

Research on Distribution Path Optimization of Agricultural Cold Chain Logistics Based on Genetic Algorithm

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Abstract

The variety and output of fresh agricultural products are increasing, which puts forward higher requirements for cold chain logistics and distribution. In the cold chain logistics system, distribution is a key link, which requires higher transportation technology and transportation environment. Route optimization of distribution links is extremely important in logistics optimization, and it is an indispensable part of distribution process optimization. However, problems such as unreasonable delivery time of trucks and long driving distance of empty cars often occur today. In order to improve this phenomenon, we should optimize the cold chain logistics distribution path of fresh agricultural products, improve the efficiency of cold chain logistics, reduce the distribution cost of fresh agricultural products and meet people's demand for fresh agricultural products. In this paper, an optimization model of fresh cold chain route distribution with comprehensive cost based on genetic algorithm is established, and the optimal distribution scheme with the minimum total distribution cost under the condition of meeting the customer's time window is studied. By scientifically and reasonably optimizing the cold chain logistics distribution vehicle route, the goals of reducing distribution cost, ensuring cold chain product quality and improving customer satisfaction can be achieved.

Keywords: *Cold chain products, Logistics, Genetic algorithm*

I . Introduction

Cold-chain logistics is a fast logistics mode that keeps the goods in the specified low-temperature environment all the time, maintains the quality of goods and reduces the loss of goods. Vehicle Routing Problem(VRP) refers to the location of the distribution center, the location and demand of customer demand points, and the cargo capacity and capacity of a certain number of distribution vehicles owned by the distribution center. On the premise of satisfying certain constraints, the vehicle distribution scheme is reasonably arranged with specific optimization indicators as the goal [1]. In the actual operation process of enterprises, except for some enterprises with large investment scale and advanced management, the route of distribution vehicles will be optimized [2]. Most smaller enterprises will assign distribution tasks to express delivery staff with low education level and weak optimization consciousness [3]. The variety and output of fresh agricultural products are increasing, which puts forward higher requirements for cold chain logistics and distribution. In the cold chain logistics system, distribution is a key link, which requires higher transportation technology and transportation environment [4]. Socialized and mature cold chain logistics is an unavoidable and urgent problem for fresh e-commerce. Many enterprises choose self-built cold chain logistics, repeated investment and offside operation because the market cold chain logistics can't meet customers' needs, resulting in waste of social resources [5]. From the perspective of supply and demand of fresh agricultural products, there are regional restrictions in the production and consumption of fresh agricultural products, and there is great asynchrony and contradiction between supply and demand. From the perspective of supply chain management, the timeliness of transportation and storage of fresh agricultural products increases the difficulty of logistics organization of fresh agricultural products [6].

Literature [7] studies the location-vehicle routing optimization problem with time window in perishable goods supply chain network. Literature [8] introduced the freshness loss coefficient to reflect the change of product

quality with time, and considered the two objectives of total distribution cost and customer satisfaction, established a multi-objective optimization model of distribution path of fresh agricultural products, and analyzed the sensitivity of the model parameters. Literature [9] studies the cold-chain distribution of perishable food, and optimizes the model of cold-chain food distribution with the aim of minimizing the cost and meeting the customers' pre-quality requirements for various foods. Literature [10] uses particle swarm optimization to solve the multi-objective cold chain distribution optimization model, and analyzes the sensitivity of carbon tax and refrigerated truck speed. Literature [11] aims at minimizing the transportation cost, and studies the common distribution of frozen foods with different characteristics. Literature [12] Considering the limitation of loading capacity related to the unit volume of different frozen foods, a vehicle routing optimization model for multi-variety quick-frozen food distribution was established and solved by genetic algorithm. Literature [13] studies the integrated scheduling problem of perishable goods production and distribution with time windows in time-varying road network environment, establishes a mixed integer programming model, and uses mixed genetic algorithm to solve it. In this paper, an optimization model of fresh cold chain route distribution with comprehensive cost based on genetic algorithm is established, and the optimal distribution scheme with the minimum total distribution cost under the condition of meeting the customer's time window is studied.

II. Logistics Network Planning of Fresh Agricultural Products Based on Cold Chain Logistics

A. Logistics Network Planning of Fresh Agricultural Products

Fresh agricultural products logistics is more difficult to organize than general logistics because of its complicated circulation channels, numerous intermediate links and benefit contradiction between logistics costs. Therefore, it is necessary to implement comprehensive systematic planning and layout for fresh agricultural products logistics, so as to ultimately reduce the overall cost of logistics operation and maximize efficiency. Cold-chain logistics refers to a logistics process in which some agricultural products and fresh products need to keep fresh agricultural products at a suitable humidity and temperature in order to ensure product freshness and reduce waste, so as to complete every link of product production, processing, logistics and transportation, warehousing and storage, and finally complete product sales [14]. Logistics network planning of fresh agricultural products mainly involves three links: data collection, model building and logistics network design. In view of the seasonal and regional characteristics of fresh agricultural products, and the general life cycle is short. In the logistics planning of fresh agricultural products, besides the structural design of circulation channels, the cold chain system and logistics system must be effectively combined. Therefore, the logistics planning of fresh agricultural products is to ensure the quality of fresh agricultural products, so that the whole logistics process can achieve the highest efficiency and the lowest cost.

Cold-chain logistics distribution of urban agricultural products refers to the short-distance road transportation and distribution activities that are sent from the distribution center to the clients within the city and suburban areas by using cold-chain professional equipment within a specified time. The basic process of cold chain logistics distribution of fresh agricultural products in cities is shown in Figure 1.

Compared with traditional normal-temperature logistics, cold-chain logistics is quite different in products, storage environment, vehicle selection, customers, transportation network, distribution center and so on. We compare and analyze normal-temperature logistics and cold-chain logistics by collecting data and consulting literature. Compared with the general logistics network, the logistics network of fresh agricultural products mainly includes agricultural products producing areas, precooling stations and distribution centers of fresh agricultural products, among which the agricultural products producing areas mainly include agricultural products producing bases and retail investors. In the whole cold chain logistics system, the cold chain logistics of fresh agricultural products is a very important component. Agricultural products should be kept fresh and safe in all aspects such as production, processing and distribution, and all links should be effectively connected. These links together constitute the supply chain of agricultural products, but the cold chain supply chain is not independent and needs to be effectively combined with other supply chains. Agricultural products in the downstream demand of cold chain

logistics have strict requirements for all links, and the overall logistics links and transaction times need to be highly organized, coordinated and systematic. Only in this way can we ensure the better quality and timeliness of fresh agricultural products.

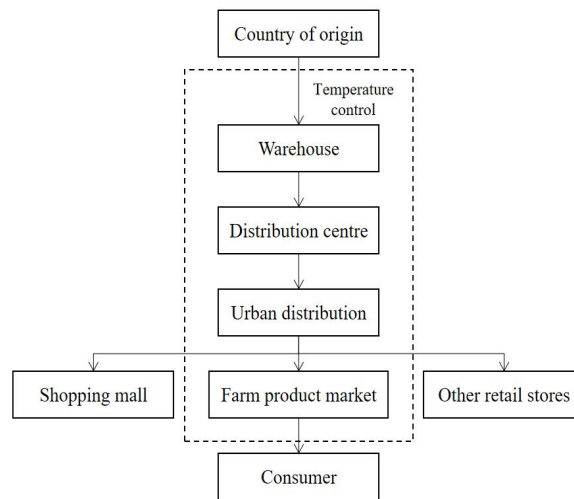


Fig.1 The Basic Process of Cold Chain Logistics and Distribution of Urban Fresh Agricultural Products

B. Cold Chain Logistics of Fresh Agricultural Products

Fresh agricultural products have very high requirements on transportation conditions and transportation time in the circulation process. Compared with ordinary logistics, cold chain logistics of fresh agricultural products has the following characteristics. Fresh agricultural products have their own particularity, and distribution enterprises should deliver the products to customers within the specified time. If the delivery time exceeds the specified time, fresh agricultural products will deteriorate or even rot, causing serious food safety problems, which will not only cause economic losses to distribution enterprises and customers, but also cause adverse effects on the environment. However, it is far from enough to ensure that the product is in a low-temperature environment during transportation. In order to ensure the quality and freshness, it is necessary to strictly control the temperature and keep it in a suitable low-temperature state in every link of the product from processing in the production factory to transportation, storage and even final sales. Compared with other circulating products, fresh agricultural products have higher requirements on transportation equipment, and need to be equipped with perfect refrigeration and freezing equipment, which all need a lot of financial support. At the same time, in the distribution process of fresh agricultural products, in order to ensure the freshness of agricultural products, refrigeration equipment should be kept on during the whole distribution process, which will consume a lot of energy and increase the distribution cost.

Genetic algorithm is an optimization method of efficient and parallel global search developed by mimicking the biological evolution mechanism. During the search process, the information of the search space is automatically obtained, and it is successively generated in the population of potential solutions through operations such as selection, crossover, and mutation. Approximately optimal solution. Let $x_i \in R^n$ be the factor that affects the optimization of the logistics distribution path, and y_i is the optimization value of the logistics distribution path. The optimization model of logistics distribution path based on genetic algorithm is to find the relationship between x_i and y_i :

$$f : R^n \rightarrow R \quad (1)$$

$$y_i = f(x_i) \quad (2)$$

R^n is a factor that affects the optimization of logistics distribution paths. The establishment of the logistics distribution route optimization model seeks to establish the following expressions:

$$f(x) = \sum_{i=1}^k (a_i - a_i^*) K(x, x_i) + b \quad (3)$$

In the formula: x is the factor that affects logistics and distribution, x_i is the i sample among the k samples, and $K(x, x_i)$ is the kernel function. The kernel function uses a radial basis function:

$$K(x, y) = \exp\left[-\frac{\|x - y\|^2}{2\sigma^2}\right] \quad (4)$$

In each generation of genetic algorithm, individuals are selected according to their fitness values in the search space, and new approximate solutions are generated, which promotes the evolution of individuals in the population and makes new individuals more adaptable to the environment than the original individuals. In order to better ensure that fresh agricultural products can be kept at low temperature, we need to start from the process of transportation and storage, and improve the grade of refrigeration equipment to achieve our established goal. The choice of refrigeration equipment is particularly important, for example, the choice of transport vehicles, the construction of pre-cooling stations and cold storage all need a large amount of financial support, and the related equipment will also consume a lot of electric energy and fuel during operation. In the cold chain logistics distribution of fresh agricultural products, we should not only pay attention to the timeliness of distribution, but also pay attention to the organization and coordination ability of distribution enterprises. In the specific process of distribution, there is often a phenomenon that the distribution vehicles fail to deliver products. If the distribution enterprises have poor coordination and management ability and fail to communicate with customers in time, the agricultural products will deteriorate or rot, resulting in economic losses.

The market demand for agricultural products has been fluctuating, so its transportation cost is also high. In the process of cold chain transportation, professional equipment is needed for management and operation, and the investment return period is long. In the process of cold chain transportation, the market demand and the price of fresh products fluctuate greatly, and natural factors such as traffic, weather, etc. will also cause the operation cost to increase and the energy consumption cost to be unstable. In the logistics industry, there is no unified definition of cold chain logistics. Generally speaking, cold chain logistics refers to the logistics business in which goods are kept in a suitable temperature and humidity state from production to final arrival at consumers, fully kept fresh during transportation, and the loss of goods is minimized.

III. Logistics Path Optimization of Fresh and Cold Chain

If the cold chain logistics transportation and distribution link takes too much time to exceed the time window specified by the customer, then although the products at this time may still be edible, the probability of selling them is greatly reduced. Low cost is not only the goal pursued by enterprises, but also the supply chain. Cost still has an unshakable strategic position. Refrigeration technology is applied to the whole logistics activities and special devices are used to monitor the transportation process, transportation form, time and temperature in real time. According to the development of logistics concept, combined with agricultural economic theory. The logistics of agricultural products is defined as the physical economic activity of agricultural products' material entities and related information from producers to consumers, which is customer-oriented and aimed at realizing

the value of agricultural products. In China's agricultural product logistics system, the mode dominated by wholesale market operators is dominant, which is suitable for China's small-scale peasant economy. Logistics operation is mainly based on traditional self-sufficient logistics, with low operation efficiency and complicated logistics circulation channels. Figure 2 shows the development process of cold chain quality evaluation system.

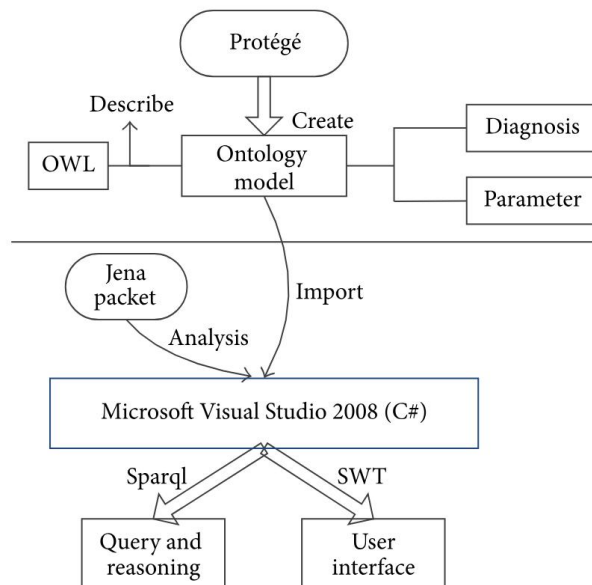


Fig.2 The Development Process of the Cold Chain Quality Assessment System

The operating cost of cold chain logistics is very high, including not only the operating cost of normal temperature logistics. Besides, it includes oil consumption, electricity cost, daily maintenance cost and depreciation cost of refrigeration facilities and equipment which are different from normal temperature logistics and needed to maintain low temperature environment. As far as the enterprise itself is concerned, many business processes of agricultural products trading enterprises are still in the past, and electronic information control and settlement systems are rarely used. The development of fresh agricultural products logistics lags behind, which affects the development of Chinese agriculture, causes its price to fluctuate greatly, and harms the interests of both consumers and producers. The special natural attributes of fresh agricultural products make the production process more dependent on natural forces, individual vitality of crops and natural conditions. In the process of cold chain, the whole process of cold chain logistics information system needs to be established, and the information transmission between e-commerce and customers needs a sound information exchange system. Therefore, the cold chain logistics system of fresh agricultural products of e-commerce can not be separated from advanced logistics information technology. The cold chain logistics monitoring system of agricultural products has different functions in the process of agricultural products production, processing, storage, transportation and sales.

IV. Conclusion

With the rapid development of social economy and the strong promotion of the attitude of green and healthy living, the problem of diet health has aroused the people's concern and attention. As the necessities of life, the freshness and quality of agricultural products are paid more attention, which makes the cold chain logistics, a new industry, gradually enter people's field of vision. In order to better meet people's needs, effective strategies must be adopted to optimize the cold chain logistics distribution path of fresh agricultural products. Based on the in-depth analysis of the distribution of cold chain logistics of urban agricultural products, this paper analyzes the distribution path of cold chain logistics of agricultural products with the factors such as cost, time, waiting time for loading and unloading as the optimization objective. When optimizing the distribution path, we can make full use of information technology to build a network information platform for cold chain distribution. In this paper, genetic algorithm is combined with distribution path optimization, and the realization conditions of genetic algorithm in

logistics distribution path optimization are proposed. The higher the priority of fresh delivery, the lower the satisfaction of customer satisfaction time window, and vice versa. However, the influence of fresh delivery priority on the actual delivery cost is uncertain, but it will generally increase the actual delivery cost of delivery vehicles.

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