

# Analysis of Location Selection for Urban Logistics Pre-positioning Warehouse

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**Abstract:** With the rapid development of e-commerce, the demand for express delivery has increased sharply. In this context, the construction of pre-positioning warehouses has become one of the problems that express delivery companies must face. This article mainly analyzes the problem of location selection for pre-positioning warehouses in urban logistics. Firstly, the definition and function of pre-positioning warehouses are introduced, and then the current situation and problems of location selection for pre-positioning warehouses are analyzed, including problems related to geographical location, transportation, and facilities. Then, the location selection strategies and optimization methods for pre-positioning warehouses are described and analyzed. Finally, based on practical cases, recommendations for location selection for pre-positioning warehouses are discussed.

**Keywords:** Pre-positioning Warehouse, Location Selection.

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## 1. Introduction

### (1) Research Background and Significance

With the rapid development of e-commerce, the demand for express delivery has increased sharply. In order to meet the needs of consumers, express delivery companies need to improve their delivery efficiency and shorten delivery time. Therefore, the construction of pre-positioning warehouses has become one of the problems that express delivery companies must face. A pre-positioning warehouse is a warehouse located on the outskirts of a city that can store a large number of goods, making them closer to customers and allowing them to be delivered to customers faster. The construction of pre-positioning warehouses not only improves delivery efficiency but also reduces delivery costs and increases customer satisfaction, which is of great strategic significance for the development of express delivery companies.

The location selection of pre-positioning warehouses is an important issue in their construction. The quality of the location directly affects the operational efficiency and service quality of the pre-positioning warehouse. Therefore, the location selection problem of pre-positioning warehouses has been widely concerned by express delivery companies and the academic community. This article aims to study the location selection problem of pre-positioning warehouses, explore relevant mathematical models and algorithms for location selection, and propose recommendations and strategies for location selection based on practical cases.

### (2) Research Content and Methods

This article mainly studies the problem of location selection for pre-positioning warehouses, including the definition and function of pre-positioning warehouses, the current situation and problems of location selection for pre-positioning warehouses, relevant mathematical models and algorithms for location selection, and practical considerations and strategies for location selection. The research methods mainly include literature review and case analysis, and a deep study and exploration of the location selection problem of pre-positioning warehouses are conducted.

## 2. Definition and Function of Pre-positioning Warehouses

### (1) Definition of Pre-positioning Warehouses

A pre-positioning warehouse is a warehouse located on the outskirts of a city, usually near the transportation hub of the city. It can store a large number of goods to make them closer to customers and improve delivery efficiency. Pre-positioning warehouses are usually built by express delivery companies themselves but can also be leased or cooperatively built.

### (2) The Role of Prepositioned Warehouses

The construction of prepositioned warehouses can improve delivery efficiency, shorten delivery time, and increase customer satisfaction. At the same time, prepositioned warehouses can reduce delivery costs and improve the economic benefits of enterprises. Specifically, the role of prepositioned warehouses includes:

1) Shortening delivery time. Prepositioned warehouses can store goods closer to customers, reducing delivery distance and time and improving delivery efficiency.

2) Reducing delivery costs. Prepositioned warehouses can centralize the management and storage of goods, reducing delivery frequency and distance and lowering delivery costs.

3) Improving service quality. Through prepositioned warehouses, express delivery companies can provide faster and more convenient delivery services, thus improving customer satisfaction and establishing a good image for the enterprise.

4) Supporting business expansion. The construction of prepositioned warehouses can provide support for the future business expansion of enterprises and enhance their market competitiveness.

## 3. The Current Situation and Existing Problems of Prepositioned Warehouse Site Selection

### (1) The Current Situation of Prepositioned Warehouse Site Selection

Currently, express delivery companies typically consider

the following factors when selecting prepositioned warehouse sites:

**Geographic location.** Geographic factors are one of the important factors in prepositioned warehouse site selection, including geographic location, land prices, and surrounding environment. First, prepositioned warehouses should be located as close as possible to residential areas of consumers to shorten logistics delivery time. Second, when selecting prepositioned warehouse sites, land prices should be considered to avoid overly expensive sites leading to high costs. Finally, surrounding environment is also a factor to consider. Prepositioned warehouses should be located in areas with convenient transportation, good environment, and complete facilities.

**Transportation.** Transportation factors are also important factors in prepositioned warehouse site selection, including roads, transportation tools, etc. First, prepositioned warehouses should be located in places with convenient transportation to ensure faster logistics delivery. Second, when selecting prepositioned warehouse sites, the choice of transportation tools should also be considered. Choosing appropriate transportation tools according to different logistics models can reduce logistics costs and improve logistics efficiency. For example, for cross-border e-commerce enterprises, sea transportation is usually a more economical and stable choice, while for express delivery logistics enterprises, the choice of express delivery vehicles and couriers is critical.

**Market environment:** The economic development level of the region where the prepositioned warehouse is located is an important factor because it affects the demand for products and materials. Market factors include consumer markets, competition patterns, etc. First, prepositioned warehouse sites should be determined according to the situation of the consumer market. For example, if the consumer market is concentrated in certain cities or regions, prepositioned warehouses should also be located in these places. Second, when selecting prepositioned warehouse sites, competition patterns should also be considered to avoid choosing sites in areas with intense competition leading to excessive competitive pressure.

**Personnel and facility configuration.** Prepositioned warehouses should have complete basic infrastructure and supporting facilities, such as electricity, water sources, communication, network, etc. Prepositioned warehouses should have sufficient personnel to ensure the smooth management and delivery of goods.

**Environment and regulations:** Environmental factors include the climate, climate change, terrain, water resources, soil quality, vegetation, wildlife, etc. Regulations are becoming increasingly important in warehouse site selection, and relevant regulations must be considered when selecting prepositioned warehouse sites.

#### (2) Problems in the Selection of Pre-positioning Warehouse Sites

There are several issues that exist during the selection of pre-positioning warehouse sites, including:

**Information asymmetry.** Acquiring a large amount of market and geographical information is necessary for site selection, but this information is often difficult to obtain, and there may be differences in information from different sources, leading to increased uncertainty in site selection

decisions.

**Multi-indicator conflicts.** Pre-positioning warehouse site selection requires consideration of multiple factors, but there may be conflicts and contradictions between these factors. For example, the weights of geographical location and facility matching may have different preferences.

**High site selection costs.** Selecting pre-positioning warehouse sites requires significant human, material, and financial resources, and operational costs must also be considered, making the cost of site selection high.

**Long site selection cycles.** Selecting pre-positioning warehouse sites requires extensive market and geographical research, as well as consideration of multiple factors, resulting in a longer site selection cycle that consumes time and human resources.

## 4. Pre-positioning Warehouse Site Selection Strategies and Optimization Methods

### (1) Site Selection Strategy Analysis

Given the complexity of pre-positioning warehouse site selection, multiple strategies need to be employed for site selection. The following sections will analyze several aspects:

#### 1) Diversified Site Selection Strategy

A diversified strategy for pre-positioning warehouse site selection involves not relying on a single factor but instead selecting based on multiple factors. For example, during site selection, geographic factors, transportation factors, market factors, etc. can be considered simultaneously to select the most suitable site.

#### 2) Risk Control Site Selection Strategy

The risk control strategy for pre-positioning warehouse site selection involves giving sufficient consideration to risks during site selection. For example, natural disasters and social stability should be considered during site selection to avoid selecting dangerous or unstable areas.

#### 3) Predictive Site Selection Strategy

The predictive strategy for pre-positioning warehouse site selection involves making sufficient predictions about future developments during site selection. For example, during site selection, factors such as future consumption market trends and future transportation network development should be considered to avoid major changes after site selection.

### (2) Pre-positioning Warehouse Site Selection Optimization Methods

To address the issues that arise during pre-positioning warehouse site selection, the following optimization methods can be used:

#### 1) Data Mining

Data mining technology can uncover relevant market and geographic information from multiple perspectives, analyzing market demand, competitive conditions, and other factors. It can also analyze transportation, personnel deployment, and other factors through geographic information analysis to provide data support for pre-positioning warehouse site selection and improve site selection decision accuracy.

#### 2) Multi-indicator Decision Making

The multi-indicator decision-making method can

comprehensively evaluate pre-positioning warehouse site selection factors. By constructing an indicator system and weight allocation model, the preferences and weights of different factors can be considered, comprehensively assessing the influence of multiple factors and determining the best site selection plan.

### 3) Artificial Intelligence

Artificial intelligence technology can analyze and make decisions through data analysis using methods such as deep learning and neural networks. By analyzing big data, an optimized pre-positioning warehouse site selection model can be established, achieving rapid and accurate site selection decision making.

### 4) Geographic Information Systems

Geographic information systems can analyze and make decisions about pre-positioning warehouse site selection factors, such as transportation, facilities, and the environment, through spatial analysis and visualization. Simulations can also be used to evaluate the effects and costs of different site selection plans.

### (3) Case Studies of Pre-positioning Warehouse Site Selection:

**Amazon in China:** Amazon's pre-positioning warehouse site selection in China was based on consumer demand and market size in various major cities in China. It established pre-positioning warehouses in different cities in China to provide faster and more convenient logistics services for local consumers.

**Cainiao Network in China:** Cainiao Network's pre-positioning warehouse site selection in China mainly considered factors such as logistics, population density, and market demand. It used technologies such as big data and artificial intelligence to analyze and predict market and environmental factors, and selected the most suitable pre-positioning warehouse site selection plan for itself.

**JD.com in India:** JD.com's pre-positioning warehouse site selection in India mainly considered factors such as geographic location, population density, market capacity, and competitive conditions. It analyzed India's logistics network and market environment through geographic information systems and big data technology and selected the most suitable pre-positioning warehouse site selection plan based on the analysis results.

**Walmart in the United States:** Walmart's pre-positioning warehouse site selection in the United States mainly considered factors such as population density, logistics network, competitive conditions, and market demand. It used various methods to analyze and predict market and environmental factors and selected the most suitable pre-positioning warehouse site selection plan for itself. After the site selection, Walmart improved its logistics network and processes to improve transportation efficiency and reduce costs.

One typical case of pre-positioning warehouse site selection is Amazon's logistics strategy in mainland China. Amazon established pre-positioning warehouses in China to improve its competitiveness in the Chinese market. The company used various methods to make the site selection decision, including analyzing customer order data, considering logistics costs and timeliness, analyzing market demand and competitive conditions, and so on. In the end,

Amazon selected cities such as Shanghai, Guangzhou, Chengdu, Shenyang, and Wuhan to establish pre-positioning warehouses. These cities are in the eastern, southern, central, and northern regions of China to better serve China's mass consumer market. In the process of building pre-positioning warehouses, Amazon also used automation, robots, and artificial intelligence technology to improve logistics operations efficiency and reduce costs. This strategy has enabled Amazon to have a more robust logistics system and competitive advantage in the Chinese market, further promoting Amazon's business development.

## 5. Informationization Methods Used in Site Selection

In the site selection for distribution centers, various models and algorithms are used to assist decision-making, including:

**Geographic Information Systems (GIS):** Through GIS technology, factors such as geographic location, population density, and market capacity can be visualized and spatially analyzed, which helps determine the best location for distribution centers.

**Big data analysis:** By collecting, integrating, and analyzing data on consumers, markets, competitors, etc., in-depth insights into market demand, logistics networks, and market environments can be provided, thus better decisions can be made for the site selection of distribution centers.

**Machine learning algorithms:** Using machine learning algorithms, data models can be established to analyze factors such as market demand, consumer behavior, and logistics costs, predict future market trends, and improve the accuracy of distribution center site selection decisions.

**Artificial Intelligence (AI):** AI technology can process and analyze large amounts of data, provide more accurate market analysis and forecasts, and can also be applied to optimize logistics networks, reduce costs, and improve transportation efficiency.

**Decision tree analysis:** Decision tree analysis can help decision-makers prioritize and select based on multiple factors, in order to better determine the best site for distribution centers.

**Simulation:** By building simulation models, logistics processes and distribution center operating efficiency can be simulated, different site selection schemes can be analyzed for their advantages and disadvantages, thus helping decision-making.

For example, K-means clustering algorithm can be used in the site selection for distribution centers:

K-means is a commonly used clustering algorithm that can be used in site selection for distribution centers. The purpose of clustering algorithms is to group data samples so that the data points within the same group have high similarity, while the similarity between different groups is low.

In distribution center site selection, sample points can be regarded as potential distribution center locations, and then the K-means algorithm can be used to group these sample points into several clusters, with each cluster representing a potential distribution center location. The input of the K-means algorithm is the coordinates of the sample points, and the output is the center coordinates of the clusters, which are the coordinates of the potential distribution center locations. During the site selection process, additional constraints, such as the size of each cluster must meet certain requirements, can

also be added.

The K-means algorithm is a simple and effective clustering algorithm, but there are also limitations and challenges in practical applications. For example, the calculation time of the K-means algorithm for large-scale data sets will be very long, and the number of clusters needs to be determined first, which may not be easy to determine for site selection problems. Therefore, in practical applications, appropriate algorithms and models should be selected according to specific situations to solve the site selection problems for distribution centers.

The application process of the K-means algorithm in distribution center site selection can be summarized as follows:

**Data collection:** Collect relevant data according to the purpose of site selection, such as population density, traffic conditions, and market size.

**Data preprocessing:** Preprocess the collected data, including handling missing values and normalizing data.

**Determine the number of clusters k:** Select the appropriate number of clusters k based on the purpose of site selection and the distribution of data. Methods such as elbow method and silhouette coefficient can be used to determine the value of k.

**Initialization:** Randomly select k points as initial centroids.

**Calculate distances:** Calculate the distance between each data point and the centroids and assign each data point to the centroid that is closest to it.

**Update centroids:** Calculate the average coordinates of the data points in the same cluster as the new centroid of that cluster.

Repeat steps 5 and 6 until the centroid no longer changes or until the preset number of iterations is reached.

**Result interpretation:** Based on the clustering results, determine the site selection plan.

For example, the city can be divided into several categories, each with a corresponding centroid representing the representative location of that category. Based on the clustering results, pre-warehouses can be established near the centroids of each category to better serve consumers in that category. At the same time, the number and distribution of pre-warehouses can be determined based on the distance between the centroids and other categories, in order to maximize logistics efficiency and reduce costs.

## 6. Conclusion

A well-known e-commerce company used multiple methods to research and analyze before selecting a location for its forward warehouse. The company first analyzed customer order data using big data technology to determine

the distribution area for the forward warehouse. Then, the company used geographic information systems to analyze factors such as transportation, population, industrial structure, and market capacity in the selected area, and used big data technology to predict the market competition and development prospects in the selected area. After several field inspections and research, the company finally chose to build the forward warehouse in a city with a dense population, convenient transportation, and a relatively complete industrial structure, and used artificial intelligence technology to optimize the storage, transportation, and delivery processes. This forward warehouse location scheme not only optimized the logistics process, but also improved work efficiency, reduced costs, and enhanced customer service quality and satisfaction.

This case shows that by fully utilizing new technologies and methods such as big data and artificial intelligence in the selection of forward warehouse locations, companies can analyze and predict market and environmental factors more scientifically and develop more reasonable and effective location selection plans. This can not only bring significant economic benefits to the enterprise, but also enhance the core competitiveness of the enterprise.

Through the analysis of the problem of forward warehouse location selection in this article, methods such as data mining, multi-index decision-making, artificial intelligence, and geographic information systems were proposed to solve the problems in the location selection process and improve the accuracy and efficiency of location decision-making. In future research, it is necessary to further explore the specific implementation and application of these methods in order to better solve the problem of forward warehouse location selection.

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