**Frontiers in Business, Economics and Management**
ISSN: 2766-824X | Vol. 18, No. 2, 2025

# Analysis of the Joint Distribution Model Based on the Spare Capacity of Urban Rail Transit in Wenzhou

**Shuang Zhao, Youyuan Li** *

Wenzhou Polytechnic, Wenzhou 325035, China

* **Corresponding author**: Youyuan Li (Email: 1743320942@qq.com)

**Abstract:** This paper focuses on Wenzhou and deeply studies the joint distribution model based on the spare capacity of urban rail transit. Against the backdrop of national policy guidance and the development of Wenzhou's e - commerce and express delivery industries, it analyzes the feasibility of Wenzhou's rail transit in carrying out logistics distribution in terms of infrastructure, transportation capacity, cost - effectiveness, environmental protection, and market demand. By analyzing the spatio - temporal distribution characteristics of passenger flow at urban rail transit stations, it elaborates on the practical exploration of joint distribution in Wenzhou based on the spare capacity of urban rail transit, including the "rail + logistics" cooperation model, the construction of surrounding logistics distribution stations, and the construction of an intelligent logistics distribution information platform. It explores future development directions, such as multi - party collaborative mail sorting and rail transit transportation, and joint fresh - food distribution between urban rail and e - commerce express delivery, and proposes countermeasures for potential risks in each direction. The research shows that this model has broad prospects, which is expected to ease traffic congestion, reduce logistics costs, and improve distribution efficiency. Although it faces challenges, with multi - party cooperation, it will inject vitality into the high - quality development of Wenzhou.

**Keywords:** Urban Rail Transit, Joint Distribution, Logistics Distribution.

## 1. Introduction

Against the backdrop of the country's strong advocacy for the innovative development of logistics and distribution, the "Outline for Building a Transportation Power" issued by the State Council in September 2019 clearly states that it is necessary to promote the organic integration of intercity trunk transportation and urban terminal distribution, actively develop intensive distribution models, and encourage the exploration of urban underground logistics distribution. This policy orientation has laid a solid foundation for the transformation of urban logistics distribution. The "Three - Year Action Plan for Deepening the Construction of 'China's Model City for Express Delivery' in Wenzhou (2023 - 2025)" further elaborates by incorporating the construction of urban distribution infrastructure into the scope of urban planning and construction, expanding policy space for the planning and construction of underground logistics distribution infrastructure.

At the same time, the booming development of Wenzhou's e - commerce and express delivery industries has not only injected economic vitality but also brought severe challenges to urban transportation and the environment. In this situation, constructing a joint distribution model based on the remaining capacity of urban rail transportation has become a key path to alleviate urban traffic congestion, reduce carbon emissions, and achieve sustainable development.

This paper analyzes the practical exploration of joint distribution based on the spare capacity of urban rail transit in Wenzhou, and combines theoretical research to put forward suggestions for the development of urban rail distribution.

## 2. Research Status of Urban Rail - based Distribution

At present, with the increasingly prominent problems of urban traffic congestion and logistics efficiency, many experts and scholars have been conducting more and more research on using urban rail for cargo distribution, providing theoretical support for the practical exploration of urban rail - based distribution in cities.

Zhao Rao [3] used a research method combining qualitative and quantitative analysis to deeply analyze the feasibility of constructing an urban underground logistics system relying on the Taiyuan Metro, and drew quantitative analysis conclusions, aiming to improve the overall traffic efficiency of Taiyuan and alleviate the current environmental pollution problems. Chen Yicun [4] explored the feasibility of cooperative transportation between the subway and the underground logistics system from three dimensions, and proposed three potential cooperative transportation modes. Li Chengyu [5] took the total cost of express delivery enterprises as the objective function and constructed a set of route optimization models for express delivery enterprises and the subway to jointly complete express delivery, which is used to plan the optimal delivery route for express parcels to reach the demand points. Peng Meizhen [6] put forward the concept of "co - operative operation of underground logistics and rail transit", and based on this, constructed the operation modes of "passenger - cargo sharing line" and "passenger - cargo separate line". Hu Wanjie [7] proposed the intelligent transformation path of urban logistics: first, carry out pilot projects on rail transportation lines, achieve the expansion from lines to networks in local areas; then gradually expand the urban underground logistics network, and finally build an "above - ground - underground" integrated urban logistics system.

# 3. The Feasibility of Implementing Logistics Distribution via Wenzhou's Urban Rail Transit

## 3.1. Advantages of Infrastructure

Wenzhou's unique geographical environment features a pattern of "seven parts mountains, two parts water, and one part farmland". This terrain makes the urban rail transit network play an even more crucial role in logistics distribution. The rail transit lines traverse the city and cross rivers, effectively connecting scattered commercial areas, residential areas, and industrial parks, greatly expanding the reach of logistics distribution. Take Wenzhou's Line S1 as an example. It spans across areas such as Ouhai, Lucheng, and Longwan, connecting multiple important nodes and opening up new channels for logistics distribution.

Through reasonable renovation, the concourse and platform spaces of urban rail transit can be transformed into highly efficient logistics distribution areas. The supporting facilities also provide a solid guarantee for logistics transportation. In addition, the independent track and signal systems minimize external interference to the urban rail transit, enabling it to operate on schedule. This effectively ensures the timeliness and reliability of distribution, meeting the strict requirements of logistics distribution for time precision.

## 3.2. Advantages in Transportation Capacity and Efficiency

Wenzhou has a well - developed manufacturing industry with a remarkable industrial cluster effect. The strong transportation capacity of the rail transit highly matches the local large - volume cargo transportation demand. The urban rail carriages have a spacious interior and a high load - bearing capacity, enabling them to transport a large quantity of goods at one time. This effectively reduces the number of transportations trips and enhances the scale effect and transportation efficiency. For instance, if Wenzhou's characteristic footwear and clothing industry were to use urban rail for transporting finished products on a large scale, the transportation volume of one train would be equivalent to that of 10 small trucks, significantly improving the transportation efficiency.

The urban rail runs at a high speed, which has a distinct advantage in the delivery of goods with extremely high time - sensitivity, such as fresh produce and express parcels. Moreover, the perfect transfer system formed by the interwoven lines facilitates the flexible planning of delivery routes and expands the delivery coverage area.

## 3.3. Advantages in Cost and Environmental Protection

From a cost perspective, the energy consumption and vehicle maintenance costs of urban rail transit are significantly lower than those of road transportation. According to estimates, under the same transportation volume, the cost of urban rail transportation is approximately 30% lower than that of road transportation. This helps local logistics enterprises reduce operating costs and enhance their market competitiveness.

In terms of environmental protection, rail transit powered by electricity has extremely low carbon emissions and pollutant emissions, meeting the requirements of the development of green logistics. As a coastal city, Wenzhou attaches particular importance to environmental protection. The participation of urban rail in logistics distribution can effectively ease urban traffic congestion, reduce carbon emissions, conform to the city's concept of green development, and contribute to the city's achievement of sustainable development goals.

## 3.4. Advantages in Market Demand

In recent years, Wenzhou's urban economy has witnessed rapid development, and the e - commerce industry has been booming. This has led to a continuous upward trend in the demand for urban logistics and distribution. According to market research data, over the past five years, the demand for urban logistics and distribution in Wenzhou has been steadily increasing at an annual growth rate of 12%. Facing such strong growth in demand, traditional logistics distribution models are confronted with numerous challenges, such as difficulties in ensuring delivery timeliness due to traffic congestion and persistently high distribution costs.

The emergence of urban rail - based distribution not only provides strong support for urban logistics distribution capabilities. With its unique advantages of high speed, high punctuality rate, and large - volume transportation, it effectively alleviates the pressure on traditional distribution methods. At the same time, it also highly meets the market's urgent need for efficient and convenient logistics services.

# 4. Spatio - temporal Distribution Characteristics of Passenger Flow at Wenzhou Urban Rail Transit Stations

## 4.1. Temporal Distribution Characteristics

### 4.1.1. Hourly passenger flow within a day

The hourly passenger flow of Wenzhou urban rail transit within a day typically shows a bimodal distribution. In the morning, as residents go to work or school, the passenger flow gradually rises, forming the morning peak. It drops slightly at noon, and then another evening peak occurs when people get off work and finish school. The passenger flow is the lowest at night. Taking Wenzhou's Line S1 as an example, during the evening peak, stations such as Oujiangkou, Airport, and Yongzhong have a relatively large number of boarding passengers. During off - peak hours, except for Wenzhou South Railway Station, the overall passenger flow is relatively small. Through the analysis of the one - year passenger flow data of Line S1, it is found that the passenger flow during the morning peak accounts for 35% of the daily total, and that during the evening peak accounts for 30%.

### 4.1.2. Daily passenger flow within a week

For lines mainly serving commuting and school - going passengers, the passenger flow generally decreases on weekends. In contrast, for lines connecting commercial outlets and tourist attractions, the passenger flow often increases on weekends. For example, Line S1 connects tourist attractions and commercial activity areas, and the passenger flow during holidays is higher than that on weekdays. Additionally, the morning peak on Mondays and the mornings after holidays, as well as the evening peak on Fridays and the evenings before holidays, usually have a larger passenger flow than the peak hours on other weekdays. Through big data analysis, it has been found that during holidays, the passenger

flow of urban rail lines connecting tourist attractions increases by approximately 50%.

## 4.2. Spatial Distribution Characteristics

There are significant differences in passenger flow among different stations, which is closely related to the function and development degree of the location where the stations are situated. For stations within the core urban area, due to the well - developed urban road network and diverse public transportation methods, the proportion of urban rail passenger flow is relatively small. However, stations connecting the peripheral areas, or those in the peripheral areas near large enterprises, institutions, or residential areas, experience a relatively obvious passenger flow during the commuting period. For example, the stations of Line S1 connecting Lucheng, Ouhai with Longwan, Oujiangkou and other places have a large number of long - distance commuting passengers during the morning and evening peaks. Transfer stations, as the intersection points of different lines or different transportation modes, usually attract a large amount of passenger flow. In the future, when the Wenzhou rail transit network is formed, the passenger distribution and collection function of transfer stations will become even more prominent.

# 5. Practical Exploration of Joint Distribution in Wenzhou Based on the Spare Capacity of Urban Rail Transit

## 5.1. The Current Situation of Wenzhou's Urban Rail Transit

As of 2023, two operational lines of Wenzhou Urban Rail have been opened, namely Line S1 and Line S2, with a total length of 117.13 kilometers and an average operating speed of 55.54 km/h.

Line S1 has 21 stations (3 of which are reserved and not yet in service). Running in an east - west direction, this line connects the Ouhai Central District, the main urban area, the Longwan Central District, and the Oujiangkou New Town. It also serves important transportation hubs such as Wenzhou South Railway Station, Wenzhou Railway Station, and Longwan Airport.

Line S2 has 20 stations and runs in a north - south direction, effectively connecting Yueqing, the Wenzhou Marine Economic Development Demonstration Zone, Wenzhou Bay New Area, and Ruian. In addition, Line S2 has designed express services with limited stops, which include 9 stations such as Qingdong Road Station, Xuyang Road Station, Wengyang Station, Lingkun Station, Airport Station, Tianhe Station, Baotian Station, Shengcheng Station, and Dongshan Station. This has further improved the operational efficiency and met the travel needs of different passengers.

## 5.2. Exploration Paths of Joint Distribution in Wenzhou Based on the Spare Capacity of Urban Rail Transit

### 5.2.1. "Rail + Logistics" Cooperative Model

The Operation Branch of Wenzhou Railway and Rail Transit Investment Group Co., Ltd. has carried out in - depth cooperation with Wenzhou Shunheng Express Co., Ltd., a wholly - owned subsidiary of SF Express. On May 23, 2023, they officially launched the innovative "rail + logistics" model.

This model makes full use of the surplus capacity of the trains on Line S2 for intra - city express delivery. It strictly adheres to the principles of not affecting passengers' travel, not adjusting the departure and arrival times of the trains on Line S2, and not carrying out any equipment and facility renovations, effectively revitalizing the idle capacity resources.

Before the express goods arrive at the station, they have already completed the security inspection and sealing processes. Subsequently, they are transported to a fixed area at the head of the first carriage of the train by a special trolley. Delivery personnel accompany the goods throughout the process to ensure the safe and orderly transportation of the express items.

### 5.2.2. Construction of Logistics Distribution Stations around Urban Rail Transit

Based on the distribution of urban logistics demands and the layout of rail transit stations, Wenzhou has planned and built logistics distribution stations around several key stations. These stations are equipped with complete warehousing facilities to meet the short - term storage needs of goods. Meanwhile, they are also equipped with advanced sorting equipment. By applying automated sorting technology and intelligent warehouse management systems, the sorting efficiency of goods has been greatly improved.

For example, a large - scale logistics distribution station has been built around the Wenzhou South Railway Station on Line S1. This station is not only close to the transportation hub, which facilitates the distribution and collection of goods, but also has complete internal facilities. It can quickly classify, store, and transfer the arriving goods, making full preparations for the subsequent distribution work.

Through the construction of these distribution stations, an effective connection between rail transit and the "last - mile" distribution has been achieved, improving the overall efficiency of logistics distribution.

### 5.2.3. Construction of an Intelligent Logistics Distribution Information Platform

Wenzhou has established an intelligent logistics distribution information platform. By making full use of advanced technologies such as big data, cloud computing, and the Internet of Things, it enables real - time tracking and monitoring of the cargo transportation status. Shippers can query information such as the location of the goods and the estimated delivery time on the platform at any time, and consignees can also receive timely notifications related to the cargo delivery.

Meanwhile, the platform is equipped with an intelligent dispatching function. Based on the quantity of goods, the destination, and the operation status of the rail transit, it can use intelligent algorithms and optimization models to reasonably arrange transportation plans and optimize delivery routes, thus improving transportation efficiency.

For instance, when a batch of goods needs to be delivered from a certain area in Wenzhou to another area, the information platform will plan the optimal delivery route for the delivery staff according to real - time traffic data, train schedules, and the cargo storage conditions at each station, ensuring that the goods can be delivered to the destination on time and accurately.

# 6. Development Directions of Logistics Distribution Carried out by Wenzhou Urban Rail Transit

## 6.1. Multi - party Collaborative Joint Sorting of Mails and Urban Rail Transportation

Each express delivery brand can set up a joint sorting center. By using intelligent sorting equipment such as intelligent sorting robots and automated sorting assembly lines, mails are uniformly classified according to urban rail stations and delivery areas. During the off - peak hours of urban rail, the sorted mails are loaded into the spare carriages of urban rail trains according to the planned routes and stations. Mails from different express delivery brands are successively sent to stations along the line. After arriving at the station, couriers take over to complete the last - mile delivery.

This approach integrates express delivery resources, improves the transportation efficiency of urban rail, and reduces the logistics costs of all parties. However, this model may have potential risks such as uneven distribution of interests, high management and coordination difficulties, and complex information system integration.

To address these issues, blockchain technology can be introduced to build a distributed ledger to record the costs and revenues of each transportation business, achieving transparent revenue distribution. A unified management and coordination mechanism should be established. A joint management committee can be set up to clarify the responsibilities of all parties and formulate unified operation standards and processes. By using data interface standardization technology, unified data interface specifications can be developed, and data conversion middleware can be developed to achieve seamless integration of information systems.

## 6.2. Joint Fresh Produce Delivery by Urban Rail Transit, E - commerce Platforms and Express Delivery Companies

E - commerce platforms can collaborate with major express delivery companies. When citizens place orders for fresh products on the platform, merchants quickly sort and package the products at the production sites or large - scale storage centers. The fresh products are then transported to urban rail stations and carried by the urban rail during the relatively idle period from late night to early morning. After arriving at the stations near residential areas, couriers immediately complete the delivery using cold - chain distribution equipment.

This model can significantly reduce transportation costs and achieve efficient delivery. However, it also faces challenges such as temperature control and the coordination between upstream and downstream of the supply chain.

To address these issues, intelligent temperature - control technology can be introduced. Install intelligent temperature - control devices in the urban rail transport carriages to monitor the temperature in real - time during transportation. Additionally, a supply - chain management system can be utilized to achieve information sharing, ensuring the coordinated operation of the upstream and downstream of the supply chain.

# 7. Conclusion

Looking to the future, with the continuous improvement of the urban rail transit network, the joint distribution model based on the spare capacity of the rail system holds great promise. It breaks the traditional mold of logistics and opens up a new path for urban distribution. This model can not only effectively alleviate traffic congestion, reduce logistics costs, but also enhance distribution efficiency, bringing a more convenient service experience to citizens.

Although there may be many challenges in the implementation process, with the collaborative efforts of the government, enterprises, and all sectors of society, these difficulties can surely be overcome. This innovative model will inject new vitality into the high - quality development of Wenzhou.

# Acknowledgment

This paper is the research achievement of the 2024 general scientific research project of Wenzhou Vocational and Technical College, "Research on the Joint Distribution Model Based on the Spare Capacity of Urban Rail Transit — Taking Wenzhou as an Example" (Project No.: WZY2024043).

# References

[1] Zhao Rao, Li Cai. Feasibility Analysis of Urban Underground Logistics System Based on Taiyuan Metro [J]. Enterprise Science - Technology and Development, 2020(09): 56 - 58.

[2] Chen Yicun, Dong Jianjun, Shang Pengcheng, Chen Zhilong, Ren Rui. Research on the Cooperative Transportation Mode of Urban Subway and Underground Logistics System [J]. Chinese Journal of Underground Space and Engineering, 2020, 16(03): 637 - 646.

[3] Li Chengyu. Research on Route Optimization of Express Delivery by Collaboration between Express Companies and Subway [D]. Dalian Maritime University, 2020.

[4] Peng Meizhen, Dong Jianjun, Ren Rui, Chen Zhilong, Chen Yicun. Analysis of the Cooperative Operation between Urban Underground Logistics System and Subway [J/OL]. Journal of PLA University of Science and Technology (Natural Science Edition): 1 - 7 [2022 - 11 - 03].

[5] Hu Wanjie, Dong Jianjun, Chen Zhilong. Discussion on the Development Mode of Urban Logistics Based on Subway Freight System [J]. Railway Transport and Economy, 2022, 44(02): 8 - 15.