

Research on Optimization of Logistics Ordering and Crowdsourcing Delivery Models in the Digital Context: A Case Study of Dingdong Maicai Fresh Food Platform

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Abstract

Fresh products are characterized by perishability, seasonality, and susceptibility to spoilage, making them highly sensitive to time and environmental factors, which often leads to safety risks during circulation. Although distribution models centered around chain supermarkets have flourished in China, significant safety concerns persist. At present, the transportation and delivery of fresh foods in China primarily rely on room-temperature logistics, resulting in substantial product losses during these processes. Therefore, key issues include how to reduce spoilage rates in logistics and distribution, ensure product freshness, and explore methods to optimize logistics ordering and crowdsourced delivery models. This study focuses on the logistics and distribution models of fresh products, taking Dingdong Maicai as a case study. By analyzing its current logistics framework and leveraging digital technologies such as big data, smart logistics, and artificial intelligence, the research aims to enhance supply chain efficiency, refine crowdsourced delivery systems, and propose practical recommendations and optimization strategies for its logistics model.

Keywords

Digital Logistics; Fresh Product Platforms; Crowdsourced Delivery; Supply Chain Optimization; Dingdong Maicai

1. Introduction

1.1 Research Background

In recent years, with the widespread application of the Internet, big data, artificial intelligence, and other technologies, the digital economy has become an important driving force for global economic growth. Under the wave of digitalization, China's fresh e-commerce market has risen rapidly, with the market size exceeding 500 billion yuan in 2023 and an annual growth rate maintained at over 20%. Driven by

consumer demand for immediacy, freshness, and convenience, fresh e-commerce has been transitioning to a model of "online ordering + instant delivery," making logistics and delivery efficiency a core element of industry competition.

Fresh products are characterized by perishability, short shelf life, and high loss rates, which pose high demands for supply chain management. However, traditional fresh product logistics have the following shortcomings: Difficult inventory management: Large demand fluctuations can lead to inventory accumulation or stockouts; High cold chain costs: The requirement for full-process temperature control increases logistics costs; Strong delivery timeliness: Consumers expect delivery within 30 minutes to 1 hour; Low efficiency of last-mile delivery: Traditional logistics models struggle to meet the demands of high-frequency, small-batch deliveries. To address the "last-mile" delivery challenge, many fresh e-commerce platforms widely adopt the crowdsourced delivery model, which utilizes idle social transportation capacity (such as riders, private cars, etc.) for instant delivery. This model has the advantages of high flexibility, low cost, and strong scalability. However, it also has drawbacks, such as inconsistent service quality, which affects user experience; order allocation and route planning rely on manual experience, resulting in low efficiency; and high rider turnover, which impacts delivery stability.

Dingdong Maicai, as a leading fresh e-commerce platform in China, adopts a "forward warehouse + instant delivery" model. Its core strengths are as follows: (1) Intelligent warehouse management—relying on big data to predict demand and optimize inventory; (2) Efficient crowdsourced delivery system—integrating social transportation capacity to achieve 30-minute delivery; (3) Digital supply chain integration—data-driven across the entire chain from procurement to warehousing and delivery. However, as its business scale expands, Dingdong Maicai still faces issues such as low inventory turnover rate, rising delivery costs, and insufficient rider scheduling efficiency. It urgently needs to optimize its logistics and delivery model with the help of digital technologies (such as AI, the Internet of Things, blockchain).

1.2 Research Significance

1.2.1 Theoretical Significance

This research explores the specific application of big data, artificial intelligence, and other technologies in fresh supply chains, making up for the shortcomings of traditional supply chain theories in high-timeliness and high-loss rate scenarios. It constructs dynamic ordering models and intelligent delivery scheduling algorithms suitable for fresh e-commerce, providing a theoretical framework for related studies. Existing crowdsourced delivery research mostly focuses on the food delivery and courier industries. However, fresh delivery has particularities in terms of timeliness, temperature control requirements, and order volatility. Combining the case of Dingdong Maicai, this research proposes an optimization model for fresh crowdsourced delivery, supplementing the existing crowdsourced logistics theory

system. Integrating theories of smart logistics, sharing economy, and platform economy, it explores how digitalization empowers fresh e-commerce to reduce costs and increase efficiency. It provides empirical support for the integration of the digital economy and the real economy. Under the digital background, innovative research on the logistics and delivery model of fresh agricultural products will offer references for the future development of smart logistics and provide ideas for the logistics industry that combines big data, cloud computing, and artificial intelligence.

1.2.2 Practical Significance

Firstly, through AI-based demand forecasting and intelligent restocking, it reduces inventory accumulation and product expiration; optimizes forward warehouse stocking strategies to improve capital utilization efficiency; and through digital collaboration (suppliers, warehousing, delivery), it copes with sudden demand fluctuations. Secondly, based on real-time traffic, rider location, and order urgency, it optimizes dispatch logic; uses reinforcement learning algorithms to reduce rider delivery time and lower empty running rates; and establishes a scientific credit evaluation system to increase rider retention and service quality. Thirdly, in terms of logistics costs, it reduces losses through IoT monitoring of temperature control links; reduces redundant rider demand through intelligent scheduling to improve labor efficiency; and replaces traditional experience-based management to reduce trial-and-error costs. Through algorithm optimization, it achieves "30-minute delivery" or even shorter delivery times, while reducing stockouts, omissions, and delays, enhancing user stickiness. Finally, it provides full logistics tracking to enhance consumer trust. As an industry benchmark, Dingdong Maicai's optimization experience can be promoted to similar platforms such as Meituan Maicai, Hema Fresh, and MissFresh. It also provides references for the digital transformation of traditional supermarkets and community group buying. At the same time, it offers data support for the government to formulate fresh e-commerce support policies (such as cold chain infrastructure and crowdsourced rider rights protection), thereby promoting the construction of urban smart logistics systems and optimizing urban delivery networks. In summary, optimizing the logistics and delivery model will reduce logistics costs and improve logistics efficiency for agricultural producers, bringing better returns and promoting the sale of agricultural products. For fresh e-commerce, breakthroughs in model innovation will enhance corporate competitiveness and increase customer loyalty.

2. Review of Domestic and International Research on Logistics and Delivery Models

2.1 Current Domestic Research

Research on fresh agricultural product logistics and delivery models in China started relatively late but has yielded fruitful results. It mainly focuses on the concept of

joint delivery, optimization of delivery models, and comparative studies of delivery models. There are also some studies on cost control and profit sharing of delivery models. Zhao Hongmei (2016) analyzed the mechanism of fresh agricultural product logistics and delivery models in rural areas under the e-commerce environment and proposed countermeasures for applying e-commerce delivery models to rural fresh agricultural product logistics in China [1]. Li Li (2017) took the integration of fresh agricultural product logistics under the e-commerce environment as the research object. By sorting out the current situation of fresh agricultural product circulation at home and abroad, she constructed an integrated logistics and delivery model for fresh agricultural products under the e-commerce environment [2]. Chen Letian (2015) sorted out the development status of fresh agricultural product logistics under the e-commerce environment and analyzed the existing problems. By learning from the development models of fresh agricultural product logistics in developed countries, he proposed countermeasures for the development of fresh agricultural product logistics in China under the e-commerce environment [3]. Li Xiao (2018) pointed out that China's fresh agricultural product e-commerce delivery faces problems such as high delivery costs, high loss rates, and lagging cold chain logistics. There are many challenges in the application of big data in fresh agricultural product e-commerce delivery. He proposed optimizing fresh agricultural product e-commerce delivery through big data [4]. Chen Gang (2017) based on the online/offline transaction mode of fresh agricultural products, analyzed the advantages and disadvantages of the same-city delivery mode of fresh agricultural products, and put forward constructive suggestions to provide theoretical references for the sustainable development of domestic fresh agricultural product e-commerce and to improve consumer protection[5].

2.2 Current International Research

At present, the agricultural product logistics models abroad are mainly represented by the United States and Japan. The United States mainly targets supermarkets as the main distribution objects, while Japan mainly targets small-scale agricultural product wholesale markets. Foreign scholars' research on fresh agricultural product logistics and delivery models mainly focuses on how to continuously optimize the allocation in the logistics and delivery process to reduce delivery costs and improve delivery speed and efficiency. Bortolini M (2016) proposed a three-objective delivery planning method based on operational costs, carbon footprint, and delivery time targets for the tactical optimization problem of fresh food delivery networks [6]. Faccio M (2013) established a linear programming model in a food delivery network to manage delivery according to customer demand frequency and quantity [7]. Hsu C I (2011) proposed a new technology for multi-temperature joint distribution and developed a "multi-temperature co-delivery" model to ensure the quality of fresh agricultural products at a lower transportation cost[8]. Kuo J C (2010) established a multi-temperature control food cold chain joint delivery model to improve logistics

and delivery efficiency [9]. Ahumada O (2012) proposed a stochastic tactical planning model for fresh agricultural product production and delivery considering uncertain factors to reduce losses and costs of fresh agricultural products [10]. Zhong A W (2013) explored the informatization, efficiency, and supervision of agricultural product logistics from the perspective of fourth-party logistics. It was concluded that building a fourth-party logistics system can reduce agricultural product logistics costs and improve delivery efficiency [11]. Sheu J B (2007) proposed a comprehensive logistics and delivery method based on fuzzy optimization of customer groups, which can quickly respond to various customer needs. The example calculation results show that this method can improve the overall performance of the logistics and delivery system by more than 20%[12].

3. Analysis of the Current Status and Development Trends of Fresh Product Logistics and Distribution Models

3.1 Analysis of the Current Status and Issues of Fresh Product Logistics and Distribution Models

The study of logistics and distribution models for fresh products is typically based on e-commerce platforms and encompasses two main segments: from suppliers to consumer distribution hubs, and from these hubs to end consumers. The e-commerce distribution from suppliers to consumer distribution hubs mainly includes three modes: in-house delivery, third-party logistics (3PL) delivery, and joint delivery[13]. Meanwhile, the delivery from consumer distribution hubs to end consumers primarily involves home delivery, smart locker pickup, and in-store collection. Many researchers have proposed optimization solutions that integrate these two segments to enhance overall efficiency[14]. The e-commerce distribution model is illustrated in Figure 3.1.

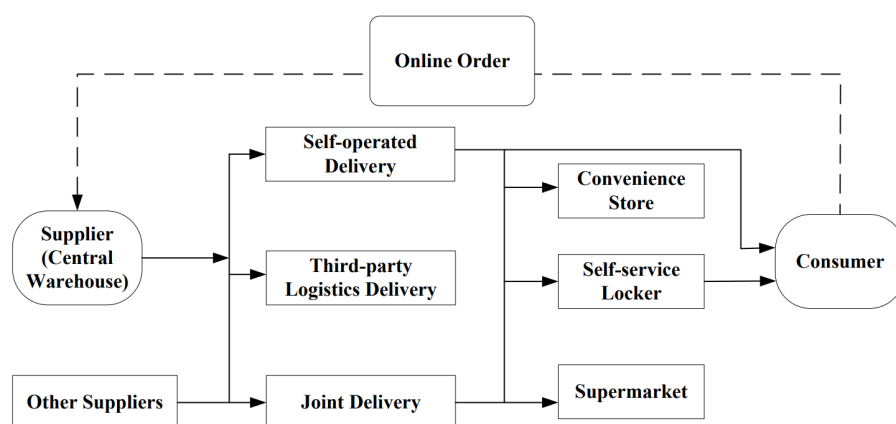


Figure3-1. E-commerce Delivery Model Diagram

To date, fresh e-commerce platforms can be categorized into three main types. The

first type includes platform-based e-commerce models, which are traditional e-commerce platforms like Tmall and JD.com that have expanded into fresh agricultural products. Examples include Tmall's Miaoxian and JD Fresh. The second type is the O2O model, which integrates online and offline platforms. These platforms, such as Shixing Fresh, combine online e-commerce with offline physical stores. The third type is the comprehensive e-commerce model, which includes platforms like Walmart's online supermarket and SF selective preference. These are large retail or logistics companies that have ventured into the fresh product sector[15].

Despite the innovative delivery models under different e-commerce modes, the primary methods still rely on a combination of in-house delivery, third-party logistics (3PL) delivery, and joint delivery, complemented by various end-delivery formats to ensure products reach consumers[16]. Each of these three main delivery methods has its own characteristics and is suitable for different platform development scenarios.

3.1.1 In-house Delivery Model

The in-house delivery model typically refers to e-commerce companies establishing their own logistics operations. The company independently manages the logistics system, and all related management activities are conducted by internal departments. E-commerce companies can strategically invest in logistics equipment and build warehouses according to their plans, while also handling logistics, warehousing, and delivery functions.

The greatest advantage of the in-house delivery model is its strong business focus and speed, which can enhance the consumer shopping experience and meet consumer needs, thereby increasing consumer loyalty to the e-commerce platform. This model also makes logistics operations more flexible and allows for precise control over delivery information, which is beneficial for traceability and analyzing consumer demands, especially in the era of big data.

However, [17]the disadvantages of the in-house delivery model are also significant. The construction and operation costs are high, requiring substantial initial investment. Small-scale e-commerce companies may find it challenging to establish a complete in-house delivery system. Moreover, the benefits of this model only become apparent when the logistics operations reach a certain scale. Additionally, the flexibility of in-house logistics may be limited, making it difficult to adapt to rapidly changing delivery requirements.

3.1.2 Third-Party Logistics (3PL) Model

The 3PL model involves e-commerce companies outsourcing all or part of their logistics operations to professional third-party logistics providers. By outsourcing logistics, e-commerce companies can save resources and leverage the expertise of third-party providers, thereby reducing human, material, and financial costs.

The advantages of the 3PL model include its professionalism. Third-party logistics

companies are experienced, specialized, and have a wide service range, which allows them to quickly set up logistics operations for e-commerce businesses. This model also facilitates business expansion for e-commerce companies and reduces operational costs[18].

However, the 3PL model has its drawbacks. It is less tailored and timely compared to in-house delivery. Third-party logistics providers cannot customize delivery solutions specifically for individual e-commerce companies. When e-commerce companies outsource their delivery operations, they lose control over the delivery process, especially regarding logistics data, which is not conducive to the company's development and adjustment.

3.1.3 Joint Delivery Model

The joint delivery model involves multiple e-commerce companies sharing the same third-party logistics provider for their delivery services. The third-party logistics company centrally plans and schedules the delivery of goods from various e-commerce companies. The essence of joint delivery is to reduce delivery costs and improve the efficiency of logistics resource utilization through economies of scale.

The advantages of the joint delivery model are that it can leverage the strengths of multiple e-commerce companies and meet their delivery needs simultaneously. This not only reduces logistics costs but also enhances the coordination of delivery operations, significantly improving delivery efficiency.

However, the joint delivery model has its limitations. The entire delivery process is shared among multiple companies, and if one company fails to cooperate or withdraws, it can disrupt the delivery operations and affect consumer trust in the companies involved. This model lacks autonomy and flexibility. Therefore, e-commerce companies should carefully consider this logistics model in the absence of standardized management[19].

In summary, while the three e-commerce logistics and delivery models have matured, their shortcomings are undeniable. Fresh agricultural products are perishable and have high loss rates, which require faster delivery speeds and stricter temperature and humidity controls during delivery. However, the current delivery of fresh agricultural products is not perfect, primarily relying on room-temperature transportation and using only ice or dry ice for preservation, which does not effectively reduce product losses. Additionally, fresh agricultural products have different preservation difficulties and packaging requirements due to their differences, and the lack of standardization makes it challenging to deliver differentiated products. Moreover, consumers of fresh agricultural products are scattered, with small, non-concentrated, and random demands, which also impact logistics and delivery. These issues cannot be resolved under various e-commerce platforms. Therefore, in the context of new retail, it is necessary to not only limit delivery models to the above but also innovate logistics and delivery models as the new retail business model continues to break through[20].

3.2 Analysis of the Development Trends of Fresh Product Logistics and Distribution Models in the Digital Age

3.2.1 Data-Driven Technology Model

Data technology is integrated throughout the logistics and retail process, combining online and offline operational models to enhance overall retail efficiency. Big data, cloud computing, and mobile internet technologies drive the operation of fresh product logistics and distribution models in the context of new retail. For instance, big data plays a crucial role. The areas closest to consumers often experience the earliest consumption changes. To adhere to the principle of consumer-centricity, it is essential to collect consumer data and apply big data analytics. This is because data is the foundation of new retail, and big data is its driving force. Only by improving the ability to acquire and utilize data can companies continuously innovate and develop. The application of big data also relies on the completeness of network infrastructure, with the establishment of robust network infrastructure being the first step in conducting big data analysis.

In addition to big data, cloud computing, and the Internet of Things, the emerging blockchain technology has also promoted the development of new retail. It further optimizes business processes, reduces costs, and improves efficiency. Blockchain can also provide integrity assurance for retail and trace the origin of products to make information more transparent.

3.2.2 Building a Multi-Level Warehouse and Distribution Network System

To improve delivery efficiency, the trend in new retail is to develop a multi-level warehouse and distribution network system. Creating a multi-level distribution system is necessary because a few warehouses cannot achieve effective delivery. Each warehouse and distribution center must achieve networked collaboration and sharing to respond to orders as quickly as possible. The focus of multiple warehouses is on end-of-line storage, also known as forward warehouses. Only by having a scientifically reasonable warehouse layout close to consumers can logistics be safer and more efficient. Creating a forward warehouse layout has become one of the development directions of new retail. Creating a tiered distribution system aims to meet customer needs by classifying products and planning transportation routes according to the information system to improve delivery efficiency. At the same time, different delivery solutions are adopted for different situations to achieve maximum optimization. Targeting consumer-specific needs for delivery is an application of big data in new retail. Tiered warehousing must be accompanied by tiered distribution to provide consumers with a multi-level and multi-faceted new retail experience.

3.2.3 Deep Integration of Online and Offline Logistics

The deep integration of online and offline logistics is reflected in the consolidation of product and logistics channels. Offline physical stores are continuously expanding into online channels, while online e-commerce is also developing into offline chan-

nels. The two sides cooperate with each other to achieve complementary advantages and a win-win situation. In terms of logistics and delivery, this has led to the realization of online ordering with offline pickup and offline ordering with online shipping, achieving unity and coordinated development. Unlike the O2O model, new retail is not a simple addition of the two but breaks the original boundaries to create a virtuous cycle of a full-channel product and logistics distribution network, which will greatly enhance the consumer experience. New retail brings offline traffic into the online space through intelligent network devices, and the mature order processing and logistics distribution systems online also bring convenience to offline operations, reducing inventory costs. At the same time, leveraging the advantages of both online and offline channels builds the new retail era.

3.2.4 Consumer-Centric Service Essence

The focus of logistics and delivery services is on the consumer-centric service essence, which has the characteristics of full-channel and multi-format. Emphasizing the satisfaction of consumer needs, various innovative methods are used to continuously meet consumer requirements for new retail, improve personalized services for consumers, and develop specific solutions for different consumers to create differentiated services. Enhancing the consumer experience and making consumers feel more involved is essential. Providing a broader range of experiential consumption services to achieve consumption scenario-ization is crucial for consumers to truly trust and be satisfied with the products. Consumption scenario-ization is the main development direction of new retail and the future direction of consumer needs. Combining online e-commerce with offline physical retail experiences and continuously striving to achieve consumption scenario-ization, such as establishing experience stores that integrate shopping, dining, and entertainment in areas with high consumer density, is essential. In summary, the service must reflect the consumer-centric service essence. Only by continuously improving services for consumers can customer loyalty be increased and industry competitiveness enhanced.

4 Research on the Optimization of Fresh Product Logistics and Distribution Models in the Digital Age

4.1 Principles and Objectives of the Optimization Model

The various stages in the logistics and distribution process of fresh products may appear to be independent, but they are in fact closely interconnected. Whether it is the sorting, processing, packaging, or transportation of fresh products, the entire process is integrated. Therefore, when constructing a distribution model, it is essential to fully grasp the overall design principles. The focus of these principles is to coordinate each distribution stage to ensure a smooth process and enhance delivery efficiency. Specifically, the following aspects should be considered:

(1)Rationality: The design of logistics and distribution stages must be rational. Com-

plex delivery processes require coordination among all stages to ensure efficient operations. In the digital age, it is necessary to meet consumers' high demands for delivery services. By analyzing and forecasting delivery requirements based on both online and offline customer needs, the logistics and distribution model can be designed more rationally[20].

(2)Safety: Safety is of paramount importance in the logistics and distribution of fresh agricultural products, as it involves personal safety. Fresh agricultural products are perishable and prone to spoilage. To reduce losses during logistics and distribution, the transportation process should not be too long. Cold chain logistics must be employed, and real-time monitoring of temperature changes during transportation is essential.

(3)Economic Viability: The principle of economic viability means that the logistics and distribution model must be designed to generate profits that can sustain the operation of the supply chain. Only a profitable model can develop effectively. Therefore, when designing the logistics and distribution model, efforts should be made to save costs. Adopting new-generation Internet and Internet of Things (IoT) technologies to automate logistics processes and reduce labor can simplify the supply chain and eliminate redundant stages, making the model more economical.

(4)Scalability: Scalability is also an important principle in model design. It refers to the ability to add or modify functions in the future without affecting the existing functions. This means that the designed model should not only meet the current market needs but also be forward-looking, capable of evolving with the times, and continuously upgrading and improving based on business and information technology developments.

Therefore, the design objectives of the innovative logistics and distribution model for fresh agricultural products should fully consider the principles of rationality, safety, economic viability, and scalability. By integrating modern information technologies and focusing on consumer service, an innovative logistics and distribution model with practical prospects can be constructed. The delivery process should be streamlined and efficient, with each module designed to simplify delivery stages and minimize complexity. To improve delivery efficiency, the module design should aim to complete delivery tasks with high quality, low cost, and short lead times. The online corporate website should leverage big data to timely convey relevant information, while offline delivery provides high-quality services. The implementation of each module's functions is the foundation for the entire innovative logistics and distribution model[21].

4.2 Dingdong Maicai Fresh Platform Distribution Model

4.2.1 Issues in Dingdong Maicai Distribution

(1)High Cost Pressures: The rent and maintenance costs of forward warehouses are high. In first-tier cities, the dense layout of forward warehouses leads to high rent

and labor costs, which are difficult to dilute in areas with high order density. Moreover, low-temperature delivery requires specialized refrigeration equipment and insulated packaging, increasing delivery costs by 30-50% compared to regular courier services.

(2) Inelastic Supply Chain: Inventory prediction deviations: The non-standard nature of fresh products leads to significant fluctuations in inventory turnover rates. Forward warehouses often face either stockouts or spoilage losses (the industry average loss rate is approximately 10-15%). Peak and off-peak delivery capacity imbalances: During lunch and dinner peaks, orders are concentrated, necessitating reliance on temporary riders. However, during off-peak times, delivery capacity is underutilized, with some areas experiencing less than 20 orders per rider per day [22].

(3) Unstable Service Quality: Delivery time depends on location: Forward warehouses in non-core urban areas have insufficient coverage, and delivery times for edge users may exceed one hour. Low standardization of end-service: Fresh products are prone to damage, and issues such as bumps and temperature control failures during delivery can lead to customer complaints (the industry average complaint rate is about 5-8%).

(4) Technological Application Bottlenecks: Limitations of dynamic routing algorithms: The existing path planning is poorly adapted to abnormal scenarios such as sudden road conditions and neighborhood closures, resulting in 10-15% of orders requiring manual intervention and adjustment. Data silo issues: Insufficient data collaboration among procurement, warehousing, and delivery systems leads to delayed inventory reallocation responses (averaging 2-4 hours).

4.2.2 Architecture Design of the Optimized Distribution Model

The overall architecture of the innovative logistics and distribution model primarily focuses on the forward warehouse delivery module, combined with third-party logistics delivery from traditional e-commerce platforms. It is supported by a data support module based on new technologies such as big data and artificial intelligence. The characteristics are as follows:

(1) Big Data Platform: The backbone of the entire logistics and distribution model is a big data platform. Its main functions include coordinating delivery plans, vehicle scheduling, and formulating vehicle usage plans. Through intelligent route decision-making, the platform optimizes the pickup and delivery of goods along the most cost-effective driving routes to achieve complete logistics and distribution.

(2) Emerging Technologies: In addition to the support of the big data platform, new-generation emerging technologies such as artificial intelligence and the Internet are also essential. Features like automatic restocking, intelligent transportation, automatic sorting, and the integration of online/offline and logistics form the innovative logistics and distribution model [13].

(3) Forward Warehouse as the Core: The forward warehouse is the core of the entire

logistics and distribution model. This delivery model mainly relies on forward warehouses for delivery. A forward warehouse is not just a storage facility but also a delivery hub. The most critical aspect of constructing a forward warehouse is its location. A scientifically rational site selection not only reduces costs but also better serves consumers[22].

(4)Location of Forward Warehouses: Forward warehouses are primarily located in areas with high customer demand. Since forward warehouses have a certain delivery range, constructing additional forward warehouses in areas with low customer demand would lead to resource wastage. Therefore, third-party logistics delivery is used to assist in areas outside the delivery range of forward warehouses. Third-party logistics, with its specialized delivery services and dedicated cold chain shuttles, can better ensure the quality of fresh agricultural product delivery [14].The overall logistics and distribution model is shown in Figure 4-1.

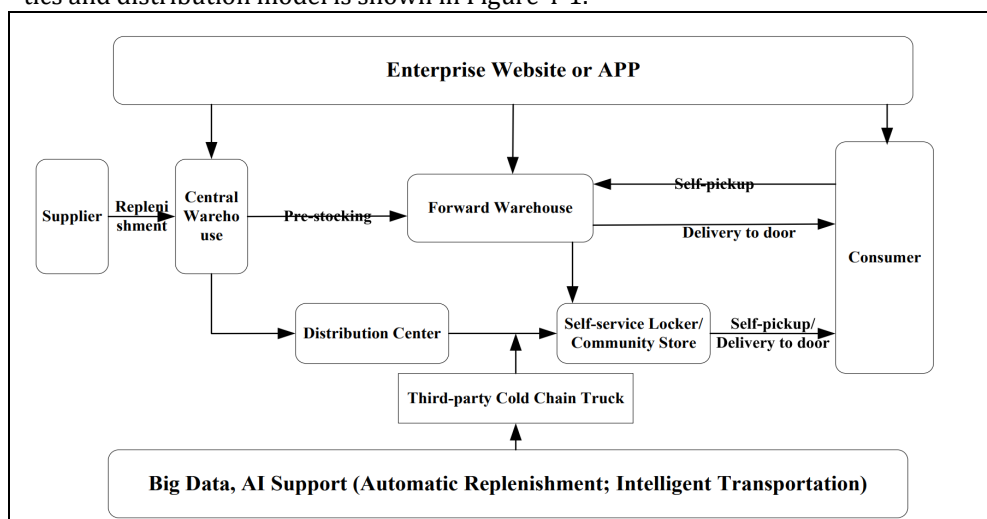


Figure4-1. Optimized Distribution Model Diagram

The entire logistics and distribution supply chain is typically divided into upstream, middle, and downstream segments. The upstream segment mainly refers to the movement from suppliers to central warehouses. The middle segment involves forward warehouses and distribution centers to lockers or community stores. The downstream segment is the final delivery to consumers[23].

1. Upstream Design

Supplier Selection: Rigorous qualification reviews must be conducted. Both the products and operations of suppliers should be thoroughly verified to ensure the high quality of fresh agricultural products supplied. The safety of fresh agricultural products is of utmost importance. Substandard products can cause adverse reactions such as food poisoning, posing significant health risks to consumers. Therefore, it is crucial to establish a traceability system for fresh agricultural products. By leveraging online orders to identify suppliers, a system of accountability can be implemented. This not only enhances suppliers' awareness of operational safety but also encour-

ages them to self-regulate.

Supplier Procurement: Reasonable demand forecasting for fresh products is essential. This ensures timely supply from vendors while also fostering a differentiated supply model. Each supplier should ideally focus on providing only one or a few types of agricultural products. Detailed information about the origin of these products must be maintained. This not only facilitates traceability but also promotes scientific farming practices among suppliers.

Central Warehouse Establishment: The location of the central warehouse should be strategically chosen. Inside the warehouse, standardized operational procedures should be adopted. Utilizing advanced technologies and intelligent means, a smart central warehouse that aligns with the new retail context should be developed.

2. Middle Segment Design

Forward Warehouse Design: The forward warehouse module is a key aspect and is elaborated separately. Distribution centers and lockers or community stores serve as supplements to the forward warehouse delivery model, drawing inspiration from e-commerce logistics.

Distribution Centers: Guided by an information-sharing platform, distribution centers follow order instructions. After conducting standard inspection and testing to ensure product quality, they proceed with tasks such as consolidating goods, sorting, packaging, and warehousing based on order attributes. Alternatively, they may directly implement delivery operations[24].

Lockers: Delivery personnel transport the ordered fresh agricultural products to consumers' neighborhoods using refrigerated vehicles. They then place the products in intelligent lockers. By entering the recipient's phone number, the locker system automatically sends a notification with a verification code to the recipient via SMS. The notification includes the time and location for collection. When the recipient collects the goods, [25]they can either enter the verification code or scan a barcode to open the locker. The collection information is then automatically uploaded to the company's platform. This locker collection method is convenient for consumers, allowing them to choose their own collection time and enhancing their experience. It also helps businesses save on labor costs. However, it does increase the costs associated with the establishment and maintenance of the equipment.

Community Stores: These stores serve as offline experience centers for specific online merchants. When consumers collect their goods from community stores, they also have the opportunity to purchase additional items. Besides fresh agricultural products, this promotes the sale of other types of goods. For community stores, [26]it stimulates consumption. For consumers, it is a win-win shopping method.

3. Downstream Design

Similar to traditional e-commerce distribution models, the final delivery unit is the consumer. Merchants use either forward warehouse delivery or third-party logistics to deliver fresh agricultural products to consumers. Although consumers represent

the last link in the supply chain and there is seemingly less resource waste and product circulation, the large and dispersed population base makes them difficult to manage and increases the complexity of delivery. The innovative delivery model for fresh agricultural products must be consumer-centric. Forward warehouse delivery should ensure a 30-minute delivery time to maintain the freshness of the products. It should also provide traceability and handle returns at the door to protect consumer rights.[27] For products collected from community stores or lockers, consumers should be able to choose their own delivery time and method on the company's website or app to meet different service requirements. In addition to the upstream, middle, and downstream segments, the delivery innovation model also requires the support of an information platform and various advanced technologies. The scientific layout of forward warehouses relies on data support, which is based on demand prediction analysis using big data. The data support module is the soul of the delivery model and will be elaborated separately. In addition, the collaborative operation of intelligent warehousing and delivery management systems, the information control of real-time decision support systems, the security management of information security control systems, and related technologies such as cloud computing, the Internet of Things, big data analysis, and information security processing all contribute to the operation of the innovative logistics delivery model.

4.2.3 Improvement and Optimization Directions for the Distribution Model

1. Cost Optimization

Dynamic Warehouse Network Configuration: Adopt a hybrid model of "central warehouse + flexible forward warehouses." In low-density areas, use mobile warehouses (refrigerated vehicles modified) to replace fixed warehouses, reducing rental costs. Collaborate with community convenience stores to establish "micro-warehouses" and share cold chain facilities (e.g., the cooperation model between Pupu Supermarket and Yonghui). **Crowdsourced Workforce Pool Management:** Build a rider grading system. Retain full-time riders in core areas and connect with third-party crowdsourcing platforms (e.g., Dada) in peripheral areas. Use algorithms to dynamically match orders with delivery capacity[28].

2. Supply Chain Intelligence

AI-Driven Inventory Forecasting: Integrate external data factors such as weather, holidays, and community events to improve SKU-level sales forecast accuracy (with a target of reducing the loss rate to below 8%). **Distributed Warehousing Coordination:** Establish an emergency replenishment channel between "regional central warehouses - forward warehouses," enabling next-day replenishment of out-of-stock items through overnight trunk logistics (referencing the Hema overnight replenishment system)[29].

3. Service Quality Improvement

Tiered Delivery Standards: Develop differentiated delivery plans based on product

characteristics (e.g., prioritizing live fresh products, time-limited delivery for frozen items), and equip with real-time temperature and humidity tracking devices. [30]Community-Based Service Network: Pilot a "group leader responsibility system" in high-end residential areas. Community leaders coordinate self-collection or timed delivery, reducing last-mile delivery costs (borrowing from the Xingsheng Youxuan model).

4. Technology Upgrade

Digital Twin Simulation System: Build a virtual urban delivery model to simulate optimal routes under extreme weather and traffic control scenarios, enhancing algorithm robustness. Blockchain Traceability System: Link the entire supply chain from origin to delivery on a blockchain.[30] Users can query product flow temperatures and quality inspection reports to enhance trust (e.g., JD Fresh's "Thousand-Mile Eye" plan).

5. Carbon Neutrality Goals

Promote Electric Refrigerated Vehicles and Recyclable Insulation Boxes: Aim to reduce carbon emissions in the delivery segment by 20% before 2025 (referencing Meituan's "Green Hills Plan").

5. Summary and Future Outlook

5.1 Summary

This paper investigates the innovation of logistics and distribution models for fresh agricultural products in the digital age. It begins with an analysis of the current status of logistics and distribution models for fresh agricultural products against the backdrop of digitalization and clarifies relevant concepts. Subsequently, it examines the impact of new retail on these models and identifies the development trends of fresh product distribution models in the digital context. Ultimately, it constructs an innovative logistics and distribution model for fresh agricultural products in the digital age, which is primarily based on forward warehouse delivery and supplemented by third-party logistics delivery. The paper focuses on optimizing the logistics and distribution model of Dingdong Maicai, a fresh product platform, and provides rational suggestions for a more digitalized and efficient logistics and distribution system, thereby supporting the construction of an innovative logistics and distribution model.

Driven by digital technology, the logistics ordering and crowdsourced delivery models of fresh e-commerce platforms are undergoing profound changes. Taking Dingdong Maicai as an example, this paper systematically analyzes the current status, pain points, and optimization paths of its logistics and distribution system, and draws the following core conclusions:

Technology Empowers Supply Chain Efficiency: The application of big data and AI technologies (such as sales forecasting algorithms and dynamic routing planning) has significantly reduced inventory deviations (target loss rate < 8%) and delivery costs,

while enhancing full-chain transparency through blockchain traceability. The smart logistics system integrates resources from "central warehouse - forward warehouse - last-mile delivery," reducing inventory reallocation response time to within 2 hours and increasing order fulfillment efficiency by about 20%.

Elastic Optimization of Crowdsourced Delivery Model: A hybrid workforce pool of "full-time + crowdsourced" riders has been established, combined with dynamic matching strategies based on real-time order heat maps, increasing the average daily order volume per rider from less than 20 to over 30, and reducing idle capacity during off-peak times by 15%. Community-based service networks (such as group leader pick-up points and refrigerated locker storage) have alleviated the pressure on last-mile delivery, improved delivery timeliness in marginal areas to within 45 minutes, and reduced customer complaint rates to below 3%.

Balancing Cost and Experience: A hybrid layout of "fixed forward warehouses + mobile micro-warehouses" has reduced single-warehouse operating costs by 18-22%, while maintaining the high-standard service of "30-minute delivery" in core areas. The promotion of recyclable cold chain packaging and electric delivery vehicles has balanced cost reduction with carbon neutrality goals (a 20% reduction in carbon emissions), in line with the industry's future sustainable development trends.

5.2 Future Outlook

Despite the powerful tools that digital technology provides for optimizing fresh logistics, further in-depth exploration is still needed in the following directions in the future: **Deep Integration and Innovation of Technologies:** Promote the application of digital twin technology in logistics simulation to simulate the supply chain's resilience under extreme scenarios and optimize emergency response mechanisms in advance. Explore the large-scale implementation of unmanned delivery devices (such as cold chain drones and automated sorting robots) in fresh scenarios to further reduce dependence on human labor. **Data-Driven Ecosystem Collaboration:** Break down data barriers between "production end - platform - consumers" to build cross-industry collaborative forecasting models and reduce supply-demand mismatches at the source. Deepen data sharing of delivery capacity with third-party platforms (such as Meituan and Dada) to establish industry-wide crowdsourced delivery standards and avoid resource waste caused by malicious competition. **Policy and Business Model Adaptability:** In response to the green needs of fresh logistics, call on the government to introduce subsidies for cold chain infrastructure to reduce the cost of corporate low-carbon transformation. Explore new service models such as "subscription-based delivery" and "time-based tiered pricing" to improve resource utilization through demand-side management. **Combination of Globalization and Localization:** Draw on international experience (such as the instant retail algorithms of Instacart in the United States and the freshness management system of 7-11 in Japan) and combine it with the characteristics of China's community economy to build differentiated com-

petitive barriers. Improvement of Risk Prevention and Control System: Strengthen food safety monitoring in the delivery process, use IoT sensors to achieve full visibility of temperature and humidity, and avoid quality dispute risks. Establish a quality-of-service credit system for crowdsourced riders, and use AI behavioral analysis to reduce service randomness and ensure consistent user experience[31].

In the digital age, the essence of optimizing fresh product logistics is the dynamic balance of the "technology - cost - experience" triangle. The practice of platforms such as Dingdong Maicai shows that only by penetrating the entire supply chain with technology and reorganizing resource allocation can the dual goals of cost reduction and efficiency improvement and user value enhancement be achieved. [32]In the future, with the maturation of technologies such as 5G and edge computing, fresh logistics may shift from "intelligent assistance" to "autonomous decision-making," ultimately driving the industry from "scale competition" to a new paradigm of "efficiency and sustainability coexistence."

References

- [1] Zhao Hongmei. Distribution Models and Implementation Strategies for Rural and Township Agricultural Product Logistics in the E-commerce Environment [J]. Research on Commercial Economy, 2016, (10): 151-153.
- [2] Li Li. Optimization Countermeasures for Fresh Agricultural Product Logistics Models in the E-commerce Environment [J]. Research on Commercial Economy, 2017, (19): 140-142.
- [3] Chen Letian. Research on the Optimization of Fresh Agricultural Product Logistics Models in the E-commerce Environment [J]. Price Monthly, 2015, (10): 76-79.
- [4] Li Xiao. Research on the Optimization of E-commerce Distribution of Fresh Agricultural Products Based on Big Data [J]. Rural Economy, 2018, (6): 112-115.
- [5] Chen Gang. Fresh Agricultural Product Intra-city Distribution Models and Optimization Strategies Based on Online and Offline [J]. Research on Commercial Economy, 2017, (6): 88-89.
- [6] Bortolini M, Faccio M, Ferrari E, et al. Fresh food sustainable distribution: cost, delivery time and carbon footprint three-objective optimization [J]. Journal of Food Engineering, 2016, 174(85): 56-67.
- [7] Faccio M, Ferrari E, Persona A, et al. Lean distribution principles to food logistics: a product category approach [J]. International Journal of Operational Research, 2013, 16(2): 214-240.
- [8] Hsu CI, Liu KP. A model for facilities planning for multi-temperature joint distribution system [J]. Food Control, 2011, 22(12): 1873-1882.
- [9] Kuo JC, Chen MC. Developing an advanced Multi-Temperature Joint Distribution System for the food cold chain [J]. Food Control, 2010, 21(4): 559-566.
- [10] Ahumada O, Villalobos JR, Mason AN. Tactical planning of the production and distribution of fresh agricultural products under uncertainty [J]. Agricultural Systems, 2012, 112: 17-26.
- [11] Zhong AW, Yan W. Development of Agricultural Product Logistics from the Perspective of the 4PL [J]. Asian Agricultural Research, 2013, 5(11): 14-17.
- [12] [12] Sheu JB. A hybrid fuzzy-optimization approach to customer-grouping-based logistics distribution operations [J]. Applied Mathematical Modelling, 2007, 31(6): 1048-1066.
- [13] Gao Hui. On MissFresh: Defining a New Model for Fresh E-commerce [J]. Modern Eco-

- conomic Information, 2018, (20): 312.
- [14] Lv Xiaoyong. Research on the Operation Models of Fresh Agricultural Product E-commerce [J]. Forum on Industry and Technology, 2017, (9): 16-17.
- [15] Von Briel F. The future of omnichannel retail: A four-stage Delphi study [J]. Technological Forecasting & Social Change, 2018, 132: 217-229.
- [16] Chopra S. The Evolution of Omni-Channel Retailing and its Impact on Supply Chains [J]. Transportation Research Procedia, 2018, 30: 4-13.
- [17] Gallino S, Moreno A. Integration of Online and Offline Channels in Retail: The Impact of Sharing Reliable Inventory Availability Information [J]. Management Science, 2014, 60(6): 1434-1451.
- [18] Taylor DH, Fearne A. Demand management in fresh food value chains: a framework for analysis and improvement [J]. Supply Chain Management: An International Journal, 2009, 14(5): 379-392.
- [19] Jedermann R, Nicometo M, Uysal I, et al. Reducing food losses by intelligent food logistics [J]. Philosophical Transactions of the Royal Society, 2014, 372.
- [20] Fan Yu. Improvement and Innovation of Fresh New Retail Models from the Consumer Perspective [J]. China International Finance (Bilingual), 2018, (8): 20-21.
- [21] Gao Jian, Liu Song. Construction of Innovative Logistics and Transportation Models for Agricultural Products under the Background of New Retail [J]. Research on Commercial Economy, 2019, (8): 106-108.
- [22] Zhang Shenhong, Wang Jing. Urban and Rural Distribution Models and Optimization of Fresh Agricultural Products under the New Retail Pattern [J]. China Logistics and Purchasing, 2018, (17): 78-79.
- [23] Ge Wei, Yi Lei, Zhong Limengtao. Fresh Distribution Strategies under the Background of "New Retail" [J]. Western Leather, 2018, 40(12): 115, 117. Wu Yongyi. New Retail: The Battle for Store-Warehouse Integration and Forward Micro-Warehouses [J]. Enterprise Management, 2018, (12): 88-90.
- [24] Gao Hui. On MissFresh: Defining a New Model for Fresh E-commerce [J]. Modern Economic Information, 2018, (20): 312.
- [25] Wang Baoyi. The Nature, Causes, and Practical Trends of "New Retail" [J]. China Circulation Economy, 2017, 31(7): 5-13.
- [26] Yan Zhanghua, Liu Lei. The Concept, Research Framework, and Development Trends of "New Retail" [J]. China Circulation Economy, 2017, 31(10): 14-21.
- [27] Zhao Shumei, Xu Xiaohong. The Meaning, Models, and Development Paths of "New Retail" [J]. China Circulation Economy, 2017, 31(5): 14-22.
- [28] Lv Xiaoyong. Research on the Operation Models of Fresh Agricultural Product E-commerce [J]. Forum on Industry and Technology, 2017, (9): 16-17.
- [29] Pei Yanhua. Research on the Location of Fresh Agricultural Product Cold Chain Distribution Centers Based on Demand Forecasting [D]. Chongqing Technology and Business University, 2016.
- [30] Kayacan E, Ulutas B, Kaynak O. Grey system theory-based models in time series prediction [J]. Expert Systems with Applications, 2010, 37(2): 1784-1789.
- [31] Drezner Z, Scott CH. Location of a distribution center for a perishable product [J]. Mathematical Methods of Operations Research, 2013, (3): 301-314.
- [32] Govindan K, Jafarian A, Khodaverdi R, et al. Two-echelon multiple-vehicle location-routing problem with time windows for optimization of sustainable supply chain network of perishable food [J]. International Journal of Production Economics, 2013, 152: 9-28.