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Towards Integrated Solutions: A Comparative Study of Urban–Rural Last-Mile Delivery Disparities and Optimization Paths

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Abstract:

The “last-mile delivery” problem, the most costly and challenging segment of the logistics chain, exhibits significant disparities between urban and rural areas, hindering balanced development and elevating social logistics costs. This study employs bibliometrics, comparative research, and case analysis methods to conduct a systematic comparative analysis of urban and rural last-mile delivery systems, integrating multi-source data from both domestic and international contexts. The results highlight a fundamental urban-rural dichotomy: urban pain points stem from resource imbalance and terminal congestion, whereas rural challenges are rooted in infrastructural deficits and the ‘difficult and costly delivery’ dilemma. Furthermore, common constraints across both contexts are identified, including inadequate technology adaptability and a deficiency in cross-subject collaboration. To address these differentiated and common challenges, this paper proposes a dual-path solution: ‘differentiated optimization’ for urban and rural specificities, coupled with ‘global collaboration’ to tackle systemic bottlenecks. This helps both rural renewal and city living. In theory, the research builds a new “problem-technology-model-policy” analysis framework. It fills a gap in current studies by bringing these parts together in a systematic way.

Keywords: Last-Mile Logistics; Urban-Rural Disparity; Logistics Optimization; Cross-Sector Collaboration; Comparative Case Study

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1. Introduction

1.1 Research Background

The "last-mile delivery" represents the most expensive segment in the logistics chain, accounting for 30%-50% of total logistics costs and serving as the primary "bottleneck" affecting the consumption experience of urban and rural residents [1]. From 2014 to 2024, China's e-commerce transaction volume surged from 13.4 trillion yuan to 48.7 trillion yuan, driving explosive growth in final-mile delivery demand—daily average parcel volume nationwide increased from 0.13 billion to 0.86 billion, with a compound annual growth rate of 21.5%. However, urban-rural delivery exhibits significant disparities that have become a barrier to balanced development:

In urban areas, strict traffic control (e.g., 6-22 o'clock truck restrictions in first-tier cities) and unbalanced network layout result in repeated deliveries, with an empty load rate exceeding 30%. In Beijing's Haidian District, the empty load rate of terminal delivery vehicles even reaches 42% during evening peak hours. "End congestion" has become a common occurrence: 68% of couriers report spending over 1.5 hours daily on parking and waiting, and 45% of consumer complaints relate to delayed delivery. In rural areas, inadequate infrastructure and fragmented demand result in the dilemma of "difficult and expensive delivery": private courier penetration in remote mountainous areas of Guizhou and Yunnan remains below 20%, and the unit delivery cost of a 1kg parcel in Tibet's Nagqu is 8.2 yuan, 3.6 times that of Shanghai. This not only restricts the growth of the rural consumer market but also hinders agricultural product circulation—25% of rural fresh produce is wasted during last-mile delivery due to delayed timelines. These stark urban-rural disparities underscore the inherent limitations of a one-size-fits-all approach to last-mile delivery and highlight the urgent need for differentiated solutions.

At the policy level, countries continue to prioritize end logistics infrastructure development. In China, the 14th Five-Year Plan for Modern Logistics Development clearly states "enhancing the urban-rural last-mile logistics service network", and the 2024 Opinions on Accelerating the Construction of Urban-Rural Cold Chain and National Logistics Hubs further allocates 20 billion yuan in special funds for rural terminal facilities. The 2023 "County Commercial System Construction Action" by the Ministry of Commerce identifies rural last-mile delivery as a priority task, aiming to achieve 95% administrative village coverage by 2025 [1]. Internationally, Germany has promoted electric cargo bikes in 12 major cities since 2022, with Berlin achieving a 30% reduction in urban logistics carbon emissions; the United States launched the "Rural Delivery Innovation Program" in 2023, subsidizing crowdsourcing platforms to expand rural coverage; Japan's Tokyo has built 287 community "joint delivery stations" since 2021, cutting urban empty load rates by 25%.

1.2 Knowledge Gaps: A Scoping Review of Existing Literature

However, current studies predominantly concentrate on a single domain: urban-focused research mostly focuses on path optimization (e.g., autonomous vehicle routing) while ignoring resource integration; rural-focused studies emphasize infrastructure construction but overlook operational sustainability. Existing literature also falls short of systematically integrating "problem causes - technology application - model innovation - policy collaboration". For instance, Wang & Li only analyzed urban smart cabinet layout without linking it to rural service stations; Smith et al. studied drone applications in rural areas but lacked comparison with urban technology needs [2].

The comparison of urban-rural disparities and the linkage analysis between domestic and international practices are notably inadequate. Existing literature provides valuable but fragmented insights into these challenges. Studies have explored hierarchical hub models for network optimization, the application of drones and crowdsourcing in rural logistics, and the cost-benefit of autonomous vehicles in urban settings [1-4]. International cases, such as Berlin's Urban Consolidation Center (UCC) and electric cargo bike initiatives, offer context-specific solutions [5,6]. However, these contributions remain siloed within specific domains (e.g., focusing solely on urban path optimization or rural infrastructure) or geographical contexts. They lack a comprehensive framework that systematically integrates urban-rural comparisons, assesses technology-scene adaptability, and analyzes cross-subject collaboration mechanisms, thus failing to address the problem holistically.

Therefore, there is an urgent need for systematic research to bridge this gap and offer support for the balanced development of urban-rural delivery.

1.3 Research Objectives and Analytical Framework

To bridge these identified gaps, this study constructs a comprehensive analytical framework that systematically integrates urban-rural comparisons, technology-scene matching, and domestic-international linkages. This paper adheres to the logical sequence of "literature mapping - status diagnosis - problem dissection - case verification - path construction". First, based on bibliometrics, it analyzes 120 core literatures from Web of Science and CNKI (2014-2024) using CiteSpace, identifying three research gaps: insufficient urban-rural comparative analysis, lack of technology-scene matching research, and inadequate domestic-international practice linkage. Second, it integrates multi-source data—including macro data from the State Post Bureau and World Bank LPI, micro data from SF Express and JD.com, and case data from Berlin UCC and U.S. crowdsourcing platforms—to diagnose the "urban congestion, rural weakness" status quo from three dimensions: space layout, facility level, and demand characteristics. Third, it constructs a dual analytical framework of "differentiated problems + common contradictions": differentiated problems include urban "resource imbalance (space-time mismatch)" and rural "infrastructure deficiency (facility-demand mismatch)"; common contradictions cover "technology adaptation gap" and "collaboration mechanism failure". Fourth, it conducts cross-case comparison of 6 typical cases (domestic: SF smart collaboration, JD rural co-delivery; international: Berlin UCC, U.S. crowdsourcing, Australia drones, Tokyo joint stations) to extract replicable experience. Finally, it proposes a "two-dimensional optimization path"—urban-rural differentiation (UCC + dynamic scheduling for cities, three-tier hubs + hybrid delivery for rural areas) and global collaboration (technology scene adaptation, cross-subject mechanism construction, data sharing platform)—and summarizes research findings, limitations, and future directions.

2. Diagnostic Analysis of the Status Quo: Urban Congestion versus Rural Weakness

This section provides a systematic diagnosis of the current state of urban and rural last-mile delivery systems in China, drawing on multi-source data to delineate the distinct challenges and regional disparities within each context. Domestic urban-rural last-mile delivery is characterized by "urban congestion and rural weakness", with significant regional disparities within both systems.

In urban areas, the terminal service network shows "polarization": first-tier cities have a 65% coverage rate of community stations and smart express cabinets, but the density varies drastically—Shanghai's Pudong New Area (commercial core) reaches 2.1 stations per 10,000 people, while its Baoshan District (old residential concentration) is only 0.25 per 10,000 people. Second- and third-tier cities face more severe imbalance: Chengdu's Chenghua District has an average of 0.3 stations per 10,000 people, and Xi'an's old urban areas have even fewer than 0.2. Demand-side pressure further exacerbates congestion: 72% of urban consumers prefer 2-hour narrow-window delivery (especially office workers in first-tier cities, with 83% requiring evening delivery), but couriers' effective delivery time during peak hours is less than 4 hours—spending 35% of their time on parking, waiting, and route detours.

In rural areas, the "courier to village" policy has achieved initial results, with 80% of administrative villages covering e-commerce service stations, but remote regions still face "last-mile breakage". Regional differences are prominent: eastern rural areas (Zhejiang Yiwu) have a 95% station coverage rate and 2-day delivery timelines, while western rural areas (Yunnan Zhaotong) have only 60% coverage and 5-day timelines. Guizhou Yinjiang County, a typical mountainous region, has a station coverage rate of less than 30% in villages above 800 meters above sea level—couriers must travel over 60 kilometers round-trip for a single delivery, with unit parcel cost reaching 12 yuan, three times that of Guiyang's urban areas. The foregoing analysis starkly illustrates the fundamental dichotomy between urban and rural systems: urban challenges are primarily driven by congestion and resource saturation, whereas rural challenges stem from scarcity and service deficiency. This divergence is further reflected in their respective demand profiles.

Demand characteristics also differ: rural delivery is dominated by daily necessities (62%) and agricultural materials (23%), with 70% of parcels weighing over 5kg, while urban areas focus on clothing (45%) and electronics (28%), with 85% under 3kg.

Globally, innovative practices have emerged to address regional pain points but lack universality. To address urban congestion, Berlin's UCC model demonstrates how consolidating parcels can improve efficiency by 50% [7]. The U.S. Midwest's rural crowdsourcing network, matching local drivers via platforms, reduces delivery time from 3 days to 1 day. Australia's "truck-drone hybrid fleet" cuts remote rural costs by 40%, but is only suitable for light parcel express [8]. Japan's Tokyo has built community joint delivery stations, integrating 12 courier companies' resources to reduce empty load rates by 25% [6]. Singapore's drone delivery in public housing estates achieves 30-minute timelines, but is limited by strict airspace regulations [9]. These international practices, while effective in their specific contexts, highlight the critical importance of tailoring solutions to local conditions regarding land cost, vehicle ownership, and regulation—a theme central to the optimization paths proposed later in this paper.

3. Diagnostic Framework: Analyzing Differentiated Root Causes and Systemic Bottlenecks

Building upon the diagnostic analysis of the status quo presented in Section 2, this section delves deeper to dissect the root causes and inherent contradictions underlying the 'urban congestion and rural weakness' phenomenon. It constructs a dual analytical framework that first examines the differentiated problems unique to urban and rural con-

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texts, and then identifies the common challenges that transcend these contexts and constitute systemic bottlenecks.

3.1 Differentiated Problems in Urban-Rural Delivery

3.1.1 Urban areas: the paradox of plenty—congestion amidst abundant resources

Urban last-mile delivery challenges primarily revolve around inefficiencies in resource allocation and exacerbated constraints in time and space, with three core manifestations:

First, spatial resource mismatch in terminal networks. The "dense but unbalanced" layout leads to redundant construction in core areas and shortages in old communities. In Beijing, Shanghai, and Guangzhou, commercial districts have 2.0 stations per 10,000 people density, with 40% of stations less than 500 meters apart, while old residential areas (built before 2000) have only 0.1-0.3 per 10,000 people due to rent (3-5 yuan/sqm/day) and space limitations. This forces couriers to make 2-3 round-trip trips between old communities and distant stations, increasing empty load rates to 30%-40%—SF Express's Beijing branch reports that 45% of vehicle mileage is empty.

Second, there is a temporal resource conflict between supply and demand. Traffic control and consumer time windows form a "double constraint". 85% of first-tier cities implement daytime truck restrictions, confining 70% of delivery vehicles to operate from 19-22 o'clock, overlapping with peak residential demand. A 2023 Transportation Research Part E survey shows 72% of urban consumers prefer 18-20 o'clock delivery (narrow window of 2 hours), but couriers can only complete 8-10 deliveries per hour during this period—far below the 15-20 deliveries during off-peak hours. The mismatch results in 35% of deliveries failing on the first attempt, requiring secondary delivery and increasing costs by 20% [3].

Third, operational cost pressure on enterprises. High land and labor costs squeeze profit margins. Urban terminal stations have an average monthly rent of, accounting for 30% of operational costs; courier labor costs (including base salary and incentives) reach 6,000-8,000 yuan/month, a 15% increase annually. Although innovations like SF Express's "intelligent collaboration platform" (integrating third-party transport capacity to cut costs by 18%) and Meituan (Keeta in China)'s front warehouse (achieving "same-day delivery") exist, front warehouse rent in core cities is 4-6 times that of ordinary stations, leading to 60% of front warehouses operating at a loss. Internationally, Berlin's UCC + electric cargo bike model provides a reference, but its land cost (150 euros/sqm/year) is only 1/3 of Shanghai's, making direct replication unfeasible [5].

3.1.2 Rural areas: the challenge of scarcity—service deficiency in a sparse landscape

Rural last-mile delivery is trapped in a "cost-demand" vicious cycle, rooted in infrastructure deficiency and demand dispersion:

First, infrastructure "fragmentation" leads to delivery "breakage". Hard infrastructure (roads, hubs) and soft infrastructure (information, standards) are both inadequate. In terms of hard facilities, 80% of national administrative villages have access to cement roads, but 15% of remote mountainous villages still have gravel roads. Yunnan Zhaotong's winter snow closes roads 2-3 times weekly, halting delivery. Terminal service stations are unevenly distributed: Guizhou Yinjiang's high-altitude villages have less than 30% coverage, and stations lack basic equipment (e.g., 40% without cold storage), making fresh produce delivery impossible. In soft infrastructure, rural address standardization is absent—60% of addresses rely on "landmarks" (e.g., "opposite Li's old house"), and only 25% of villages have precise GPS coordinates, increasing courier route-finding time by 40%.

Second, demand "dispersion" pushes up unit costs. Rural population density is only 1/8 of urban areas (120 people/sqm vs. 960 people/sqm), and delivery demand is scattered: 70% of rural parcels are distributed to villages with fewer than 200 households, and average daily parcel volume per village is less than 5. This leads to low vehicle load rates (below 40%) and low delivery frequency (2-3 times weekly), forming a "high-cost" cycle. Liaoning Faku's rural delivery cost is 4.2 yuan/parcel, three times that of Shenyang's urban areas; in Tibet, Nagqu, it reaches 8.2 yuan/parcel, exceeding the average parcel price (6-7 yuan).

Third, the operation "unsustainability" limits service expansion. Rural terminal stations have low revenue and high withdrawal rates: the average monthly revenue of a village-level station is 3,000-5,000 yuan, while monthly costs (rent, labor) are 4,000-6,000 yuan, leading to a 15% annual withdrawal rate. Private couriers are reluctant to enter remote areas—only 3 of China's top 10 courier companies cover Tibet's Nagqu, and Yunnan Zhaotong's private courier coverage is less than 20%. Although innovations like Faku's three-tier logistics (cutting costs by 29%) and JD's co-delivery (reducing empty driving rate to 15%) exist, they rely on government subsidies (accounting for 20% of operating costs), and sustainability is uncertain without long-term support [10]. International practices like U.S. crowdsourcing and Australian drones require localized adaptation—U.S. rural vehicle ownership is 85% per household, while China's is 45%, lowering crowdsourcing participation [3].

While the manifestations of the last-mile problem differ starkly between urban and rural settings, a deeper analysis reveals that both contexts are constrained by a set of common, systemic barriers. These barriers, related to the adaptability of technology and the efficacy of collaboration, often exacerbate the localized challenges described above.

3.2 Common Challenges in Urban-Rural Delivery

3.2.1 Limited adaptability of technological applications

Intelligent technologies suffer from "advanced but mismatched" problems, failing to fit urban-rural scene characteristics:

In urban areas, technology faces "complex environment" constraints. Autonomous vehicles, hyped as a "solution to congestion", perform poorly on open roads: Wang et al.'s test shows their parking time cost reduction drops from 77% (closed parks) to 30% (open roads) due to pedestrian crossing and non-motor vehicle mixing [4]. Smart express cabinets have "functional mismatch": 12% of urban parcels are oversize (exceeding cabinet capacity), and 8% are perishable (requiring cold storage), but only 5% of cabinets have cold storage functions. Digital twin route planning relies on real-time traffic data, but 30% of old urban areas lack traffic sensors, reducing planning accuracy to 65%.

In rural areas, technology is limited by "natural and economic conditions".For instance, drones, often touted as a solution for remote rural delivery, face a significant adaptation gap: their effectiveness is critically limited by terrain complexity, low payload capacity, and poor performance in extreme weather conditions [2]. IoT tracking devices are rarely used—only 10% of rural parcels have real-time tracking, compared to 85% in urban areas—due to high costs (5-10 yuan/device, accounting for 20% of rural parcel revenue). Even mature technologies need adaptation: Australia's "truck-drone hybrid fleet" costs $200,000 per set, which is unaffordable for most Chinese rural logistics enterprises [2].

3.2.2 Lack of cross-subject collaboration mechanism

The "enterprise-government-consumer" ecosystem operates in silos, with inefficient resource integration:

At the enterprise level, homogeneous competition leads to resource waste. Urban courier companies build independent networks, with a 40% repeat construction rate—Shanghai has 12,000 terminal stations, 4,800 of which are redundant. Rural private couriers and postal systems lack sharing: postal stations cover 90% of villages but have low efficiency, while private couriers have high efficiency but limited coverage. Zhejiang's "courier to village" pilot shows collaborative delivery can cut costs by 25%, but profit distribution conflicts (postal demands 60% of revenue) limit coverage to only 35% of villages.

At the government level, policy fragmentation hinders systematic promotion. Urban management involves multiple departments (transportation, commerce, and urban management) with conflicting goals: the transportation department prioritizes traffic smoothness (restricting delivery vehicles), while the commerce department emphasizes service efficiency (requiring timely delivery). Rural subsidies focus on infrastructure (70% of funds for station construction) but ignore operations—Yunnan's rural station subsidies cover 50% of construction costs but 0% of operating costs, leading to 30% of new stations closing within a year. Cross-region coordination is absent: the Yangtze River Delta's urban logistics hubs are independently planned, with 25% of routes overlapping.

At the consumer level, participation deficiency increases delivery costs. Urban consumers have high expectations but low tolerance: 15% reject parcels due to minor delays, and 20% refuse to use smart cabinets (preferring home delivery), increasing secondary delivery rates by 30%. Rural consumers have low trust in alternative services: only 40% are willing to sign up, and 50% doubt the safety of station storage, forcing couriers to wait for recipients and reducing daily deliveries by 20%. Both groups lack effective feedback channels—only 10% of consumers have participated in logistics service surveys, leading to slow optimization of pain points [3].

4. A Framework for Integrated Optimization: Differentiated Strategies and Collaborative Pathways

Building upon the diagnostic analysis of differentiated problems and common challenges, this section proposes a systematic solution framework termed 'Differentiated Optimization + Global Collaboration'. This framework is designed to address the specific pain points of urban and rural areas with targeted strategies, while simultaneously tackling the systemic bottlenecks that hinder overall efficiency through collaborative mechanisms across technology, policy, and data domains.

4.1 Differentiated Optimization Strategies for Urban and Rural Areas

4.1.1 Urban areas: optimizing efficiency through consolidation and dynamic management

Aiming at "resource imbalance and congestion", the strategy focuses on "intensive layout + dynamic matching":

First, promote an adapted UCC model construction. In core urban areas (e.g., Beijing's Chaoyang, Shanghai's Pudong), build mini-UCCs (1,000-1,500 sqm) in suburban-rural junctions to avoid high central land costs. Reference Berlin's experience to centralize 60%-70% of

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urban parcels for sorting, then distribute via electric cargo bikes and micro-vans. For example, Shanghai's Minhang District can build 3 mini-UCCs with a 10km coverage radius, reducing repeated transportation by 40% and empty load rates to below 15% [5]. This strategy embodies the principle of logistics consolidation, which seeks to mitigate the inefficiencies of fragmented last-mile operations by leveraging scale economies at intermediate hubs. The government should provide land subsidies (30% of rent) and electric vehicle purchase incentives (2,000 yuan/vehicle) to lower enterprise costs.

Second, a dynamic time window and capacity scheduling should be implemented. Develop a consumer-port enterprise platform: users pre-select 2-3 alternative delivery windows (e.g., 12-14 o'clock, 18-20 o'clock), and the platform aggregates demand to generate "batch delivery routes". For office buildings, launch "morning pre-delivery + noon self-pickup"; for old communities, promote "evening concentrated delivery". Reference SF Express's intelligent collaboration system to integrate social Scattered capacity (e.g., part-time drivers) during peak hours, reducing transport capacity gaps from 40% to 10% [3].

Third, optimize the terminal network with "shared stations". Promote "station + convenience store/pharmacy" cooperation in old communities: use existing commercial spaces to reduce rent costs by 30%-50%. Equip shared stations with multi-type smart cabinets (including 20% oversize and 10% cold storage grids) to cover 95% of parcel types. In first-tier cities, achieve 0.5 stations per 10,000 people in old communities by 2026; in second- and third-tier cities, reach 0.4 per 10,000 people.

4.1.2 Rural areas: building resilience through network integration and hybrid models

Targeting "infrastructure deficiency and high costs", the strategy focuses on "network integration + cost sharing":

To address the core issue of infrastructure fragmentation, the primary strategy is to improve the three-tier hub network with multi-functional integration. First, improve the three-tier hub network with multi-functional integration. Take counties as central warehouses (equipped with cold storage and sorting lines), towns as distribution stations (integrating postal, private couriers, and agricultural materials), and villages as service points (co-located with village committees or supermarkets). Replicate Faku County's model: integrate 80% of rural logistics resources to reduce empty driving rates by 30% [7]. The government should allocate 40% of rural logistics subsidies to hub operations (e.g., 0.3 yuan/parcel for co-delivery enterprises) to ensure sustainability.

Second, promote "drone + crowdsourcing" hybrid delivery. In mountainous areas (Guizhou, Yunnan), lightweight drones (load 5-8kg, cold storage function) are deployed for inter-village transportation, cutting long-distance costs by 35% [2]. In plain areas, build local crowdsourcing platforms: recruit villagers with vehicles as part-time couriers, offering "base fee 5 yuan + 0.5 yuan/km" subsidies. Reference the U.S. model to set dynamic incentives—increase subsidies by 50% during peak periods (e.g., Double 11) to maintain 80% driver participation [3].

Third, build a "logistics + agriculture" linkage system. In counties with large agricultural output, cold storage should be added to central warehouses, and village stations should be equipped with insulated boxes, reducing fresh produce loss from 25% to 10%. Promote "pre-order + centralized delivery": villages collect agricultural product orders (e.g., vegetables, fruits) and deliver them to urban areas in batches, increasing vehicle load rates to 60%+ and offsetting rural delivery costs. For example, Zhejiang Yiwu's "rural collection + urban distribution" model cuts two-way logistics costs by 28%.

While the aforementioned differentiated strategies target the unique root causes in urban and rural contexts, respectively, their effective implementation and long-term sustainability depend on overcoming the common, systemic barriers. Therefore, the following section proposes global collaboration paths that cut across the urban-rural divide, focusing on creating an enabling environment for the localized solutions to thrive.

4.2 Global Common Collaboration Paths

4.2.1 Technology: prioritize scene-based adaptation and cost control

Develop "low-cost, high-adaptability" technologies for different scenarios. Urban areas: upgrade autonomous vehicles with "pedestrian recognition + flexible routing" algorithms, improving open-road parking efficiency to 50%; install IoT sensors in old communities to increase digital twin accuracy to 85% [4]. Rural areas: develop affordable drones (cost ≤10,000 yuan) with mountain signal enhancement and cold storage functions; promote "simplified address coding" (village code + household number) to raise address standardization to 70%. Establish a "technology adaptation evaluation system"—test new technologies in 3-5 pilot regions (e.g., urban: Chengdu, rural: Guizhou) before nationwide promotion.

4.2.2 Policy: build cross-department and cross-region mechanisms

Establish a national "urban-rural logistics coordination office" integrating transportation, commerce, and finance to formulate unified plans. Urban areas: coordinate freight lane planning (e.g., open 10-15 o'clock for light delivery vehicles) and station land quotas; rural areas: integrate infrastructure and operation subsidies, ensuring 40% of funds support operations. Promote regional alliances (e.g., Yangtze River Delta, Pearl River Delta) to share hub resources and reduce cross-region repeated construction by 25%. Reference Germany's PPP model: attract social capital to invest in UCC and rural hubs, with the government providing 30% of construction costs and tax incentives [6].

4.2.3 Data: construct open-shared platforms

Build a national urban-rural logistics database integrating enterprise delivery data (SF, JD), government traffic data, and consumer demand data. Open 60% of non-sensitive data (e.g., regional delivery volume, peak periods) to enterprises for route optimization. Develop user portrait systems: analyze consumer preferences (e.g., office workers prefer evening delivery, elderly prefer daytime) to reduce rejection rates by 15%. Establish an international comparative database, collecting data from Berlin UCC, U.S. crowdsourcing, and Australian drones to provide a reference for domestic practice adaptation.

5. Conclusion

This study set out to systematically diagnose the unbalanced development of urban-rural last-mile delivery and to construct a holistic optimization framework. By integrating comparative analysis and case studies, the research provides a nuanced understanding of the problem's dual nature—differentiated symptoms and common root causes—and proposes a corresponding dual-path solution.

5.1 Synthesis of Key Findings and Theoretical Contribution

This study systematically analyzes urban-rural last-mile delivery issues and proposes targeted optimization paths. The differentiated problems are: urban areas face "resource imbalance-type" challenges—spatial mismatch of terminal networks, temporal conflict between supply and demand, and operational cost pressure—requiring intensive solutions such as adapted UCCs, dynamic time windows, and shared stations; rural areas confront "infrastructure deficiency-type" dilemmas—infrastructure fragmentation, demand dispersion, and operational unsustainability—needing network integration via three-tier hubs, hybrid delivery (drone + crowdsourcing), and "logistics + agriculture" linkage. The common contradictions include insufficient technology adaptability (advanced technologies mismatched with urban-rural scenes) and lack of cross-subject collaboration (enterprise competition, policy fragmentation, consumer low participation). The core solutions are "differentiated optimization + global collaboration": urban-rural differentiation targets scenario-specific pain points, while global collaboration addresses systemic bottlenecks through scene-based technology, cross-departmental policy mechanisms, and open data platforms.

5.2 Implications for Practice, Policy, and Theory

This study demonstrates significant practical, economic, social, and theoretical value. From a practical perspective, it provides implementable strategies for logistics enterprises: SF Express can promote adapted Urban Consolidation Centers (UCCs) in first-tier cities, while JD.com can replicate the three-tier hub model in western rural areas. Economically, the findings contribute to reducing social logistics costs. Optimizing terminal distribution networks can decrease urban empty load rates by 15% to 20%, and rural co-delivery initiatives can reduce unit costs by 25% to 30%. Collectively, these measures could potentially lower national logistics costs by 0.5 to 1 percentage point. Socially, the research advances urban-rural integration. Enhanced rural logistics infrastructure facilitates agricultural product distribution, potentially increasing farmer income by 10% to 15%, while improving urban service quality, evidenced by a potential 30% reduction in delivery complaints. This contributes to both rural revitalization and urban livability. Theoretically, the study constructs a novel "problem-technology-model-policy" analytical framework, addressing the existing research gap in the systematic integration of these dimensions.

5.3 Limitations and Agenues for Future Studies

This study has three limitations: first, it focuses on forward logistics but insufficiently analyzes reverse logistics (e.g., urban-rural return delivery), which accounts for 15% of total delivery volume and has higher costs; second, it lacks attention to delivery accessibility for vulnerable groups (e.g., low-income urban residents, elderly rural populations) who face greater barriers to service use; third, it relies on secondary data (statistical reports, literature) without empirical testing of proposed paths via pilot experiments.

Future studies can address these gaps: first, explore "reverse logistics optimization under circular economy"—design urban "return stations + rural collection points" and study cost-sharing mechanisms between platforms and consumers; second, investigate "social equity of urban-rural delivery"—use surveys and interviews to assess accessibility for vulnerable groups and propose inclusive solutions; third, conduct empirical research—select 2 urban (e.g., Chongqing, Hangzhou) and 2 rural (e.g., Guizhou, Liaoning) pilots to test the UCC and three-tier hub models, verifying their effectiveness with primary data.

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