

Review on Location of Fresh Cold Chain Logistics Distribution Center

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Abstract: This paper reviews the research status, existing problems and challenges, and future research directions of the location of fresh cold chain logistics distribution centers. The research background is based on factors such as the development of the fresh product market, the technological progress of cold chain logistics, the requirements of environmental protection and sustainable development, and the intensification of market competition. The significance of site selection includes improving transportation efficiency, reducing costs, improving customer satisfaction, optimizing supply chain networks, and achieving environmental sustainability. The former focuses on low-carbon, demand uncertainty, and competitive distribution center location, while the latter focuses on the new retail environment and cold chain distribution. The review of relevant literature points out that some progress has been made in the research, but there are challenges such as market demand uncertainty, incomplete data and limited model applicability. Future research directions include the location model of cold chain logistics distribution center based on big data, the location model considering sustainable development factors, and the location method of cold chain logistics distribution center integrating multi-index evaluation. In the conclusion, it is pointed out that in the past, the time window and the overall logistics network were rarely used as research evaluation indicators in the site selection problems, and the cost of reverse logistics and closed-loop supply chain was rarely considered. In the prospect part, it is proposed that in the future, we should pay attention to the problems of reverse logistics and closed-loop supply chain in the distribution of fresh agricultural products, consider the multi-objective optimization of low-carbon cold chain logistics network in different policies and fields, and combine full simulation technology and optimization technology to realize the system optimization research.

Keywords: Fresh cold chain logistics, Distribution center location, Low-carbon distribution.

1. Research Background and Significance

1.1. Research Background

With the increasing demand for healthy and fresh food, the market size of fresh products is expanding. However, the particularity and perishability of fresh products make them face many challenges in the process of logistics distribution, such as preservation and quality control. Therefore, it is particularly important to study the location and optimization of fresh cold chain logistics distribution center. At the same time, with the continuous development and innovation of fresh cold chain logistics technology, such as technological progress in temperature control, fresh-keeping packaging and transportation tools, the logistics transportation capacity of fresh products has been significantly improved. This has prompted researchers to conduct more in-depth research on the location and layout of fresh cold chain logistics distribution centers in order to further optimize logistics efficiency and reduce waste of resources. Moreover, the process of fresh cold chain logistics requires a lot of energy and resources, such as refrigeration equipment and packaging materials. The research on the location and design of fresh food cold chain logistics distribution center can effectively reduce energy consumption and environmental pollution, which is in line with the requirements of sustainable development and environmental protection in modern society. With the development of e-commerce and supply chain management, the quality and efficiency of logistics and transportation services have become the key factors in the competition of enterprises. The location and layout of

logistics distribution center for fresh cold chain products directly affect the supply chain efficiency, commodity quality and market competitiveness of enterprises. Therefore, the research on the location of fresh cold chain logistics distribution center is helpful for enterprises to improve their logistics operation ability and market competitiveness.

To sum up, the research background of fresh cold chain logistics distribution center is due to the rapid development of fresh products market, the progress of fresh cold chain logistics technology, the requirements of environmental protection and sustainable development, and the intensification of market competition. Researchers' research on the location of fresh cold chain logistics distribution center is helpful to optimize logistics efficiency, reduce costs, and adapt to the growing market demand for fresh products.

1.2. Research Significance

The location and layout of fresh cold chain logistics distribution center is very important to optimize the efficiency of logistics transportation. Through reasonable location and layout, the transportation distance can be shortened, the transportation time and loss can be reduced, and the freshness and quality of products can be improved. Reasonable location of distribution center can reduce the cost of logistics operation. By choosing a location close to suppliers and consumers with convenient transportation, distribution centers can reduce transportation costs, reduce fuel consumption, and reduce losses and risks in the transportation process. The location of fresh cold chain logistics distribution center directly affects the ability of products to be delivered to customers in a timely and safe manner. Through reasonable location, we can shorten the distribution time, reduce the loss of goods and quality

problems, improve customer satisfaction and loyalty, and enhance the competitiveness of enterprises. The rationality of the location of fresh cold chain logistics distribution center can meet the needs of the supply chain network. Through site selection, a closer supply chain network can be formed, connecting manufacturers, distribution centers and consumers, reducing intermediate links, and improving the reliability and flexibility of the supply chain. The process of fresh food cold chain logistics needs a lot of energy and resources, such as refrigeration equipment and packaging materials. Reasonable location and layout can reduce energy consumption and environmental pollution, meet the requirements of sustainable development, and reduce the adverse impact on the environment.

To sum up, the research significance of fresh cold chain logistics distribution center is to improve transportation efficiency, reduce operating costs, enhance customer satisfaction, optimize the supply chain network and achieve environmental protection and sustainable development. These studies can provide effective decision support for enterprises, optimize logistics operations, improve competitiveness, and contribute to the sustainable development of the whole fresh product supply chain.

2. Research Status

2.1. Research on the Location of Logistics Distribution Center

At present, most of the studies focus on the location of non-cold storage distribution center facilities, mainly focusing on the location of distribution centers from the perspectives of low carbon, demand uncertainty, competitive distribution center location and customer choice behavior.

2.1.1. Site selection of low-carbon distribution center

Yang Jun explored the impact of carbon emission policies faced by logistics enterprises in supply chain operation, explored the impact of different carbon emission policies on the distribution mode of logistics enterprises, and established the corresponding location model. Through the strategy analysis under different policies to guide enterprises to carry out energy saving and emission reduction, and then select the optimal decision.

Wang Mengmeng designed a two-stage heuristic algorithm to establish the damage function of perishable products and reduce carbon emissions by optimizing the supply chain links of perishable products. Combining the multi-distribution center location, vehicle routing and inventory management strategy, the location-route-inventory joint optimization model of perishable products supply chain considering the stochastic demand of customers is proposed.

Guo Peipei introduces carbon quota and carbon trading mechanism into the inventory and location decision-making of enterprise supply chain under the background of product enterprises which are easy to disassemble and assemble. By simultaneously optimizing carbon trading costs and operating costs, a nonlinear integer programming model with complex constraints is established to solve the supply chain inventory and location for product families under the carbon trading policy.

Gan Weihua used stochastic programming theory to study the distribution center location problem of O2O retail enterprises with the lowest total cost as the objective function and carbon emissions and time constraints as the constraints.

Zhang Siying proposed a bi-level programming model to make optimal decisions on the transformation of cold storage for cold chain logistics in low-carbon cities. The decision-making department of the upper model is the competent department of cold chain logistics. It studies the two policies of carbon emission trading and carbon emission reduction subsidies of the joint government, which are represented by carbon emission quota and unit carbon emission reduction subsidy rate respectively. The total cost of the whole cold chain logistics system is minimized.

2.1.2. Location of distribution center with demand uncertainty

Li Zhenping studied the location and inventory optimization of terminal logistics center under the condition of uncertain customer demand on the basis of "autonomy + outsourcing". Under different circumstances, considering the sum of expected value of fixed operation cost, pre-set cost, self-run distribution cost, outsourcing distribution cost and shortage loss cost of self-run distribution center, a two-stage continuous stochastic programming model is constructed.

Wang Haijun and others studied the emergency logistics location-route problem in emergency situations. Under the assumption that the demand of emergency supplies for each demand point and the travel time between each demand point are uncertain, a time-optimal and cost-minimum two-objective stochastic programming model with specific emergency constraints is constructed by using the chance constraint theory, and the genetic algorithm is used to solve the model.

The Zarandi first introduced the FTW variable into the LRP problem model, and proposed the LRPTW problem model with fuzzy customer requirements and time window variables under the uncertain environment; He believes that in real life, the needs of customers tend to be in a certain period of time, early or late will affect customer satisfaction, so when studying such problems, the time window can be blurred, which is conducive to improving the quality of service.

Luo Yaobo and Sun Yanming constructed a location-routing problem with volume constraints based on fuzzy time windows (Capacitated Location Routing Problem with Fuzzy Time Windows, CLRPFTW), and a two-stage simulated annealing algorithm is designed to solve the model.

Luo Yaobo and others have also studied the LRP problem considering inventory capacity, vehicle capacity constraints and the need to meet customer soft time window requirements. A Multi-Depot Location Routing Problem (MDLRP) model with soft time windows and return demand is established, and an improved hybrid genetic algorithm is used to solve the model.

2.1.3. Competitive Distribution Center Location

Li Zhenping studied the competitive selection of distribution centers with geographical restrictions. On this basis, a new distribution network planning method with geographical barriers is proposed, and on this basis, a distribution network planning method considering geographical barriers is constructed by introducing location costs and transportation costs. On this basis, by introducing the appropriate "0-1" variable, the improved distance function based on the "1-0" piecewise expression is expressed as a nonlinear function, and then it is transformed into a nonlinear optimization problem.

Wang Jun takes the distribution center in the oligopoly

market as the research object, constructs a competitive location model on the basis of two-level programming, and analyzes the competitive relationship between the distribution center of each company and the demand side of distribution service. To seek the maximum value of the revenue of the distribution center, and the following objective function is to minimize the generalized cost of the distribution service party.

2.2. Research on Distribution of Fresh Cold Chain Products

Zhao Quanwu In view of the new retail environment, taking fresh e-commerce as an example, aiming at the location of multi-category retail stores and the configuration of terminal demand points, combined with the layout and coverage of multi-category retail stores, the configuration of cold chain facilities, the selection of refrigerated products and other characteristics, A nonlinear mixed integer programming model based on multi-category retail stores is established, and a Lagrangian relaxation algorithm is designed and applied to CPLEX to test its effectiveness.

Fang Wenting established a mathematical model for cold chain logistics path optimization with the objective of minimizing the total cost. Aiming at the problem of slow convergence caused by the lack of pheromone in the initial stage of ant colony algorithm, A hybrid ant colony algorithm is constructed by combining A * algorithm with ant colony algorithm and using the global convergence of A * algorithm and the positive feedback of ant colony algorithm.

Zhang Wenfeng proposed a nonlinear mixed integer programming model with the construction cost and operation cost of the cold chain logistics network as the optimization objective for the network layout and transportation of the cold chain logistics network. The model needs to meet the maximum distance constraint of the network at the same time. The output constraint of the origin and the maximum capacity constraint of the network point, and then the quantum particle swarm algorithm is used to solve the model.

Chen Jiumei established a multi-compartment vehicle routing optimization model for fresh agricultural products with the objective of minimizing the distribution cost of fresh agricultural products distributors, and then designed a particle swarm algorithm to solve it. Finally, the superiority and stability of the particle swarm optimization algorithm in solving the multi-compartment vehicle routing problem of fresh agricultural products are verified by an example.

Wang Jing designed a multi-product and staged fresh food cold chain operation mode based on temperature control by using the quality attenuation principle of fresh food, and established a mathematical model to locate the cold chain distribution network by using particle swarm algorithm.

2.3. Review of Relevant Literature

Domestic and foreign researchers have analyzed the market demand, traffic conditions, human resources and environmental factors, and discussed the impact of these factors on the location of logistics distribution center. Researchers have proposed a variety of site selection methods and models, including traditional methods (such as expert experience method, economic analysis method, analytic hierarchy process, principal component analysis method, DEA, AHP And mathematical models and algorithms (such as metaheuristic algorithms, multivariate integer linear programming models, genetic algorithms, quantum-behaved

particle swarm optimization, ant colony algorithms, Artificial bee colony algorithm) etc., to assist decision makers in making location decisions.

In addition, there are geographic information system (GIS) technology, the use of geographic data and spatial analysis tools to improve the accuracy and efficiency of logistics distribution center location. Logistics distribution center location research has crossed the boundaries of logistics disciplines, involving economics, operations research, geography and other disciplines. The effectiveness and applicability of the location model and method are verified by the investigation and analysis of the actual cases at home and abroad.

Although some progress has been made in the research of logistics distribution center location, there are still some challenges, such as the uncertainty of market demand, incomplete data, and the limitation of model applicability. Future research can further improve the accuracy and effectiveness of location decisions based on new technologies such as big data and artificial intelligence, and further consider sustainable development factors to provide a more comprehensive solution for the location of logistics distribution centers.

At the same time, the location of the distribution center mainly focuses on the research of the location model of the distribution center, aiming at finding the optimal location through various mathematical models and methods, but there may be some problems in the actual location process, so the location of the distribution center should be consistent with the actual logistics network.

Cold chain fresh food logistics can be divided into cold chain logistics, fresh food cold chain, medicine cold chain, flower cold chain and chemical cold chain according to its service object. On this basis, this paper puts forward the cold chain technology of food quality and safety based on cold chain, three-party or four-party cold chain logistics based on cold chain, cold chain logistics based on emergency state, and the optimization problem based on cold chain logistics network. At the same time, we can also divide the cold chain logistics network optimization research into: location, inventory, VRP, LIP, IRP, LRP, LRIP, etc. They are divided into single-objective and multi-objective problems according to the different objectives to be solved. According to the different constraints, it can be divided into: considering multi-stage, multi-type products, multi-cycle, multi-temperature, multi-depot, multi-vehicle, open depot, soft time window, hard time window, fuzzy time window, etc. At the same time, we have to face the problems of inventory shortage cost, fuel consumption cost, cargo damage cost and so on. The algorithm which is suitable for a certain type of model will no longer be used, and the construction of a suitable model and the design of the corresponding multi-objective algorithm have become the focus of research.

3. Problems and Challenges in the Location of Fresh Cold Chain Logistics Distribution Center

3.1. Uncertainty of Market Demand

The key to solve the problem of demand uncertainty in the location of cold chain logistics distribution center is to strengthen market research, data analysis and communication with potential customers, as well as to establish partnerships

to cope with changes and uncertainties in demand. Conduct detailed market research in the target area to understand the local cold chain logistics market size, consumption trends, competitors, etc., in order to better predict future demand.

Firstly, data analysis, data model, collection, collation and analysis of relevant data, including population, population density, consumption capacity, logistics demand and other indicators. Through the analysis of the data, we can find out the potential demand growth points and the demand characteristics of different regions.

Furthermore, we should fully communicate with potential customers and partners to understand their needs and expectations for cold chain logistics services.

Establish partnerships with relevant suppliers, logistics service providers and regional cold chain enterprises to share information and resources. In this way, we can better grasp the market dynamics and adjust the location strategy in time.

For the scenario with uncertain demand, the location scheme with certain flexibility is selected. For example, you can choose a site with a large land area or scalability to expand or adjust in the future as needs change.

3.2. Trouble of Incomplete Data

Consult with a team of industry experts or consultants who often have the experience and knowledge to provide information on industry trends, market size, demand forecasts, etc. To help make more accurate location decisions. Consult relevant literature to synthesize data and indicators.

According to the existing data, a data model is established for analysis and prediction. Using the trend and related indicators of the existing data, we can predict the trend and estimate the market demand. At the same time, the model can be used for sensitivity analysis to understand the impact of various factors on the location decision.

3.3. Limitations of Model Applicability

Different models are used for comparison and analysis. By using multiple models, different results and predictions can be obtained to help identify the differences and limitations between the models and find more accurate and reliable location options.

Continuously update and iterate the data in the model. The market environment and demand trends are constantly changing, so regular updating of data and model iteration can better reflect the current market and demand situation and reduce the limitations of the model.

The risk and uncertainty of the model are evaluated through sensitivity analysis and risk assessment. In addition, the robustness and reliability of the model can be evaluated by simulating and testing the changes of different scenarios and variables.

4. Future Research Directions

4.1. Location Model of Cold Chain Logistics Distribution Center Based on Big Data

The location model of cold chain logistics distribution center based on big data can use big data analysis technology and tools, combined with relevant data sources and algorithms, to achieve more accurate and data-driven location decisions. Collect relevant big data, including population data, economic development indicators, transportation network,

consumer behavior, supply chain data, etc. Data can come from government statistics, enterprise databases, logistics operators, social media and other channels. According to the location objectives and needs, select the appropriate model for modeling. Use regression models, meta-heuristic algorithms, time series analysis models, etc. Algorithms such as machine learning and deep learning can be used for model training.

4.2. Location Selection Model Considering Sustainable Development Factors

The location model considering sustainable development will focus on the factors of environmental protection, social responsibility and economic sustainability. Environmental assessment: assess the environment of the site area, including natural environment, ecosystem, water resources, soil quality, etc. Consider air quality, water quality, noise pollution and other indicators to avoid excessive negative impact on the environment.

Consider the social factors of the location area, including population density, quality of life of residents, community conditions, etc. It is necessary to pay attention to local social culture, education and medical resources to ensure that the site selection project has a positive impact on the local community and avoid social inequity.

Consider the transport network of the site area, including the convenience and sustainability of transport infrastructure such as roads, railways, ports and airports. Choosing a location with convenient transportation can reduce distribution costs, reduce energy consumption, and reduce the negative impact on the transportation network.

Comprehensively evaluate the above factors, and make multi-dimensional trade-offs and decisions. Consider the long-term development and sustainability of the project, such as adapting to the future development trend, building the future logistics network, etc.

4.3. Cold-chain Logistics Distribution Center Location Method Based on Multi-index Evaluation

The cold chain logistics distribution center location method integrating multi-index evaluation can consider multiple key indexes in the location process, comprehensively evaluate the advantages and disadvantages of different location schemes, and make weighted decisions according to the importance of each index. Identify a set of key evaluation indicators, which should cover multiple aspects, such as market demand, cost-effectiveness, accessibility, environmental impact, etc.

Each indicator should correspond to a site selection goal and a sustainable development goal. According to the site selection target and specific situation, the corresponding weight is determined for each evaluation index. Through discussions with relevant stakeholders and expert opinion, weights can be determined using methods such as subjective evaluation or the Analytical Hierarchy Process (AHP).

Collect and collate data related to evaluation indicators, including market data, operating cost data, traffic network data, environmental data, etc. The data is analyzed and processed using statistical methods, data mining techniques, or specialized tools to gain insight into the site selection scheme. Different indicators are normalized to the same scale for comparison and weighted balance. Commonly used

methods include linear normalization, normalization, etc.

According to the weight of the index, the comprehensive score of each location scheme is calculated. The weighted decision can be made by the weighted sum method or the multi-criteria decision analysis method (such as TOPSIS, VIKOR, etc.). In this way, we can consider the importance of different indicators and comprehensively evaluate the advantages and disadvantages of each site selection scheme. The sensitivity analysis and risk assessment of the optimal location scheme are carried out. Evaluate the robustness and feasibility of the site selection scheme considering the changes under different scenarios and conditions.

Results interpretation and decision support based on the results of the weighted decision. Combined with the evaluation results and other relevant factors, the most suitable cold chain logistics distribution center location scheme is finally determined.

5. Summary and Outlook

5.1. Summary

Due to the perishable characteristics of fresh agricultural products, the quality and quality safety of the products tend to decrease with the increase of time, which requires that the cold chain logistics service of such products must consider its time-varying characteristics, and the research on the related problems with time windows has become the key point to solve this problem.

Previous distribution center facility location problems have considered demand uncertainty, competitive supply chain, and low-carbon context. The LRIP multi-objective optimization model of cold chain logistics is constructed by taking the minimum cost of distribution center location, the minimum cost of inventory and the minimum cost of vehicle transportation considering the cost of cargo damage as the objective function. However, in the fresh cold chain logistics distribution center location, the time window and the overall logistics network are rarely taken as the research evaluation index, and the cost of reverse logistics and closed-loop supply chain is rarely considered.

5.2. Outlook

With the increasing demand for fresh agricultural products and the rapid development of e-commerce for fresh agricultural products, the multi-objective optimization of cold chain logistics network will continue to be the focus and hot issue in this field, and it is imperative to solve the problems in its development process scientifically. At present, the theoretical basis, optimization model, algorithm improvement and application of LRIP multi-objective optimization problem of cold chain logistics network and distribution center location of fresh agricultural products have been studied, which are only some valuable attempts, and there are still many complex problems to be further explored and studied. Such problems mainly include:

When the delivery of fresh agricultural products exceeds the scheduled time or the quality deteriorates, the reverse logistics and closed-loop supply chain problems arise due to uncertainties such as customer rejection or replacement of products.

Research on LRIP multi-objective optimization of low-carbon cold chain logistics network considering different policies and different fields, such as carbon emission policies,

regulations and local policies formulated according to China's national conditions to study the multi-objective optimization of cold chain logistics network for different products; At the same time, factors such as customer's time window, environmental awareness, behavior preference, social welfare and environmental equity are added to the study of this kind of problem.

Combined with the full simulation technology and optimization technology, the system optimization research of the cold chain logistics network LRIP multi-objective problem is realized. The use of full simulation software or technology, such as ExtendSim software, can achieve a more comprehensive optimization of the logistics process.

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