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Research on the "Last Mile" Logistics Distribution Model in Rural Areas

-- A Case Study of Y Township in Guizhou Province

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ABSTRACT

This paper takes Y Township in Guizhou Province as a case to study the "last-mile" distribution problem in rural logistics. Against the backdrop of rural revitalization, Y Township, characterized by complex terrain, scattered population, and underdeveloped infrastructure, faces challenges such as low distribution efficiency, high costs, and poor user experience. The paper analyzes the drawbacks of the existing self-pickup mode and proposes countermeasures including integrating "self-pickup + crowdsourced delivery", piloting smart express lockers, developing agricultural product e-commerce, and cultivating professional talents. It aims to provide tailored and sustainable logistics solutions for rural areas with similar complex terrain and underdeveloped economies, so as to promote the healthy development of rural e-commerce and support the effective implementation of the rural revitalization strategy.

KEYWORDS

Rural logistics; Last-mile; Express self-pickup; Crowdsourced delivery

1. INTRODUCTION

Since the 19th National Congress of the Communist Party of China put forward the implementation of the rural revitalization strategy, emphasizing the promotion of rural economic development through modern technologies such as the Internet and big data, e-commerce has been incorporated into the national strategy as a key driver of the economy. Governments at all levels have introduced supporting policies to encourage the development of rural e-commerce. In addition, with the rapid development of economy and technology, the country has vigorously promoted the "village-to-village connection" project. The rapid coverage of infrastructure such as transportation and communications has laid a solid foundation for the sinking of e-commerce. By 2023, the total length of rural roads nationwide exceeded 5.4368 million kilometers; by the end of March 2025, China had achieved "5G coverage in every town", with 5G coverage in 90% of administrative villages; by the end of December 2024, the Internet penetration rate in rural areas reached 67.4%, and the number of online shopping users reached 974 million... These data indicate that with economic and technological development, online shopping has become an important part of our daily life, driving the vigorous development of the logistics industry.

According to data released by the National Bureau of Statistics, China's express delivery business volume exceeded 175.1 billion pieces in 2024, with business revenue of 1.4 trillion US dollars. Compared with 2016, before the proposal of the rural revitalization strategy, China's total express delivery business volume was 31.28 billion pieces, with revenue of 397.4 billion yuan. In 2024, China's express delivery business volume increased by 460% compared with 2016, and business

revenue increased by 252%. Such a huge volume of express delivery business in China cannot be achieved without the significant role of rural logistics. However, compared with urban logistics, the "last-mile" delivery in rural logistics faces many difficulties and challenges, including scattered rural population, large and fragmented delivery areas, complex delivery road conditions, and mismatches between delivery time and signing time. These problems lead to long delivery time, high cargo damage rate, and high re-delivery rate, which in turn cause a sharp rise in logistics costs and squeeze the profit margin of logistics. Therefore, to maintain the steady development of China's e-commerce and express delivery business, in addition to strengthening the comprehensive rural logistics services, the "last-mile" logistics delivery problem in rural areas cannot be ignored.

Against this background, this paper focuses on the research of the "last-mile" delivery problem in rural logistics, taking Y Township in Guizhou Province, a region with relatively complex terrain, as a case study. It explores the existing problems in the "last-mile" of rural logistics delivery, and proposes targeted solutions based on the current issues. It aims to provide useful insights and references for solving the "last-mile" delivery problem in rural logistics in a way that suits local conditions.

2. L ITERATURE REVIEW

Lukas Janinhoff, Robert Klein, et al. [1] (2024) argue that one way to achieve more efficient last-mile operations is to incorporate Out-of-Home Delivery (OOHD) services. OOHD, which delivers to parcel shops and lockers instead of customers' homes, has multiple advantages, including consolidating customers at a single delivery location and reducing the number of failed delivery attempts.

On the one hand, due to the relatively complete infrastructure in developed countries, private logistics enterprises have solved most delivery problems through mature networks and are more focused on cutting-edge fields such as smart cities, drone delivery, and low-carbon logistics. Therefore, there are relatively few studies on rural "last-mile" delivery. On the other hand, China's rural areas have unique characteristics such as high population density, rapidly growing e-commerce demand, and complex terrain, making the "last-mile" a common focus of the government (rural revitalization policies) and enterprises (such as JD's sinking market strategy). Therefore, research on rural "last-mile" logistics delivery is mainly concentrated in China, which is in line with China's basic conditions.

In domestic research, Mingfeng Ge [2] (2019) believes that for next-day delivery, the distribution process accounts for 45% of the entire logistics activity. The use of smart self-pickup lockers or Cainiao Stations will increase the initial construction and operation costs. Therefore, he suggests developing a delivery mode with self-pickup as the mainstay and manual delivery as a supplement. Chun Feng and Qiuxia Mou [3] (2020) argue that the mode in rural logistics where consumers have to pick up packages by themselves at town-level express service points or agent points greatly reduces the consumption experience of online shoppers in rural areas, and thus propose a crowdsourcing-based solution to improve the efficiency of package delivery in rural areas. Yanling Jin [4] (2022) created a new model for rural logistics delivery - crowdsourced logistics delivery - by combining the characteristics and difficulties of rural logistics "last-mile" delivery with practical cases. Rong Nie [5] (2024) believes that enterprises can improve delivery efficiency and reduce operating costs by introducing new logistics models such as shared logistics and multi-mode delivery, as well as leveraging intelligent logistics technologies. Wenhua Yang [6] (2025) points out that with the in-depth implementation of the rural revitalization strategy and other related policies, while significant progress has been made in solving China's rural logistics last-mile problem, there are still contradictions to be resolved, such as the contradiction between rural consumption structure and lagging infrastructure, and the contradiction between high logistics costs and the need to reduce costs, improve efficiency, and enhance quality. Xin Song [7] (2025) proposed "terminal delivery crowdsourcing" for the development of rural green logistics in Henan Province, enabling rural

logistics in Henan to achieve home delivery, reduce logistics costs, and integrate rural resources. Xiaoju Ming [8] (2025) pointed out the importance of the rural logistics system to the rural economy, and aiming at the current situation and bottlenecks of rural logistics system construction, proposed that the construction of rural logistics system should be oriented towards "networking, intelligence, collaboration, and greening", and solve the problems of cost and efficiency through methods such as three-level node layout. Yongfu Huang [9] (2025) specifically analyzed the main contradictions and typical problems faced by the development of rural e-commerce logistics in the new era, deeply explored the practical difficulties in the development of rural e-commerce logistics in the new era, and put forward core countermeasures such as improving the density of rural e-commerce logistics.

To sum up, research on the rural logistics system has been advancing, but it mainly focuses on the common problems of the rural logistics system, which can only solve problems in general directions and cannot address issues in more special regions in a tailored manner. This paper takes Y Township in Guizhou Province as the research object, further studies and analyzes the complexity and differences of the rural logistics system in view of the logistics delivery problems in Y Township, and proposes corresponding solutions. This has certain practical significance and reference value for supplementing the applicability of existing logistics network theories in rural scenarios.

3. CURRENT STATUS AND BOTTLENECKS OF LOGISTICS DELIVERY IN Y TOWNSHIP

3.1. Current Status of Logistics Delivery

Y Township in Guizhou Province is located in the southwest of Guizhou Province, in a mountainous area with a terrain that is low in the east and high in the west, and the road conditions are relatively rugged. Y Township has jurisdiction over 1 community and 11 administrative villages. To solve the common problems of rural "last-mile" logistics delivery, improve delivery efficiency, and reduce logistics costs, the express outlets in the township adopt a mode where packages are not delivered to homes, and all customers need to pick up their packages at the logistics express outlets. At present, the township has four express outlets: the first is mainly responsible for the delivery of Yunda and JD express packages; the second is a postal service outlet; the third is a SF Express self-operated outlet; the fourth is the largest express outlet in the town, covering all express packages of four courier companies: Zhongtong, Shentong, Yuantong, and Jitu. The main logistics delivery problems in Y Township are concentrated in the fourth outlet. Due to the backward logistics infrastructure in Y Township, there are no logistics facilities such as smart express lockers. After the logistics outlets adopted the non-delivery mode, all consumers in the town, including those in administrative villages, can only pick up their express packages at the express outlets during their free time using pickup codes.

3.2. High Operating Costs

Although the self-pickup mode in Y Township solves problems such as high delivery costs and time mismatches, it has also created new problems, resulting in persistently high operating costs that have not been improved.

First, queuing occurs, leading to increased time costs and error rates. Most people are at work or engaged in farming during the day, so most people concentrate on picking up express packages from 5 pm to 7 pm. Consumers in subordinate villages also concentrate on picking up packages at the stations on weekends. Such regular and concentrated pickup times lead to queuing. When there are too many people queuing at the express outlet, couriers may skip the step of verifying package information to ease the queue, which will increase the rate of wrong pickups and thus the probability of secondary pickups. Second, express backlogs lead to inventory backlogs, which in turn increase

storage costs. When consumers arrive at the outlet and see the queue, some who are in a hurry will decide to pick up their packages another day, which further causes inventory backlogs at the express outlet. Third, there are complaint costs caused by damage to fresh products due to delayed delivery. Fresh products are perishable and not suitable for long-term storage at express outlets. The non-delivery mode and frequent queuing in Y Township will increase the damage rate of fresh products, leading to higher complaint and compensation costs.

3.3. Backword Infrastructure and Logistics Technology

Y Township still faces the common problems in rural logistics: weak infrastructure construction and lack of professionalism in logistics technology.

3.3.1. Weak Infrastructure Construction

At present, Y Township has four logistics express outlets, all of which are only equipped with basic equipment such as code scanners, logistics handheld devices, and express outbound scanners. There is no use of logistics equipment and technologies such as unmanned vehicles, drones, or smart express lockers, resulting in relatively weak logistics infrastructure. In addition, due to the lack of development of characteristic agricultural product e-commerce, there are no local jobs to make a living at home, so most young people choose to work in other places. Those left in the town are mostly middle-aged and elderly people, resulting in an aging population. This makes the construction and use of intelligent logistics systems difficult, with a lack of professional talents and significant challenges in later maintenance.

3.3.2. Lack of Professionalism in Logistics Technology

The third-level logistics network nodes below the county level lack professional personnel. The current managers are directly employed after simple training, with a low level of professionalism and technical mastery in logistics. They view logistics work only as a means of making a living, without the desire to improve and progress, leading to stagnant logistics technology. The weak infrastructure construction and unprofessional logistics technology make it impossible for the local logistics system to achieve cost reduction and efficiency improvement, let alone provide consumers with good service satisfaction.

3.4. Low Logistics Density

As Yongfu Huang [9] (2025)stated, the coverage of express outlets in a region does not mean that the region can achieve efficient goods receiving and dispatching; it only means that basic goods pickup and delivery needs can be met. Due to the lack of development of characteristic agricultural product e-commerce, the demand for logistics is greater than the external supply, and the demand for express delivery is unstable, resulting in low logistics density. In addition, Guizhou is the only province in China without plains, so the road conditions in Y Township are relatively rugged, increasing the difficulty and cost of logistics delivery. Unmanned vehicle and drone delivery are not feasible here. Combined with the rule that express packages at township outlets need to be picked up in person, many consumers will only shop online as a last resort. This further hinders the modernization of the rural logistics system, making the development of rural logistics lag behind the times and restricting the improvement of overall logistics efficiency.

4. COUNTERMEASURES FOR LOGISTICS DEVELOPMENT IN Y TOWNSHIP

4.1. Implementing a New Delivery Mode

To address the problems of queuing, express backlogs, and damage to fresh products in the current self-pickup mode in Y Township, the original full self-pickup mode can be changed to a combination of self-pickup and partial delivery. The delivery part covers administrative villages far from the express outlets, and this part of the express delivery adopts a crowdsourcing mode. Self-pickup points can be set up at places such as village stores in the administrative villages that need delivery, and cooperation can be established with passenger buses to regularly transport express packages from the township to each administrative village every day. This delivery mode can ease queuing pressure, reduce inventory backlogs, lower complaint rates, and improve the signing rate and freshness of fresh products.

4.2. Piloting the Use of Smart Express Lockers

At present, Y Township is carrying out the construction of agricultural photovoltaic and wind farm projects, which have attracted many foreign personnel, and the volume of express delivery will increase accordingly. Taking this opportunity, express lockers can be tried to improve the efficiency of express delivery. Although the initial investment in building express locker self-pickup points will be high, as long as publicity for express locker self-pickup is done well in the early stage, operating procedures are standardized, and supervision is strengthened, costs can be reduced in the later stage by reducing the number of manual workers at express outlets and charging fees for overtime storage in express lockers. In addition, this mode can make pickup time more flexible for customers, easing queuing and inventory backlogs.

4.3. Developing Agricultural Product E-Commerce to Improve Logistics Density

In recent years, the number of people returning to their hometowns to start businesses has increased sharply and formed a certain scale. According to data, in 2023, the number of people returning to rural areas nationwide exceeded the number of people moving to cities for the first time, with a net inflow of 2.76 million. Against this background, Y Township can attract more young people to return home and start businesses, develop agricultural product e-commerce, increase the external supply of logistics, and stabilize transportation volume. At present, the township has characteristic agricultural products such as chili paste, Daerba, Wan'er cake (local foods), Chinese medicinal materials such as platycodon grandiflorum and gastrodia elata, seasonal fruits like plums, and it can also operate Miao costume factories. These distinctive local agricultural products, combined with the advanced technologies and concepts of returning entrepreneurs and strong support from relevant government policies, are bound to promote the upgrading of rural industries, accelerate the economic development of Y Township, and drive the development of local logistics.

4.4. Cultivating "New" Talents for Rural Logistics

The government and logistics enterprises should regularly hire professionals to provide professional skill training for current logistics practitioners, including training on express system operation, customer service standards, fresh logistics handling, and the use of intelligent equipment. In addition, while vigorously developing agricultural product e-commerce, the government and logistics enterprises can carry out college student volunteer service and internship programs through cooperation with colleges and universities, attracting college students majoring in logistics management, e-commerce, and other related fields to carry out summer internships, graduation internships, or volunteer service projects. College students can not only bring cutting-edge logistics

concepts, technologies, and innovations but also assist outlets in promoting the application of digital management tools and helping middle-aged and elderly employees adapt to the operation of intelligent equipment, playing a role in "passing on experience and helping others learn".

5. SUMMARY

The rural logistics "last-mile" problem is a major bottleneck affecting the sustainable and healthy development of rural logistics and the improvement of farmers' living standards, and it is more prominent in mountainous and economically underdeveloped areas. Taking Y Township in Guizhou Province as an example, this paper analyzes in detail the problems existing in the rural logistics delivery system, such as low efficiency of the self-pickup mode, high operating costs, weak infrastructure, and insufficient logistics density. Based on existing research results and combined with the actual situation of Y Township, it proposes targeted countermeasures, including optimizing the terminal delivery mode, piloting the application of intelligent equipment, developing local agricultural product e-commerce, and strengthening the training of professional logistics talents.

Therefore, the construction of the rural logistics system must comprehensively consider factors such as regional characteristics, economic development level, and technical applicability, and cannot simply copy the existing models of cities or developed areas. By implementing measures such as the "self-pickup + crowdsourcing" composite delivery mode, introducing smart express lockers, improving regional logistics density, and strengthening talent team building, Y Township can alleviate the current logistics problems to a certain extent, thereby improving service efficiency and user experience. Although these measures may increase enterprise operating costs in the short term, with the continuous development of rural e-commerce and the continuous improvement of policy support systems, the rural logistics system is expected to gradually achieve intelligent, intensive, and sustainable development, providing important support for the comprehensive promotion of rural revitalization. This study also provides practical references and feasible paths for optimizing logistics systems in areas with similar natural and economic conditions.

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