Proceedings of ICEMGD 2025 Symposium: Digital Transformation in Global Human Resource Management
DOI: 10.54254/2754-1169/2025.LD25028

Research on Optimization of Community Distribution Strategy under the Trend of Intelligent Economy

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Abstract. In the context of rapid advancements in the field of intelligent economy, there is an increasing demand for community distribution. This study is firmly rooted in the paradigm of an intelligent economy. Its objective is clear: to explore the contemporary challenges associated with optimising community distribution strategies. This investigation is being conducted in the context of the rapid advancements witnessed in the field of e-commerce, which have resulted in the diversification of consumer demands. This is happening because of inefficiency and high costs in community distribution. The intelligent economic background creates an opportunity for community distribution. This involves analysing the current situation and problems of community distribution, analysing the application of intelligent logistics technology in community distribution, proposing optimisation strategies based on intelligent algorithms for distribution path optimisation, dynamic demand prediction, and customer service quality, and verifying the feasibility of the strategies through case studies. The findings show that using intelligent technology to optimise community distribution is the key to achieving efficient and high-quality results, ensuring both enhanced efficiency and elevated customer satisfaction.

Keywords: community delivery, path optimization, demand forecasting, customer service quality

1. Introduction

With the rapid development of e-commerce and the continuous improvement of consumers' requirements for delivery services, community delivery, as an important link connecting merchants and consumers in the "last mile", is becoming increasingly important [1]. However, traditional community distribution still has problems such as low distribution efficiency and high distribution costs. In these circumstances, the smart economy precisely offers an opportunity for community delivery to improve services. The so-called "last mile" refers to an innovative economic form mainly relying on big data technology, artificial intelligence technology and Internet of Things technology [1]. At present, apart from the forms and methods on how community distribution enterprises can rationally utilize community distribution in the context of the intelligent economy, there are no relevant similar literature studies. To sum up, this paper analyzes the current problems existing in community distribution and discusses relevant countermeasures in combination with the technical

DOI: 10.54254/2754-1169/2025.LD25028

characteristics of the current intelligent economy, which can provide references for community distribution enterprises in their future operations.

2. Current situation analysis

Currently, China's community distribution system is a transitional mode of fully developed integrated development of traditional models and intelligent technologies, and presents a phased characteristic of “effective supply cannot meet the rapid increase in demand”. The number of instant delivery orders in China rose from 19.5 billion per year in 2019 to 40 billion per year in 2023, with compound annual growth rate over 20% [2]. But the growth rate of instant delivery capacity at the same time was only around 15%, with a large gap. The Deloitte report showed that 60% of global consumers demand delivery within 2 hours, but the delivery rate did not exceed 50%, especially in remote areas [3]. In the traditional community, the express package delivery of express only depends on the traditional distribution route planning by delivery personnel. Therefore, the delivery distribution is unbalanced and the delivery cost is high. The terminal hardware equipment of community delivery business is insufficient, and the accessibility index of “the last mile” is relatively small. According to China Post Research Institute, the delivery efficiency of manual route planning under traditional delivery is 30%~40% less than the intelligent route planning, and the average of one day’s more than 8~12km travel mileage [4]. According to the data of SF Express ‘same-city service, after using AI scheduling, the number of deliveries per day increases by 25% , but as many as 40% of express delivery companies have not adopted intelligent route optimization [5]. Despite the fact that some companies have started to release artificial intelligence express delivering technology, including drone and artificial intelligence express lockers, their application scenarios are narrow and their problems include insufficient technical maturity and imperfect data sharing mechanism [6]. Customers have set higher standards for services like timeliness and personalization delivery. Both traditional techniques are obviously inadequate in delivering capacity, given the existing requirements.

3. Problem analysis

Due to the insufficient application of big data analysis and artificial intelligence technology in community distribution, the problems existing in reality include:

3.1. Relying on manual labor and lacking dynamic data analysis

It is more or less depending on the empirical value of route planning and the function of dynamic data analysis is not involved, the control of delivery time is not rational enough, which seriously affects the delivery efficiency, currently community distribution path planning is still based on manual experience mainly, and lacks of intelligent dynamic adjustment ability [7]. Based on the statistics from the China Federation of Logistics and Purchasing in 2023, more than 65% of the community delivery companies are still in the fixed route planning mode, with only 28% of the enterprises realized the connection with the real-time traffic big data system [8]. Take the leading express delivery company for example. The average delivery distance of the manual road planning line of the urban distribution business is 15% ~ 20% higher than that planned by the intelligent algorithm, resulting in about 30 fewer orders of daily delivery volume [9]. Directly impact delivery punctuality. On the one hand, JD Logistics’ test data indicates that, post AI dynamic path planning,

DOI: 10.54254/2754-1169/2025.LD25028

on-time delivery rate can rise from 82% to 94%, yet the rate penetration of the technology nationwide remains under 35% [10].

3.2. Specific navigation device for the back-end delivery

Currently, the back-end delivery personnel of some enterprises have not yet carried a certain type of navigation device. When it is carried out under the guidance of a mobile phone app of road condition data, it fails to get the current situation in time, resulting in the occurrence of delivery time out phenomenon. According to a survey by Meituan Research Institute in 2023, about 40% of crowd-sourced delivery riders use civilian mobile phone navigation instead of specialized delivery navigation devices [11]. This equipment difference results in delivery rider's 3-5 minutes delay to respond in real-time road conditions and risks of 10%-15% delivery timeout in rush hours (from Institute of Logistics, Beijing Jiaotong University) [12]. A typical example is one of the same-city delivery platform in Shanghai. Piloted the professional navigation equipment in 2023, and the average time of rider delivery decreased from 42 minutes to 35 minutes, the delivery time-out rate decreased by 8 percentage points [13]. But because of the cost, its penetration rate in the cities under the second-tier level is less than 20% [13]. The technical equipment level at the end distribution varies, which hinders the progress of improving the distribution efficiency.

3.3. Information resources cannot be fully shared

There is a problem that information resources cannot be fully shared, which will have an impact on the entire process and the effect of the business. Due to the failure to effectively connect the data of each link, an information barrier has been formed. According to a 2024 research report by the China Association of Warehousing and Distribution, the data intercommunication rate among the multiple systems involved in community distribution is only around 45% [14]. Take a certain new first-tier city as an example. The data sharing rate among express delivery enterprises, community service stations and property management systems is less than 30%, which leads to a repeat delivery rate as high as 12% (local government logistics monitoring data) [15]. Research by Alibaba's Cainiao Network shows that establishing a unified data platform can increase the overall delivery efficiency by 18%, but currently, less than 15% of communities across the country have achieved complete data sharing [16]. There are still some aspects where the technical performance is not very high and the utilization rate of infrastructure is low. For example: Although some big data and artificial intelligence technologies have been applied in the process of transporting parcels, the proportion of technology usage in these two fields is less than 30%. The investigation found that the major domestic logistics enterprises have not made good use of big data, AI and other technological means. Many leading enterprises have applied them to their own enterprise intelligent dispatching systems [17]. However, the majority of small and medium-sized enterprises still rely on manual labor or platforms to fulfill the requirements for intelligent dispatching, resulting in significant disparities in the development levels among enterprises. For instance, the average delivery time for enterprises using intelligent dispatching systems is 2.1 hours, while traditional enterprises using ordinary algorithms have to wait for as long as 3.8 hours (SF Express and JD.com are exceptions) [18]. In addition, the proportion of last-mile delivery accounts for 30% to 40% of the total cost, and the penetration rate of smart lockers and unmanned vehicles is low [18]. Therefore, community delivery still fails to solve the pain point of the "last mile" difficulty. Intelligent terminal devices have the problem of low coverage. The report indicates that as of the end of June 2021, there were a total of 800,000 sets of smart express lockers across the country [19]. The average coverage rate,

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calculated by the number of people served, was 58%, indicating a certain gap in coverage. The coverage area was mainly concentrated in the central areas of first-tier cities, reaching over 85%, while in third - and fourth-tier cities and counties, it usually did not exceed 40% [20]. Unmanned delivery equipment has just begun to be used. Only a few enterprises such as Meituan and JD.com have no more than 5,000 unmanned delivery vehicles in use, and the delivery method is mainly applied for trial use within a certain scale. From the perspective of technical application, the main reason is that at present, the unmanned delivery technology of most enterprises is not mature and is still in its infancy. In terms of policies and regulations, the lack of relevant support and the insufficient legal binding force in policies cannot guarantee the innovation of technology and its commercialization feasibility. Some specialized laws and regulations, such as the Cybersecurity Law and the Data Security Law, have not issued regulatory details for related aspects.

4. Optimizing strategy

Based on intelligent economic technology, the community distribution strategy is optimized from multiple aspects.

4.1. Optimize by leveraging intelligent technologies

With the support of intelligent economic technology, community distribution optimization is carried out. The traditional community distribution route optimization process is dynamically planned and calculated based on the application of intelligent technologies (genetic technology, ant colony technology), and the routes are dynamically generated and optimized. Dynamic demand forecasting is carried out. Through this purposeful and targeted optimization algorithm, a more complete demand forecasting algorithm is established when facing distribution fluctuations of different natures. Based on the demand forecasting results, human resources, vehicles and other resources are allocated in advance to avoid insufficient transportation capacity during peak periods or waste of transportation capacity during off-peak periods. The system introduces intelligent optimization technologies such as genetic algorithm and ant colony algorithm. The advantages of this type of algorithm lie in the following: Firstly, this type of algorithm has a powerful global search capability. The simulation experiment of the Institute of Logistics of Tsinghua University shows that when the ant colony algorithm is used to solve the path optimization problem of 100 distribution points, it can save 23% of the driving distance compared with the traditional method [21]. Secondly, it has the ability to respond dynamically. The actual measurement data of JD Logistics in the Yizhuang Development Zone of Beijing shows that after integrating real-time traffic data, the dynamic route planning system can reduce the average delivery time by a full 18%. In the last aspect, the algorithm has the function of autonomous learning. As data accumulates, the effect of system optimization will continue to improve. The pilot project of Cainiao Network in Hangzhou shows that the optimization effect of the system has increased by 7 percentage points after half a year of operation.

4.2. Build an intelligent logistics and distribution platform

Construct an intelligent logistics distribution platform and actively and strongly attract various logistics companies to participate and share the platform in order to minimize logistics distribution's wasted losses of poor data circulation and the logistics production model of traditional logist industry's assembly line way. The information silos phenomenon is now becoming the primary "bottleneck" limiting the construction of community distribution. According to the industry report

DOI: 10.54254/2754-1169/2025.LD25028

issued by China Association of Warehousing and Distribution in 2024, the integration degree of the system currently possessed by the express delivery enterprises, the community property management, and the e-commerce platform is only under 40%, resulting in the high repeat delivery rate as high as 10% to 15% [22]. The order information among logistics companies lacks corresponding sharing. Many couriers in the same community travel back and forth in the community. Based on the calculation of NDRC, the loss caused by low-efficiency distribution due to this reaches more than 12 billion yuan every year. The model of platform construction should be "the combination of government guidance and market operations". Specifically, the present study this paper need to solve the problem of standard unification firstly. It is recommended that the Ministry of Transport should take the initiative to develop unified standards such as data format, interface protocol, security rules and so on. Second, the infrastructure should be perfected. People may learn from Zhejiang Province to include the last-mile infrastructure of express delivery into the system of urban public services and to offer policy support like land use, electricity. The last is innovation about operation mechanism. The reform pioneered by Shenzhen is worthy of being propagated: the operation is carried out by the platform company of the third party, and each express delivery enterprise pays according to the amount of use, not only ensure the impartiality but also to ensure the sustainability. Establish a scientific benefit distribution mechanism and distribute benefits according to the principle of “who contributes who gets”. Meanwhile, a transitional period should be set up to let enterprises use the system step by step. By continuously promoting the platform-based conversion, the comprehensive sharing and economical utilization of power grid resources of large communities will be realized within 3–5 years.

4.3. Dynamic demand forecasting

Build and share together with technology enterprises, and introduce more unmanned delivery vehicles and unmanned aircraft resources, and expand the vehicle application. For example; for Meituan’s drone delivery through unmanned delivery vehicles in Xiongan New Area, the use of unmanned delivery vehicles can transport 30% of the last mile delivery volume, and the cost of each delivery item can decrease by 40%.Cainiao Logistics constructed the “Shared Station”, the after-integrating last mile delivery resources of express delivery enterprises, delivery efficiency is up by 25%. To apply the unmanned delivery machine on a large scale， the logistics company must create the perfect industrial chain. The first is from a hardware perspective; technologies that need to be broken through are 3 points: using multimodal sensor fusion technology to guarantee the perception reliability in the environment, high energy battery to overcome the high range problem unmanned aerial vehicle in delivery at the same time, lightweight body materials to reduce cost of manufacture. Regarding the software, three big systems including high-accurate map system for unmanned aerial vehicle’s landing position, intelligent dispatching system for human-machine collaboration and remote monitoring system for operation safety must be established. Last, from an infrastructure’s perspective, people should explicitly define three kind of standard: first, the road right standard requires to define driving rules; second, the charging standard requires to define unified interface protocol; and last, the communication standard ensures interconnection and interoperability. From the side of implementation path, it is suggested to use "trinity" strategy: The first step (1-2 years) is based in closed scenario and build demonstration project in environment like campuses, park; the second step (2-3 years) extend to urban branch road, and choose 3-5 new towns and districts to implement large scale pilot project; The third step (3-5 year), fully covered and form business closed loop completely. the logistics business learn from Shenzhen’s development experience: by measures like establishing a dedicated support fund (200 million yuan/annum), constructing test

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demonstration areas (six areas have been built so far) and streamlining administrative approvals, the number of unmanned delivery vehicles in the city showed 300% growth in 2023.

5. Conclusion

To sum up, this article analyzes the issue of community delivery and combines the technological advantages and favorable impacts brought by the development of the intelligent economy. It plans based on the scheme of optimizing the delivery path by artificial intelligence. On this basis, it analyzes problems such as dynamic delivery demand prediction and unmanned delivery based on artificial intelligence. And the rationality and effectiveness of these distribution strategies are illustrated through specific examples. However, at present, due to the incomplete infrastructure, the relevant laws and regulations for drone and unmanned vehicle delivery are not yet perfect. Community delivery in the intelligent economy still needs further development. In the future intelligent unmanned delivery environment, people should constantly explore the new skills brought about by the development of the intelligent economy, fully utilize technologies such as big data, do a good job in business management, actively learn new technologies, new functions and new applications, and apply them to actual work, and strengthen human power for management and the combination of technology and human power. Special attention should also be paid to the application and work of key technologies, as well as the security of data in distribution enterprises and the protection of personal privacy. Making the smart economy work better for community delivery.

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