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Research on strategies for improving cold chain logistics in Dalian under the community group buying model

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Abstract. With the advancement of the digital era, community group buying has emerged as a new form of e-commerce. It has developed rapidly across China and has gradually become an important component of the retail market. As a major economic center in Northeast China, Dalian has witnessed the rapid growth of the community group buying market, which has not only transformed the consumption habits of urban residents but also demonstrated the vitality of this business model. The rise of community group buying has brought greater convenience to consumers while simultaneously creating both challenges and opportunities for traditional retail industries. However, with the rapid expansion of the market, community group buying has also encountered a series of problems, including insufficient transportation network coverage and unscientific route selection, all of which have affected its long-term development. This paper conducts an in-depth discussion of the current status of the community group buying distribution model in Dalian, the problems existing within it, and the corresponding countermeasures and recommendations. The study aims to provide valuable references for the development of community group buying in Dalian and across China, thereby promoting the healthy and sustainable growth of this model.

Keywords: community group buying, cold chain, route optimization

1. Introduction

The rapid development of the community group buying model has posed new challenges to the fresh food cold chain logistics system. As an important port city and distribution center for fresh agricultural products, Dalian's cold chain transportation is closely related not only to commercial efficiency but also to public welfare and food safety. At present, the city faces multiple difficulties in practice, including uneven transportation network coverage, unscientific route planning, and inadequate supervision of whole-process temperature control. These issues have severely restricted service efficiency and sustainable development. Based on Dalian's regional economic conditions and consumption characteristics, this study employs empirical investigation and systematic analysis to explore the root causes of the existing problems and proposes multi-level and systematic improvement strategies. The research is intended to provide both theoretical references and practical guidance for optimizing the regional cold chain logistics system.

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2. Current development status of the community group buying model in Dalian

There are numerous community group buying platforms, and competition among them is extremely intense. Most of these platforms rely on social media applications such as WeChat and Douyin for promotion and sales, attracting consumers through low prices and convenience. Some platforms have begun to focus on specific categories such as fresh food and daily necessities in order to satisfy increasingly diversified consumer demands. To enhance user experience, certain platforms have introduced intelligent technologies including big data analysis and artificial intelligence-based recommendation systems, thereby achieving more precise market positioning and personalized services. The rise of community group buying has brought considerable convenience to consumers, while also presenting new challenges and opportunities for the traditional retail industry. In Dalian, community group buying distribution models are mainly divided into two types: self-pickup and home delivery [1]. Under this model, merchants provide technological, resource, and operational support, while consumers enter the platform through links shared by community leaders in online groups. The platform is responsible for product supply and distribution, and orders are generally delivered to community pickup points on the following day, where consumers collect them at their convenience. The community group buying model initially entered the household consumption market through high-demand fresh agricultural products. Community operations are managed by group leaders, and the higher the level of community engagement, the more distinct the degree of differentiation among communities becomes. From the perspective of warehousing and distribution, the order fulfillment process generally operates as follows: all suppliers first deliver goods to a shared warehouse; once sales orders are generated on the platform, the shared warehouse transfers products to a central warehouse for unified sorting. The central warehouse then distributes goods to grid warehouses, which subsequently sort products for community leaders. Finally, community leaders complete the final sorting and distribution for consumers in batches.

The development of the community group buying model in Dalian demonstrates the dual characteristics of a typical port city and a fresh food consumer market. Its evolution not only follows the general developmental trajectory of the industry but is also profoundly shaped by local economic and geographical conditions. At present, the Dalian market has attracted national platforms such as Meituan Select and Duoduo Maicai, along with several regional local platforms, forming a highly competitive multi-actor market structure. Their business networks cover most communities in the urban districts and are gradually expanding into northern county-level areas. This model relies on a three-tier supply chain system consisting of "online pre-sale + central warehouse–grid warehouse–community leader pickup point", effectively integrating the supply and demand of high-value fresh products such as local seafood and fruits, while significantly improving circulation efficiency. Nevertheless, its development still faces many structural challenges. On the one hand, the distribution of cold chain infrastructure remains uneven. Warehousing and distribution networks in core port areas and major urban districts are relatively well developed, whereas northern hilly counties and remote island regions suffer from insufficient coverage, resulting in significant service blind spots. On the other hand, platform operations still rely heavily on extensive temperature-control methods such as foam boxes and ice packs, while a comprehensive cold chain traceability system has yet to be fully established. Consequently, the loss rate of high-quality fresh products, particularly aquatic products, remains high. In addition, the regulatory framework has lagged behind innovations in business models. Problems such as opaque algorithm-based pricing, loose management of community leaders, and insufficient interdepartmental coordination continue to constrain the standardized development of the industry. Despite these challenges, community group buying has become an important component of livelihood consumption in Dalian. Its development not only reflects

the transformative role of digital technology in traditional circulation systems but also highlights the urgent need for business model adaptation and institutional innovation under regionally differentiated conditions.

3. Analysis of fresh food cold chain logistics problems in Dalian

3.1. Insufficient coverage of the cold chain logistics network

The insufficient coverage of the fresh food cold chain transportation network in Dalian's community group buying sector stems from the dual constraints of economic rationality and geographical realities [2]. From a cost–benefit perspective, enterprises tend to demonstrate a pronounced "siphon effect" in the layout of their distribution networks, concentrating resources heavily in densely populated urban districts. In contrast, northern hilly areas and remote island regions, characterized by complex terrain and dispersed populations, often suffer from inadequate services or unstable transportation capacity due to low order density and high delivery costs, resulting in marked spatial inequality in service provision. At the same time, the uneven spatial distribution of cold chain infrastructure further intensifies the coverage problem. Key facilities such as cold chain distribution centers and front warehouses are primarily concentrated around port areas and core urban districts, failing to establish an effective multi-level network capable of covering the entire region. Consequently, peripheral areas experience longer delivery distances, lower delivery efficiency, and weaker temperature-control guarantees, significantly increasing the risk of cold chain disruption in both the "last mile" and even the "first mile" of transportation.

This issue not only restricts the expansion of service coverage but also generates a series of negative consequences. Insufficient network coverage limits residents' equal access to high-quality fresh products, exacerbates disparities in consumption and services between urban and rural areas, and hinders the establishment of upward distribution channels for local specialty agricultural products, thereby affecting the positive interaction between farmers' income growth and consumption upgrading. Furthermore, Dalian experiences sharp seasonal fluctuations in demand. During peak seafood consumption periods in summer and severe snowstorm conditions in winter, the existing transportation network often becomes overstretched, exposing structural weaknesses in emergency response capabilities and flexible resource allocation. Therefore, systematic measures are urgently needed, including the innovation of urban–rural collaborative distribution models, increased investment in cold chain infrastructure in underserved areas, and the establishment of intelligent logistics scheduling platforms, in order to enhance both the coverage and resilience of the transportation network and promote regional coordination and market equity.

3.2. Unscientific selection of cold chain logistics routes

The problem of unscientific route selection in Dalian's community group buying fresh food cold chain transportation primarily results from insufficient algorithmic support and the absence of dynamic response mechanisms. At present, route planning largely depends on drivers' experience or basic navigation tools, lacking intelligent algorithms capable of integrating multiple constraints such as real-time traffic conditions, order density, and temperature-control duration. As a result, the system is unable to effectively cope with complex scenarios including winding roads caused by Dalian's hilly terrain, cross-sea traffic bottlenecks during peak hours, and seasonal snow and ice conditions [3]. Meanwhile, because route planning is not effectively coordinated with order forecasting and inventory management systems, route selection often exhibits a passive response pattern rather than proactive and systematic optimization. This leads to low transportation efficiency, frequent detours, and repeated routes, which not only increase energy consumption

and delivery costs per unit but also prolong the transit time of fresh products, thereby heightening the risk of quality deterioration.

The lag in route optimization directly constrains service quality and operational performance. Unscientific route planning results in unstable delivery timeliness, causing considerable fluctuations in delivery times across different regions and negatively affecting consumer experience as well as platform reputation. In addition, unnecessary extensions of transportation distance and duration require cold chain equipment to operate continuously at high energy consumption levels, making precise temperature control difficult to maintain. This problem becomes particularly severe during high-temperature summer periods, when temperature fluctuations inside transport vehicles can easily lead to cold chain interruptions. Moreover, the increase in ineffective driving mileage further raises vehicle depreciation, labor, and fuel costs, thereby weakening enterprises' profitability and market competitiveness.

3.3. Difficulties in regulating community group buying distribution platforms

The regulatory difficulties surrounding community group buying distribution platforms in Dalian reveal the governance challenges faced by regional port cities under digitally driven consumption models. Supported by technological empowerment and business model innovation, this sector has rapidly penetrated the market, while its regulatory complexity stems from the interaction of multiple factors. On the one hand, platform operations exhibit highly decentralized and fluid characteristics. Resource allocation and pricing are largely controlled through algorithmic "black box" systems, making it difficult for regulatory authorities to penetrate data barriers and effectively supervise pricing practices and quality control. On the other hand, as an important distribution and consumption center for fresh products, Dalian faces particularly prominent issues in cold chain logistics, including temperature-control standards, food safety traceability, and the standardization of "last-mile" delivery services. Traditional territorially segmented regulatory approaches are increasingly unable to cope with logistics networks characterized by cross-regional operations, grid-based structures, and instantaneous distribution processes. In addition, platforms often adopt asset-light operating models to avoid assuming primary responsibility, transferring operational risks to franchise-based community leaders or third-party service providers. This has resulted in ambiguous divisions of rights and responsibilities, creating structural loopholes in the protection of consumer rights and interests. Local governments therefore face a dilemma between encouraging innovation and preventing risks: excessive intervention may suppress the vitality of emerging business models, while insufficient regulation may lead to disorderly market competition and deficiencies in public service provision. Although Dalian has attempted to establish adaptive collaborative governance mechanisms, institutional lag remains evident in areas such as data sharing, standard unification, and interdepartmental coordination. Consequently, there is an urgent need to enhance the responsiveness and resilience of the regulatory system through legislative restructuring, technological empowerment, and diversified co-governance mechanisms, thereby promoting the high-quality development of the regional market [4].

4. Strategies for improving fresh food cold chain logistics for community group buying in Dalian

4.1. Constructing a multi-level collaborative governance framework to improve network coverage

To systematically improve the coverage of Dalian's community group buying fresh food cold chain transportation network, it is necessary to establish a multi-level collaborative governance framework characterized by market-oriented operation and technology-driven support. The first priority is to optimize the spatial layout of cold chain infrastructure. Through policy incentives and land-use planning support, intensive and shared cold chain transit stations or front warehouses should be established in northern hilly areas and remote coastal regions to effectively complement the core warehousing and distribution network. At the same time, it is essential to actively explore a flexible infrastructure system combining "mobile pre-cooling devices + distributed small-scale cold storage facilities" in order to address seasonal demand fluctuations and geographical accessibility challenges [5]. Secondly, innovation in urban–rural two-way logistics organization models is required. By relying on big data platforms to integrate fragmented orders and multi-platform resources, hybrid distribution schemes such as "urban–rural joint distribution" and "passenger–cargo integrated transportation" can be promoted. Such measures would extend service coverage while reducing marginal delivery costs. In addition, enterprises should be encouraged to adopt modular and tiered temperature-control equipment and technologies. Combined with dynamic routing algorithms, these approaches can facilitate low-cost and highly resilient last-mile cold chain service coverage.

4.2. Intelligent dynamic route optimization strategy integrating multi-source data

A dynamic route optimization system integrating multi-source data and intelligent decision-making algorithms should be established. Centered on artificial intelligence technologies, the system should rely on deep learning and reinforcement learning algorithms to incorporate multiple constraints—including real-time traffic flow, road hierarchy, weather conditions, temperature-control duration limits, spatial distribution of orders, and warehouse locations—into a unified optimization framework. In this way, it can generate refined transportation plans characterized by minimal energy consumption, optimal delivery efficiency, and stable temperature control. At the same time, customized algorithmic models tailored to Dalian's unique geographical and transportation characteristics should be developed. Particular attention should be given to complex scenarios such as cross-sea traffic bottlenecks, winding roads in hilly areas, and winter road closures caused by snow and ice. Predictive obstacle-avoidance functions and flexible scheduling capabilities should therefore be embedded into the system so that route planning possesses both forward-looking and anti-interference capacities. Moreover, it is essential to eliminate information silos and promote deep integration between route planning systems and upstream order management systems, inventory control systems, and downstream in-vehicle temperature-control equipment. Such integration would enable end-to-end coordination from demand forecasting to fulfillment and delivery, transforming traditional static and passive route allocation into dynamic and proactive intelligent scheduling. In addition, carbon emission indicators should be explicitly incorporated into optimization objectives. Multi-objective Pareto optimization methods may be explored to balance delivery timeliness, cost control, and green low-carbon development, ensuring that route selection not only satisfies economic and reliability requirements but also aligns with sustainable development goals. Ultimately, by constructing a systematic, adaptive, and iterative intelligent decision-support system, transportation route planning can shift from experience-driven operations to data-driven management, thereby comprehensively

improving the service resilience, operational efficiency, and environmental sustainability of Dalian's fresh food cold chain logistics system.

4.3. Enhancing regulation through multi-stakeholder collaborative governance

It is necessary to establish an adaptive governance system centered on data-driven regulation and supported by multi-stakeholder collaboration. First, efforts should focus on strengthening the legal and technological foundations of regulation. Specialized local regulatory legislation should be introduced to clearly define platform responsibilities in areas such as food safety, price formation, data security, and the protection of workers' rights and interests. In particular, platforms should be required to register their algorithms and open key data interfaces in order to address the problem of insufficient regulatory transparency caused by "algorithmic black boxes". Second, regulatory mechanisms should be innovated through the establishment of a cross-departmental collaborative supervision platform. The functions of departments responsible for market regulation, transportation, cyberspace administration, and commerce should be integrated, while big data, artificial intelligence, and blockchain technologies should be utilized to conduct real-time monitoring and intelligent analysis of platform operational data. This would enable full-chain digital supervision covering enterprise registration, product traceability, price monitoring, and delivery tracking, thereby transforming regulation from passive response to proactive early warning. At the same time, flexible governance tools such as "regulatory sandboxes" should be introduced to provide room for business model experimentation under the premise of maintaining safety standards, thus balancing innovation incentives with risk prevention and control. Furthermore, a diversified co-governance structure should be established. Platforms must strengthen their self-regulatory obligations by developing industry self-discipline standards and integrity systems, while channels for consumer complaints and public-interest litigation should be improved. The positive role of public oversight and media supervision should also be fully utilized, thereby forming a collaborative governance network involving governments, platforms, industry associations, and consumers. Ultimately, through the deep integration of legislation, technology, institutional mechanisms, and collaborative governance, a new regulatory ecosystem can be established that both effectively standardizes market order and prudently encourages innovation vitality. Such a system would comprehensively enhance the precision, effectiveness, and resilience of governance.

5. Conclusion

Through a systematic analysis of the core problems and optimization pathways of Dalian's fresh food cold chain transportation system under the community group buying model, this study finds that Dalian is currently confronted with multiple challenges, including uneven cold chain network coverage, low transportation route efficiency, difficulties in whole-process temperature-control supervision, and ambiguous platform responsibility allocation. These issues have seriously constrained the quality assurance and service efficiency of fresh products. To address these critical problems, the study proposes a series of multi-level improvement strategies centered on intelligent algorithm optimization, infrastructure planning, and multi-stakeholder collaborative governance. These strategies include the construction of a data-driven dynamic route planning system, the improvement of urban–rural coordinated cold chain network layouts, the establishment of a whole-process temperature-control supervision system based on Internet of Things technologies, and the innovation of diversified co-governance mechanisms under government guidance. These measures not only provide concrete implementation approaches for the modernization of Dalian's cold chain logistics system but also offer valuable references for the digital transformation of fresh food supply chains in other port cities with

similar characteristics. The significance of this study lies in its integration of theoretical exploration with empirical analysis. It not only enriches research at the intersection of community group buying and cold chain logistics but also provides practical guidance for regional livelihood protection and consumption upgrading.

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