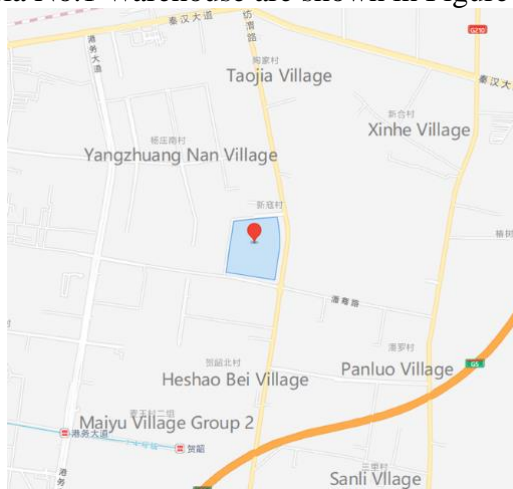


Figure 5 Location of Xi'an Asia No.1 Warehouse

3.3 Policies and regulations

3.3.1 Policies Support

(1) According to the “Notice of the Xi'an Municipal People's Government on the Issuance of the Development Plan for Modern Logistics Industry in Greater Xi'an from 2018 to 2021”^[3], Xi'an is to build a backbone logistics node system with two international logistics hub ports (Xi'an Dry Port and Xi'an Airport), five regional hub logistics parks (Lintong, Jinghe New City, Fengdong New City, Qindu in Shaanxi and Chang'an Citation Town) and 11 logistics centers (Xinfeng, Yanliang, Gaoling, Jingkai, Qinhan, Sanqiao, Zhouzhi, Gaoxin, Space Base, Baqiao and Lantian). The two ports, five parks and eleven centers are the core of the system.

(2) Relying on existing warehouse and distribution resources in the countryside, the government hopes to build township distribution transit stations and village-level public service points, and promote the merger of passenger and freight stations (yards), trade markets, agricultural distribution points and postal courier service points to enhance rural logistics services. Asia No.1 Logistics Park is located in a suburban area with several villages nearby, and they are able to provide labour to Jingdong and improve their own logistics services, achieving a win-win situation.

(3) According to the “Xi'an Industrial, Warehousing and Logistics and Key Project Special Subsidy Management Measures”^[4], Baqiao District and Space Base warehousing and logistics bases can receive subsidies of RMB 120,000 to 160,000 per acre. Jingdong can get a subsidy of 45.39 million yuan just for its Asia No.1 Warehouse in Baqiao District.

3.3.2 Future Policies

According to the "14th Five-Year Plan for the Development of Modern Logistics Industry in Xi'an"^[5], the government will adjust and optimize the existing urban distribution network. According to the 14th Five-Year Plan for Modern Logistics Industry in Xi'an, the government will adjust and optimize the existing urban distribution network. It will promote the "retreat of old logistics centers within the bypass highway into the park", or transform them into public distribution centers with unified storage, centralized sorting and common distribution functions. This also means that Jingdong cannot build its warehouses in urban areas simply because of transport costs.

4. Space Base Distribution Center Site Selection Study

4.1 Transport costs

We have selected distribution points around the space base and still adopted the MATLAB multi-objective planning method for the location of the Space Base Distribution center. The optimization result is shown in Figure 6.

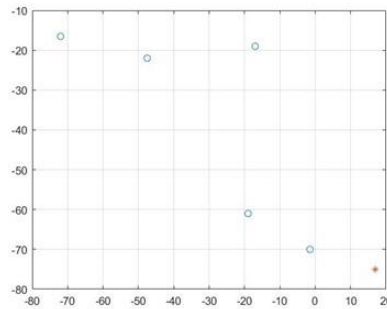


Figure 6 o is the distribution center, * is the Space Base distribution center. Based on the results of the optimization, the site of the Space Base is shown below.

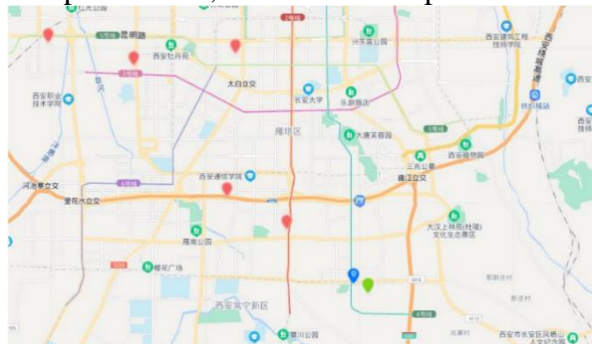


Figure 7 Blue points are optimized points, green are actual Space Base Distribution centers and red are nearby distribution points

It can be seen that when choosing the Space Base as a distribution center, Jingdong considered transportation costs. The distribution center mainly provides distribution services for small batches and multiple varieties of goods, with transportation being the mainstay and warehousing being a supplement, and transportation costs account for a relatively large part of the total cost of operating the distribution center.

4.2 Policies and regulations

(1) Policies Support: With the signing of the "Strategic Cooperation Agreement on Building a Smart Logistics System" between Shaanxi Provincial Government and Jingdong Group, Jingdong became the first company in the world to propose the use of drones to create a short-haul aerial logistics network. Xi'an Space Base has provided tremendous support and generous conditions for the development of Jingdong's unmanned system technology. In particular, it has provided pipeline airspace, R&D and manufacturing plants and test flight bases for drones, which are difficult to provide elsewhere.^[6]

(2) Policy Future policies: The "Carbon Peaks Action Plan by 2030"^[7] states that carbon peaks will be integrated into the whole process and all aspects of economic and social development,

including green and low-carbon energy transition actions and green and low-carbon transport actions, which are closely related to the logistics industry, which will further promote the development of unmanned and intelligent logistics.

The Space Base Distribution and Logistics Center focuses on promoting innovation and promotion in a range of logistics technologies and equipment such as logistics robots, smart warehouses, unmanned vehicles, drones and aviation logistics airport operations and management, making it the preferred choice for low-carbon logistics development.

Whether from the cost factor or the development strategy factor, choosing the Space Base as the distribution center will significantly expand the development space of logistics modernization, improve the efficiency of logistics services and increase customer satisfaction.

5. Conclusion

In the context of carbon peaking and carbon neutrality, the Xi'an Asia No.1 Warehouse and the Space Base Distribution Center will further develop towards intelligence and unmanned distribution. At the same time, under the guidance of national and regional policies, the Xi'an Space Base Distribution and Logistics Center will further develop towards systematization and internationalization, accelerate the promotion and application of unmanned distribution and unmanned retail technologies, and support logistics enterprises to develop new modes of contactless and unmanned distribution.

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