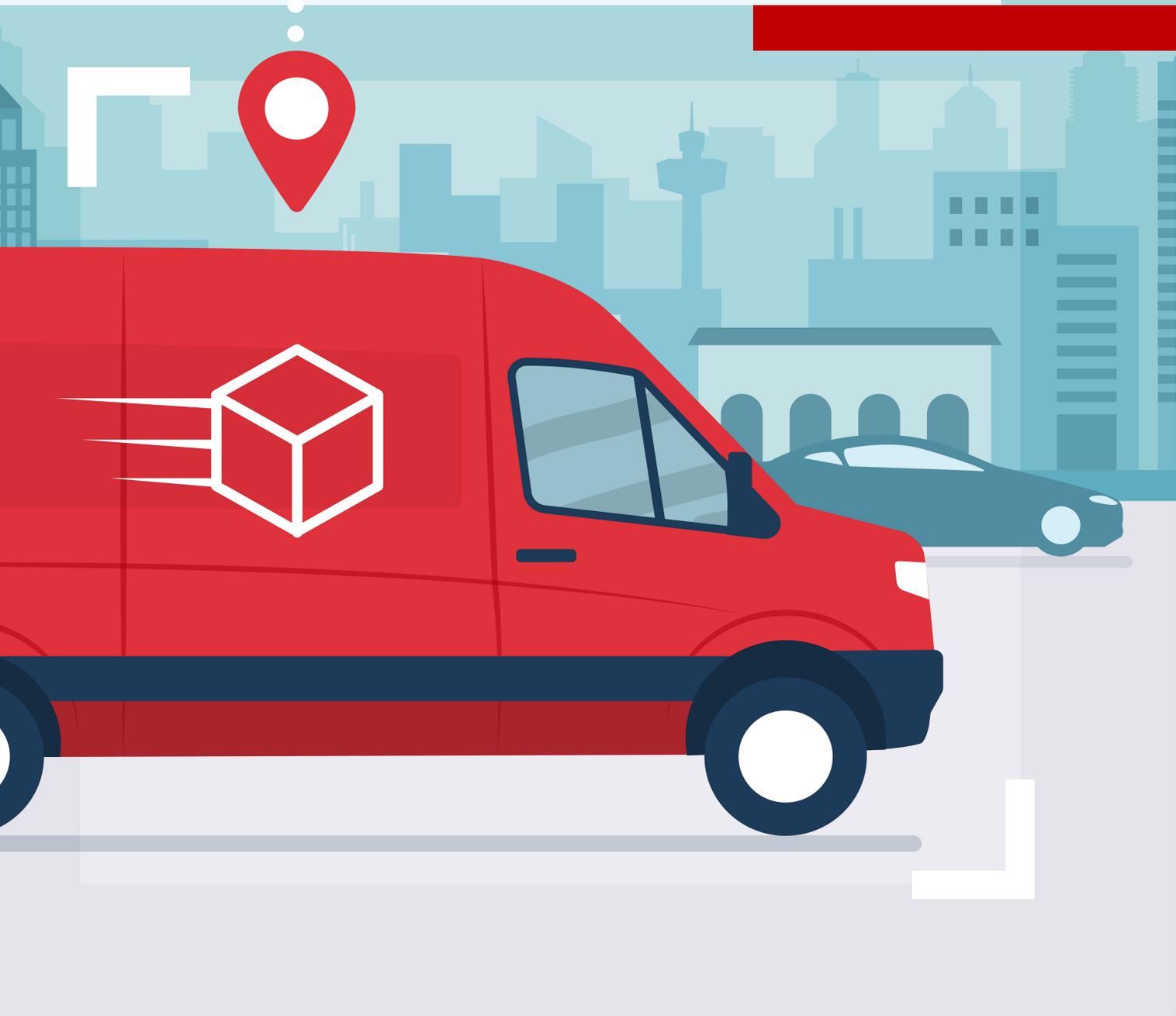


Research on the Setting of Temporary Loading/Unloading
Zones for New Energy Logistics Vehicles in Chancheng
District of Foshan, Guangdong Province, P.R. China



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Executive Summary

Recognizing the importance of the ease of use of urban logistics vehicles, and current challenges that they face relating to parking, this study considers the new energy vehicle (NEV) promotion needs in urban freight sector, examines the potential of having dedicated loading/unloading zones for these vehicles, and focuses on solving problems of parking them in difficult contexts. The study has developed a scientific planning methodology for the development of loading/unloading zones dedicated to the use of new energy logistics vehicles (NELVs), including the selection of their location and the management of their loading/unloading spaces. The study uses Chancheng District in Foshan as the research setting to examine the scheme of dedicated loading/unloading zones for NELVs, standardize the parking of urban logistics vehicles, and highlight policies and management strategies relating to NELVs, so as to further improve the convenience of traffic policies relating to urban logistics vehicles, improve the overall efficiency of freight distribution systems, alleviate urban traffic congestion, and promote green low-carbon transportation. The study findings can be used as a reference for other cities in China to promote their own initiatives in the setting of dedicated loading/unloading zones for urban logistics vehicles.

The main components of this study are as follows:

1. Case study

This study reviewed national and international examples of urban logistics vehicles parking planning strategies and analyzed the principles, forms and management policies of the setting of temporary loading/unloading zones for urban logistics vehicles in China and abroad.

Research findings revealed that both domestic and international cities regulated logistics vehicle behaviors, such as by the setting of restrictions on parking time and locations, based on logistics vehicle parking demands, and traffic and road

conditions. Currently, domestic cities pay more attention to the selection of locations for temporary parking zones, and international cities place more emphasis on the management of logistics vehicle parking sites. International cities also have more severe penalties for illegal parking than those imposed in China. Cities in developed countries were found to have conducted more in-depth planning and research on logistics vehicle parking than that conducted by Chinese cities, but across all locations, it was noted that there is still a lack of in-depth studies on the setting of temporary loading/unloading zones dedicated for NELVs.

2. Status analysis

This study analyzes the current situation of existing temporary parking zones for urban logistics vehicles in Chancheng District of Foshan City and the relevant policies related to their use. Following field investigations and analysis of the status of temporary parking zones for urban logistics vehicles in various types of areas in Chancheng District, Foshan City, it was determined that the main existing problems relating to their use are:

- Issues relating to location and management: The location of loading/unloading zones for logistics vehicles needs to be optimized, and parking management measures need to be strengthened.
- Issues relating to illegal behavior: Random (illegal) parking of logistics vehicles is common, which affects road traffic safety and travel convenience.
- Issues relating to effective planning: A scientific and comprehensive method for setting up temporary loading/unloading parking zones has not yet been formed.

3. Effective methods for planning the setting and use of dedicated zones

This study adapted the concept of the Sustainable Urban Logistics Planning (SULP), and therefore

analyzed the setting of dedicated loading/unloading zones for urban logistics vehicles from the core aspects related to this theory, which are outlined below.

Scenario analysis. Plans must analyze the necessity and feasibility of setting up dedicated loading/unloading zones in different scenarios. Planners must summarize differences relating to land use, shop types and road conditions, and form a method of analysis to use this information to determine the necessity and feasibility of dedicated parking lots for loading/unloading purposes for each unique context.

Demand estimation. This study uses the concept of demand estimation to evaluate parking demands based on the amount of time needed for parking to meet the needs of loading/unloading requirements for nearby stores and services. For example, a calculation would be made on the estimated amount of time parking spaces would be used for temporary parking and loading/unloading operations for both on-road loading/unloading zones or on-road available spaces, based on the distribution requirements of stores along the street. The study puts forward a calculation model for distribution parking demand that can be used to determine this estimation.

Calculation of the number of dedicated loading/unloading zones. The study presents a method for determining the number of zones needed by correlating the frequency of the use of loading/unloading zones to overall shop demand in one geographic location. For example, a starting threshold for the minimum number of dedicated loading/unloading zones needed would be determined by seeing the frequency of the use of a zone by shops over a set period of time (such as a given road section between 9:00 to 17:00 sees at least 60 uses of loading/unloading zones, or during the same time, the shops in the section each need to use the zone a minimum of 4 times). The calculation model for this method is proposed in further detail in the study.

Location selection of dedicated loading/unloading zones. The site selection model proposed by this study is established with the goal of maximizing meeting the needs of distribution parking demands and minimizing comprehensive costs from each dedicated loading/unloading zone, by locating zones in a way that they meet the requirements of each store.

Design of dedicated loading/unloading zones. The design of dedicated loading/unloading zones for NELVs mainly considers the development characteristics and size of these vehicles, their relevant specifications and standards, and the size of existing distribution vehicle loading/unloading zones.

Management measures. In order to ensure dedicated loading/unloading zones are used exclusively by NELVs and to improve the utilisation efficiency of loading/unloading zones, corresponding management measures are proposed in terms of time and space management, order management, and fee reduction policies.

Pilot implementation. Two pilot areas in Chancheng District were selected as locations to demonstrate the application of the study's proposed scientific, reasonable and effective implementation plan for the setting of dedicated loading/unloading zones for NELVs. Part of the research schemes have already been implemented in two selected areas. The pilot programs in Houlong 1st Street and Gaomiao Road have facilitated the parking of logistics vehicles which serve shops along the street, by standardizing parking order, improving loading and unloading efficiency, and reducing random parking on motorways and non-motorized vehicle lanes by setting up dedicated loading zones and corresponding traffic signs for NELVs.

4. Suggestions for policies and measures

The study presents executable policies and measures for the relevant departments of freight distribution and stakeholders to further improve the setting,

implementation and application of loading/unloading zones for NELVs. Recommendations made for decision makers mainly consider departmental coordination, planning guidance and public participation.

Strengthen departmental coordination. The bureau of transportation together with the traffic management bureau, urban management and law enforcement sectors, communities and street representatives have set up a working group for the setting of dedicated loading/unloading zones for urban logistics vehicles. The group serves to coordinate zone planning, implementation, supervision and law enforcement efforts, while also providing a dynamic evaluation of these processes, including collecting and responding to feedback on their operation.

Focus on planning guidance. To guide planning processes, and ensure high-quality development, research will continue to be carried out on special plans relating to urban green freight distribution, the planning of dedicated parking zones for urban freight distribution vehicles, and specifications and standards for setting up dedicated parking zones for urban logistics vehicles.

Encourage public participation. To ensure public support for the initiative, public awareness campaigns on green freight distribution will be launched through multiple channels. These campaigns serve to educate the public to know the importance of regulations relating to loading/unloading zones, and how they benefit their communities, therefore making distribution modes more efficient and the overall management of distribution vehicles and handling tools more accepted and professional.



1 Overview

1.1 Background

In September 2020, General Secretary Xi Jinping announced at the general debate of the 75th United Nations General Assembly that China will increase its nationally determined contributions, adopt more powerful policies and measures, aim to have carbon dioxide emissions peak by 2030, and strive to achieve carbon neutrality by 2060. The Outline of a National Multidimensional Transport Network issued in February 2021 proposed to accelerate the process of green and low-carbon development, reduce the emissions intensity of pollutants and greenhouse gas, and reach the peak of carbon dioxide emissions in the transportation sector as soon as possible. At present, the carbon emissions of the transportation sector account for about 11% of total carbon emissions, while freight carbon dioxide emissions account for about 65% of the total emissions of the transportation sector. Neutralization has a very important meaning in this field and promoting the reduction of emissions from freight transport is of great significance in promoting the peaking of carbon dioxide emissions in the transportation industry and ultimately, achieving carbon neutrality.

In 2017, the Ministry of Transport, the Ministry of Public Security and the Ministry of Commerce jointly organized and launched the Urban Green Freight Distribution System Demonstration Program, with the objective to build an “intensive, efficient, green and intelligent” urban freight service system, and to provide strong support for promoting sustainable urban development. In 2019, Foshan was successfully selected as one of the second batch of cities in the demonstration program. According to the program’s action plan, the setting of temporary loading/unloading zones for logistics vehicles is one of the key evaluation indicators for the success of the greening urban freight.

The Sino-German Cooperation on Low Carbon Transport (CLCT) project is funded by the International Climate Initiative (IKI) and implemented by the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH. It aims at strengthening cooperation between Germany and China in the field of climate protection in the transport sector. The overall goal of the project is to

provide Chinese policy makers and relevant governmental authorities with effective and efficient implementation strategies to further develop a low carbon transport sector in China. A key objective of the CLCT project is to promote low-carbon freight and logistics transportation development.

In response to the national goal of “Peaking Carbon Emissions and Achieving Carbon Neutrality”, and in order to fulfill the requirements for Urban Green Freight Distribution System Demonstration Program, this study therefore proposes to carry out research on the setting of temporary loading/unloading zones for new energy logistics vehicles (NELVs) in Chancheng District, Foshan City based on the framework of the CLCT. Taking Chancheng as a pilot district of Foshan, the study team conducted research on the setting of loading/unloading zones for NELVs, so as to further improve the policy of facilitating urban logistics vehicles and help the overall promotion of NELVs. At the same time, the overall study’s ambition aimed to provide a reference for research on temporary loading/unloading zones for NELVs in other cities in China, so as to explore new ways to develop China’s low-carbon freight development.

1.2 Objectives

The objectives of the pilot project were to:

- Develop a Methodology Study. Based on a domestic and international case study, and combined with an outline of the characteristics of Chancheng District, the study developed a scientific and comprehensive methodology for allocating temporary loading/unloading zones for NELVs, including approaches to identifying parking areas, planning policies, designation guidelines, the configuration of related facilities and further relevant steps, to guide the implementation of subsequent plans. The methodology study served as the theoretical foundation to other project objectives and was considered as crucial to the success of the project.
- Run a Pilot application. The study developed an allocation plan for temporary loading/unloading zones for NELVs and selected at least two pilot

sites in Chancheng District to implement the plan. Through this approach, the next objective consisted of the testing of the scientific concept grounding the project, promoting its theoretical methodology, and further guiding the implementation of the setting up of temporary loading/unloading zones for NELVs.

- Analyze the experience and provide a summary. Through the Sino-German cooperation, the study explored effective measures to alleviate the difficulties faced by NELVs relating to road access, parking and loading/unloading, explored the possible benefits in support of an increased market share of NELVs, and summarized the lessons and experiences gained from this study that could be useful to other cities of similar contexts in China.

1.3 Research Objectives and Definitions of Key Terms

(1) Urban logistics vehicles

According to the Technical requirements for types of urban logistics vehicles (GB/T 29912-2013), the term ‘urban logistics vehicles’ refers to cargo vans and closed vans used for cargo transportation (including express delivery) services in urban areas.

Cargo van: A logistics vehicle with a cargo part consisting of a closed container, where the cargo part is separated from the driver’s cabin.

Closed van: A freight truck with an enclosed cargo part, and the cargo part is integrated with the driver’s cabin.

(2) NELVs

NELVs refer to cargo vans or closed vans driven mainly or entirely by new energy sources, including pure electric trucks, plug-in hybrid electric trucks, fuel cell trucks, and clean energy trucks that meet the National VI emission standards, and related protocols, that are approved and listed in the Recommended Model Catalog for Promotion of New Energy Vehicle Application by the Ministry of Industry and Information Technology. Currently, the main types of NELVs in Foshan are pure electric trucks and hydrogen fuel cell trucks.

(3) Temporary loading/unloading zones for NELVs

The term ‘temporary loading/unloading zones for logistics vehicles’ refers to the special parking sites or roadside loading/unloading zones in the urban commercial areas, residential areas, industrial areas, large public zones, and related locations, where logistics vehicles are allowed to park for a limited duration of time (in general up to 30 minutes), to perform loading or unloading operations. This project focused on roadside temporary loading/unloading zones.

For the purpose of this project, roadside temporary loading/unloading zones for logistics vehicles were divided into two types – shared temporary loading/unloading zones and dedicated temporary loading/unloading zones.

Shared temporary loading/unloading zones: Roadside temporary parking lots for both passenger vehicles and logistics vehicles.

Dedicated temporary loading/unloading zones: Roadside temporary parking lots for only logistics vehicles.

1.4 Technical Processes

The first technical step of this project consisted of extensively collecting information on domestic and international cases, including parking policies, setting methods, loading/unloading zones design, management measures, and related information, and then summarizing related lessons and experiences. Secondly, the project included the conducting of an investigation and survey to obtain information about urban development status, logistics vehicle development status as well as current relevant policies in Chancheng District, Foshan City to assess existing problems and understand possible future trends of freight distribution system development. The project then developed a systematic methodology of setting up temporary loading/unloading for NELVs, which may include considerations of the principles of loading/unloading zone allocation, parking demand predictions, parking site selection, the design of loading/unloading zones, a demonstration of site selection methods, the management of loading/unloading zones management and control measures, and related activities. Finally, the

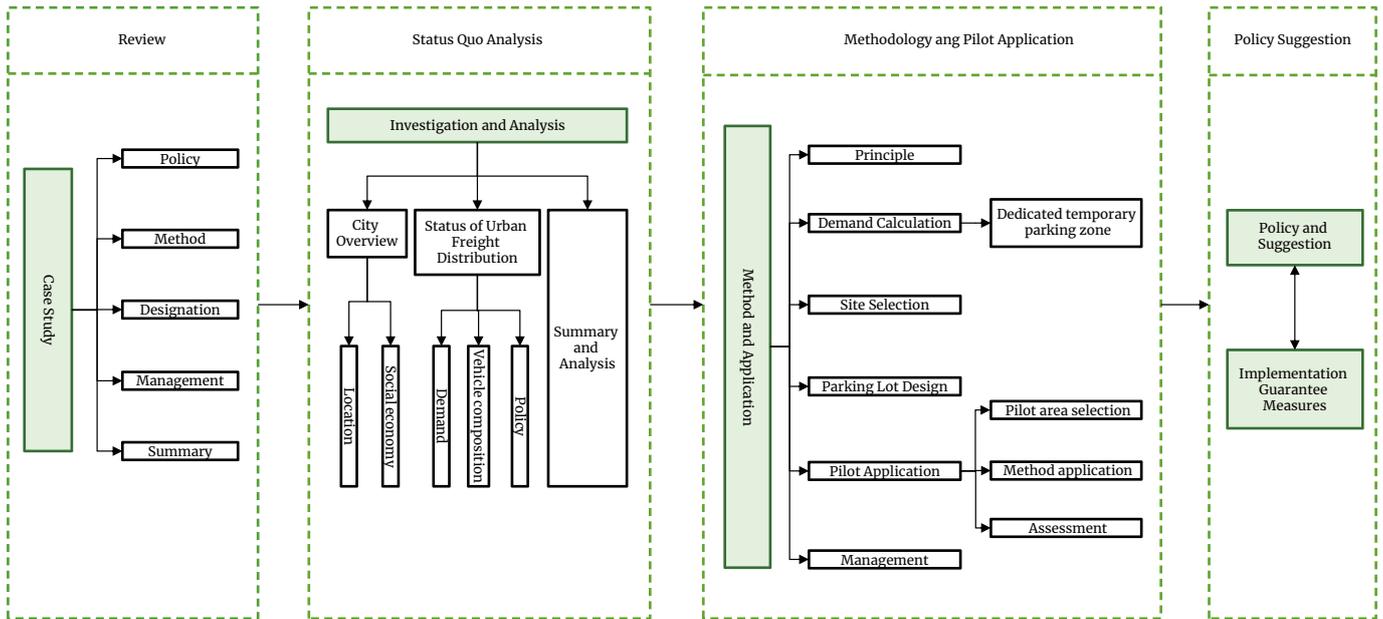
project formulated relevant recommendations for policies and measures to be presented to related government departments and be used to provide a demonstration of opportunities and lessons learned for other cities.

Specifically, this research included the following four research outputs:

- Case study
- Status analysis
- The setting of methods and the demonstration of applications
- Suggestions on policies and measures

The technical route of the project is shown in Figure 1.

■ **Figure 1 Technical route and methodology concept**



Source: Nanjing Institute of City and Transport Planning, hereafter as "NICTP"



2 Case Studies

This chapter contains an analysis of case studies of cities both in China and abroad that have set up loading/unloading zones for logistics vehicles, in order to obtain evidence of some experiences that can be used for reference in different locations.

2.1 Domestic Cases

Currently in China, only a few cities have designated temporary loading/unloading zones for urban logistics vehicles. The urban logistics vehicles mentioned here include both conventional fueled logistics vehicles and NELVs. In most cases, logistics vehicles have park on the side of motor vehicle lanes, bicycle lanes or randomly on sidewalks, and there is a lack of relevant management measures. In 2017, the Ministry of Transport, the Ministry of Public Security and the Ministry of Commerce jointly organized and launched the National Demonstration Project of Green Urban Freight. The first batch of demonstration cities subsequently set up temporary loading/unloading zones in accordance with the corresponding requirements and provided valuable experiences. This report section analyzes the experience in setting loading/unloading zones, and related policies and management measures in case study cities in China.

2.1.1 Suzhou

Suzhou has been actively promoting its “parking facilitation” program, which aims to relieve the parking difficulties of urban logistics vehicles. Suzhou has set up dedicated loading/unloading sites and temporary loading/

unloading zones for urban logistics vehicles within existing roadside loading/unloading zones in such areas as business centers, residential communities, and trading markets.

Suzhou has also set up 50 free loading/unloading bays for NELVs under limited time in the green freight demonstration zone of Gucheng district. At the same time, all roadside loading/unloading zones are allowed to be used temporarily for loading/unloading by logistics vehicles. Per day, the city offers free parking to NELVs for the first hour, whereas conventional logistics vehicles receive only the first 30 mins for free. In addition, NELVs are allowed to temporarily park for loading/unloading operations on 4m or wider bicycle lanes outside the Gucheng district during off-peak hours, under the premise that the loading/unloading behavior will not affect road traffic operations. These measures effectively fulfilled the loading/unloading demand of urban logistics vehicles in this area.

As shown in Figure 2a, purple parking signs indicate that the loading/unloading areas is available for all urban logistics vehicles, and the green parking signs indicate that the loading/unloading areas are only available for NELVs (see Figure 2b).

To summarize, in Suzhou, there are 4 different policy options and regulations currently tested and in operation for permanent and time-limited loading bay concepts:

1. Free use of all roadside car loading/unloading zones as time-limited loading bays for delivery vehicles;
2. Variable time limitations for unloading operations according to vehicle emission categories (with time limitations favoring NELVs);
3. Time-limited loading bays on bike lanes during off-peak hours, and;
4. Separated loading bays for green and non-green distribution vehicles.

■ Figure 2 Layout of temporary loading/unloading areas for urban logistics vehicles in Suzhou



(a) Temporary loading/unloading areas for urban logistics vehicles in the old town

Source: Suzhou green distribution WeChat APP



(b) Signage of a time-limited loading bay for NELVs

2.1.2 Changsha

Changsha allows urban logistics vehicles to temporarily park along roads where parking is generally prohibited to other vehicles. In June 2021, the Changsha Public Security Bureau traffic police set up 158 dedicated loading/unloading zones for urban logistics vehicles around markets, superstores, schools, and other surrounding roads, which basically meet the temporary loading/unloading needs of urban logistics vehicles.

One such temporary loading/unloading zones is 6m long and 2.4m wide, with horizontal street signage including yellow markings limiting the boundaries, and white words, and truck patterns indicating its purpose (see Figure 3). These roadside loading/unloading zones are dedicated for urban logistics vehicles to load/unload goods. Other vehicles are not allowed to park in these spaces and will receive penalties in the event of a violation.

2.1.3 Chengdu

Chengdu began distributing a type of special license plate for NELVs on November 20, 2017. Vehicles with new energy number plates are allowed to travel in the administrative region of Chengdu without restriction, whereas other vehicles are restricted according to the end number of the license. Among the new energy license vehicles, pure electric urban logistics vehicles can further travel into the central urban area without restriction (other logistics vehicles must apply for a permit first).

This green urban logistics policy option can be called: restriction-free access to the city center for pure electric delivery vehicles only. Further parking policies favorable for NELVs include the rule that locally registered vehicles with new energy number plates can stop for a time-limited duration on roadside loading bays and loading/unloading areas with costs fully covered by the government, for free, within the first two hours. Moreover, the parking fee at the Park & Ride (P+R) lots run by the government is 50% off from 7:00 to 19:00 for NELVs. Additionally, Chengdu is also encouraging other parking facilities to offer parking fee reductions or exemptions to new energy vehicles.

2.1.4 Hengshui

Pure electric urban logistics vehicles with a total weight of up to 4.5 tons and with a logo of the National Demonstration Project of Green Urban Freight can stop in the loading/unloading areas managed by the government, with fee reductions or exemptions in the main urban area of Hengshui, according to the Notice on Formulating the Charge Reduction Policy for Urban Green Freight NELV

Parking Service, issued in June 2020 in Hengshui City. This policy option can be called: Parking fee reduction for NELVs.

In November 2020, the Hengshui Traffic Police Detachment set up more than 60 dedicated curbside loading bays for NELVs along and around roadside groceries/supermarkets and express companies, which further reduced the time spend in search of parking, eased loading/unloading difficulties for NELVs and improved the business operation environment of the city.

The city's dedicated loading/unloading zones are for exclusive use by NELVs, and other vehicles are not allowed to occupy them. These dedicated loading/unloading zones have horizontal traffic signages, marked by a green boundary and with the words "Dedicated Loading/unloading zones for NELVs" (see Figure 4).

2.1.5 Shenzhen

Shenzhen Municipal Transportation Commission issued a draft of the Notice on the first time (first hour) parking fee exemption for NELVs at roadside loading/unloading zones (draft for comments) in April 2018. According to the Notice, new energy vehicles can park on roadside loading bays managed by the Shenzhen Road Traffic Management Center for free once a day for the first hour.

In 2021, Shenzhen set up a "logistics vehicles restriction area" policy in Huaqiangbei district. Under its rules, only NELVs are allowed to enter the district for four times and stop for no more than 1 hour each time between 10am to 10pm each day. To coordinate with the policy and to facilitate the orderly loading/unloading of goods, the Shenzhen Traffic Police Department applied a series of supporting measures with other related administrative departments, such as the setting up of dedicated loading/unloading spaces, delineated by green markings and the words "dedicated loading/unloading zones for loading/unloading" as horizontal traffic signage painted on the ground (see Figure 5). This distinctive policy option can be summarized as: Access allowance limited to four times per day with time-limited stopping of maximum one hour each, between 10:00 and 22:00, every day. This differentiated policy has offered NELV accessibility privilege that is in favor of NELV operators' business development.

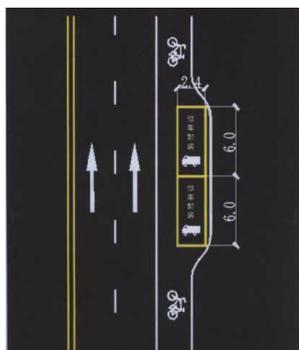
2.1.6 Luzhou

To promote the implementation of the National Demonstration Project of Green Urban Freight in Luzhou, the city's Jiangyang district, recently improved its distribution terminals, and added temporary parking signs and road

markings for logistics vehicles to alleviate parking and loading difficulties at some supermarkets, farmer’s markets, and express delivery points in the city.

The city’s dedicated loading/unloading zones are exclusively for urban logistics vehicles, and other vehicles are not allowed to occupy them. The loading/unloading zones are delineated by green road markings and the words “distribution vehicle temporary parking” are painted on the ground. At these dedicated loading/unloading zones with “distribution vehicle temporary parking lot” signs, NELVs with a special logo of “Urban Logistics Distribution Vehicle” can park for free, whereas conventional fueled logistics vehicles can only get 50% off compared to the tariff for passenger cars (see Figures 6 and 7). This distinctive policy option can be summarized as: Parking infrastructure creation and management with fee reduction for NELVs.

■ **Figure 3 Time-limited loading bays for urban logistics vehicles in Changsha**



■ **Figure 4 A dedicated loading/unloading zones for urban green logistics vehicles in Hengshui**



Source: HENG SHUI WAN BAO
https://www.sobu.com/al/431953489_722860

■ **Figure 5 The dedicated loading/unloading zones for loading/unloading in Shenzhen**



Source: Traffic Police Department of Shenzhen Public Security Bureau
http://szjj.sz.gov.cn/JGDT/content/post_8635579.html

■ **Figure 6 Vehicles with a special logo of “Urban Logistics Vehicle”**



■ **Figure 7 Logistics and distribution vehicle temporary loading/unloading zones in Luzhou**



Source: Luzhoufabu WeChat official account
<https://mp.weixin.qq.com/s/ifxobQZ8tSdsIZfqiK8arg>

2.1.7 Analysis of domestic cases

(1) The temporary parking policies for urban logistics vehicles are formulated based on the actual needs and demands of the city, and these policies are contributing to parking convenience for logistics vehicles.

At present, some cities in China have set up time-limited loading bays for logistics vehicles and have implemented corresponding temporary parking policies. For example, some policies allow logistics vehicles to park for a limited duration of time at all kinds of roadside motor vehicle loading/unloading zones, while others have policies which are designed for dedicated loading/unloading zones that are reserved exclusively for logistics vehicles. Parking fee reduction policies for logistics vehicles are implemented in the cities of Suzhou and Chengdu, providing parking fee exemptions for NELVs. Some other measures that cities are taking include the setting up of temporary loading/unloading zones around business stores, express delivery terminals, large supermarkets and other areas with strong delivery demands.

In terms of the setting up of temporary loading/unloading zones, most cities adopt the method of converting existing passenger vehicle loading/unloading zones to freight delivery vehicle loading/unloading zones. Suzhou even allows NELVs to temporarily park for loading/unloading operations during off-peak hours on bicycle lanes with a width of 4 meters or more outside Gucheng district and gives NELVs priority status, corresponding to a favorable policy option in an updated, modernized parking policy.

In summary, the work of setting up temporary loading/unloading zones for loading/unloading purposes of urban logistics vehicles being promoted in these cities has a positive effect on regulating the parking behavior of logistics vehicles and reducing their impact on traffic flows. An outline of typical related measures being taken by each studied city is displayed in Table 1 Typical measures relating to NELV parking in each city.

(2) Domestic Chinese cities mainly focus on allocation planning and the setting up of temporary loading/unloading zones. The scale of loading/unloading zones and parking management needs to be further addressed.

At present, domestic cities still do not pay enough attention to the development of their urban freight distribution systems. Most cities focus on the travel management of logistics vehicles within a specific area, with the approach of issuing permits to logistics vehicles, and generally ignoring their parking and loading/unloading difficulties. From studying these domestic cases, it has been found that various number of temporary loading/unloading zones for loading/unloading by urban logistics vehicles have been set up in urban commercial districts, residential communities, and other areas in the first batch of cities in the National Demonstration Project of Green Urban Freight. However, while this approach seeks to complete the relevant requirements of the Program and to solve the problem of the lack of loading/unloading zones, the effect of setting such zones still needs to be evaluated.

■ Table 1 Typical measures relating to NELV parking in each city

Number	Typical measures
1	Free use of all roadside car loading/unloading zones as time-limited loading bays for delivery vehicles.
2	Variable time limitations for unloading operations according to their vehicle emission category (more favorable for NELVs).
3	Time-limited loading bays on bike lanes during off-peak hours.
4	Separated loading bays for green and non-green logistics vehicles.
5	Restriction-free access to the city center for pure electric delivery vehicles only.
6	Parking fee reduction for NELVs.
7	Access allowance limited to four times per day with time-limited stopping of maximum one hour each, between 10:00 and 22:00, every day.
8	Parking infrastructure creation and management with fee reduction for NELVs.

In spite of implementation efforts to set up loading/unloading zones in these cities, the number of these zones still does not meet the increasing distribution demands of the industry, with only 100-200 temporary loading/unloading zones currently being available in each case city. At the same time, some roadside loading/unloading zones are shared by freight and passenger vehicles but occupied by passenger vehicles for most of the day. As a result, logistics vehicles still have to occupy other spaces such as motor vehicle lanes, bicycle lanes or sidewalks for loading/unloading purposes.

(3) There is a lack of theoretical support and uniform standards in terms of the number of loading/unloading zones, site selection, designation, and related planning processes.

The setting of temporary loading/unloading zones in these cities is done to meet the requirements of the National Demonstration Project of Green Urban Freight, but their parking demands are not seriously considered. This has led cities to taking a case-by-case approach to setting zones that has been adapted to their own local experiences, street space, and local business configurations. The size, design, as well as the signs and road markings of loading/unloading zones for logistics vehicles are different across these cities. For example, road markings of temporary loading/unloading zones in Shenzhen, Hengshui, and Luzhou are green, while they are yellow in Changsha and Suzhou. The size of the loading/unloading zones also varies. It is therefore necessary to further develop and hone theoretical research on the demand for temporary loading/unloading zones, and related processes including location selection and their layout design.

2.2 International Cases

In most foreign countries, there are almost no set dedicated loading/unloading areas for NELVs. However, some cities have benefited from exploring trials for the setting and management of urban loading/unloading zones.

2.2.1 London, England

In London, parking and loading bays are designed to ensure that their use, and turnover of use, is well adapted

to surrounding buildings and the characteristics of the street. According to Streetscape Guidance 2019 of London, the distribution, placement, and type of bay provided should correspond to the surrounding land uses and the dimensions of the street. The arrangement of parking and loading controls should not restrict the free and safe flow of traffic, particularly buses, nor should they adversely impact on pedestrian movement.

In addition, the setting of parking and loading bays should comply with the following principles^[1] :

- 1) Parking and loading facilities should be located for the convenience and safety of all road users, not just motorists. When locating a loading bay, the designer needs to consider the vehicle type, frequency of use, and the type of goods.
- 2) Calculating the time it takes for the driver to walk to deliver the goods must be considered to ensure that the loading bay can operate as intended and that users are able to operate legally.
- 3) The location of the bay and its signage should take account of, and coordinate with, other street furniture to avoid clutter. Bays must be visible to motorists and pedestrians through the use of appropriate markings. Loading and parking bays should be marked using contrasting paving where possible rather than paint.
- 4) A vertical sign detailing restrictions as to the nature of activity, duration, and hours of operation must be erected next to the bay for the directions to be enforceable (see Figure 8).

■ **Figure 8 Enforcement traffic signage for loading bays in London**



Source: Streetscape Guidance

The London Transport Authority strictly stipulates that all illegal parking behavior shall be fined. The fines range from €70 to €150 (£60 to £130). In addition, the drivers who have their cars towed away or locked by police due to serious violations of regulations need to pay a significant towing fee or locking fee. In addition, the London Councils published general regulations on loading/unloading in 2022. Loading/unloading is permitted on single and double yellow lines for a maximum of 40 minutes if loading is observed (see Figure 9). You must not cause an obstruction and ensure that there is no loading ban.

- Loading/unloading is not permitted on a red line during its operational times. Double red lines apply all day, most single red lines apply between 7am and 7pm but are signed.
- On clearways stopping to load and unload is banned (see Figure 10).
- You can stop to load and unload on parking bays (pay and display, residents' bays etc.) for a maximum of 20 minutes during controlled hours.

2.2.2 Paris, France

Following legislation changes and charters with businesses in 2008, Paris developed new loading bay design rules. In order to facilitate loading/unloading practice, Paris now has loading bays set up at about every 50 meters along city streets. These loading bays are mainly set in shopping streets, with less located in residential areas.

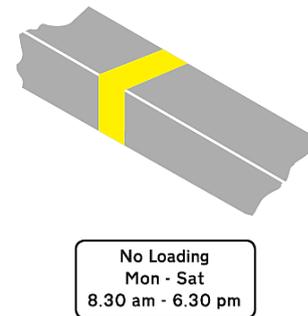
The marking lines of loading bays along the street in Paris are yellow, and come in two forms: yellow dotted lines and yellow solid lines (see Figure 11). A yellow dotted line indicates that the loading bay can be parked in by vehicles other than urban logistics vehicles from 8 p.m. to 7 a.m., and a yellow solid line indicates that the loading bay is dedicated for urban logistics vehicles. The loading bays are frequently occupied by cars and other vehicles, therefore a main problem with loading bays along the streets of Paris is enforcement for their use.

Paris also developed a new tool for the online visualization of loading bays, from which users can see the location of loading bays and a map of the area around the loading bay. The disadvantage is that the visualization tool is not dynamic and real-time (see Figure 12.)

2.2.3 Valletta, Malta

In Valletta, the Sustainable Urban Logistics Planning (SULP) allowed for the modification of access rules and the setting of schedules and itineraries of logistics vehicles for their entering and exiting of the city, and their use of pedestrian zones during strict time-windows to allow for loading/ unloading operations.

■ **Figure 9 Yellow lines on curb with an example of times**



Source: London Councils

<https://www.londoncouncils.gov.uk/services/parking-services/parking-and-traffic/parking-advice-members-public/loading-and-unloading>

■ **Figure 10 Clearway sign, meaning no stopping at any time**

Clearways



Source: London Councils

<https://www.londoncouncils.gov.uk/services/parking-services/parking-and-traffic/parking-advice-members-public/loading-and-unloading>

■ **Figure 11 The example of Paris loading bay management**



The following specific access and loading bay rules apply to the city center of Valletta:

- Goods vehicles are allowed to provide services between midnight and 9:30am from Monday to Saturday; for Monday and Thursday, deliveries are also allowed between 14:30 and 16:30. These service time restrictions ensure that Valletta’s pedestrian area is free from trucks and vans during the peak business hours for pedestrians and tourists.
- For other non-pedestrian areas, since streets in Valletta are narrow, and to avoid congestion, it is common practice for delivery vans to park on the curb while loading/unloading. This poses a risk to the health and safety of pedestrians and causes damage to street

infrastructure and adjacent buildings. To avoid this, loading bays are to be implemented in adjacent streets, with an average distance of about 50-100m, depending on if the area is more commercial or residential.

- Parking and access to Valletta for vehicles is a constant point of discussion amongst stakeholders since the issue affects all residents and visitors to the city. Parking availability within the city is currently completely saturated, therefore, while some loading/unloading bays do exist, their number is limited.
- Goods distribution vehicles that deliver regularly to retailers in the charging zones within Valletta are allowed limited free access in all of the charging zones at the times defined in Table 2. These vehicles must be registered to deliver, and must not be left unattended.

■ **Figure 12 A tool for the online visualization of loading bays**



Source: Paris Delivery Map https://capgeo.sig.paris.fr/Apps/Places_Livraison/

■ **Table 2 Access rules to Valletta for goods distribution vehicles, 2019**

Day	Free Access to Charging Zones	Access to Pedestrian Zones
Monday	Midnight – 09:30 hrs	Midnight – 09:30 hrs
	14:30 hrs – 16:30 hrs	14:30 hrs – 16:30 hrs
	18:00 hrs – Midnight	19:00 hrs – 20:00 hrs
Tuesday, Wednesday & Friday	Midnight – 09:30 hrs	Midnight – 09:30 hrs
	13:00 hrs – 16:00 hrs	
	18:00 hrs – Midnight	19:00 hrs – 20:00 hrs
Thursday	Midnight – 09:30 hrs	Midnight – 09:30 hrs
	13:00 hrs – 16:00 hrs	14:30 hrs – 16:30 hrs
	18:00 hrs – Midnight	19:00 hrs – 20:00 hrs
Saturday	All Day	Midnight – 09:30 hrs
		19:00 hrs – 20:00 hrs
Sunday	All Day	

2.2.4 Tokyo, Japan

Omotesando Shopping Street is one of the most prosperous shopping streets in Tokyo. There are many boutiques, cafés and restaurants on both sides of the avenue. There are vehicle loading/unloading zones set up along Omotesando, which can also be used by other types of vehicles with a parking metering system. The street has a parking time limit for logistics vehicles of 60 minutes from 9 am to 8 pm, with no time limit for the rest of the day.

Loading/unloading zones are set along both sides of Omotesando (see Figure 13). The advantage of this layout is that the walking distance between loading/unloading zones and delivery points is short, which can better meet the needs of the buildings on both sides of the road and meet the temporary parking needs of the delivery vehicles. However, there are some shortcomings of the loading/unloading zones for logistics vehicles on Omotesando:

- The loading/unloading zones provided are not dedicated for logistics vehicles, even for only a part of the day. Therefore, the availability of loading/unloading zones cannot be guaranteed for logistics vehicles. This situation can cause side-by-side parking or other illegal parking behavior and affect the safety and/or convenience of other road users.
- There is a parking time limit for logistics vehicle from 9 am to 8 pm, and no limit for the rest of the day. This not only reduces the turnover rate of the loading/unloading zones and the loading/unloading efficiency, but also causes a great impact on the ease of parking of passenger cars.

2.2.5 New York, U.S.A.

The number of roadside loading/unloading zones for loading/unloading is insufficient on many commercial streets in New York City. Most retailers and grocery stores do not have on-carriageway loading/unloading zones for loading/unloading, and the few on-carriageway loading/unloading zones which do exist are often occupied by passenger vehicles. Therefore, an OHD (Off-Hour Deliveries) plan was adopted in New York, which shifts freight deliveries to off-hours (7 pm to 6 am, outside of

regular business hours, see Figure 14). The OHD brings many benefits not only to related companies and suppliers but also to the city. By shifting logistics vehicles traffic to off-hours, the following benefits are experienced by the communities and the city:

- Logistics vehicles do not travel with cars and buses during regular business hours, thereby reducing traffic congestion;
- Reduction of traffic congestion around loading/unloading zones and nearby roads;
- Improved traffic safety as logistics vehicles do not travel with pedestrians and bicyclists during peak hours;
- Reduction in transportation costs, and freight companies have less penalties for parking violations during off-hours, and more importantly, the deliveries are more efficient at night, and;
- Reduction in emissions as logistics vehicles do not travel during peak hours.

■ Figure 13 Urban logistics vehicles loading/unloading zones in Omotesando, Tokyo



Source: CityIF

<https://www.163.com/dy/article/EFLANCNI0521C7DD.html>

■ Figure 14 Temporary parking of delivery trucks during off-hours



Source: Huaqingchengyun WeChat official account

<https://mp.weixin.qq.com/s/IrXcLwZ0tMAv6IbulXGthg>

2.2.6 Analysis of international cases

(1) The Streetscape Guidance^[1] of London formulates detailed standards and guidance on the setting of loading/unloading zones for logistics vehicles, which is a useful reference for Chinese cities.

The Streetscape Guidance^[1] of London systematically discusses the principles, methods, and management measures for the setting of loading/unloading zones for urban logistics vehicles. It proposes four types of loading/unloading zones for delivery vehicles and illustrates setting features, evaluations, and provides on-site pictures. The practice of formulating this type of guidance on the setting of loading/unloading zones for logistics vehicles is useful to this study, and the guidance given by the plan itself is a good reference for conducting research in the field of urban transport.

(2) The current number of loading/unloading zones in foreign countries is insufficient. Measures such as delivering during off-peak hours, charging parking fees, and strengthening the management of transport have been implemented to alleviate parking difficulties in international cities.

After learning from the practices of the international cities of London, Tokyo, and New York, it can be found that the parking resources in the urban centers of developed countries, especially in their commercial districts, are very tight, and freight delivery vehicles have to occupy road space temporarily to load/unload goods. In order to reduce the impact caused by the parking of freight delivery vehicles, cities have taken different measures. Tokyo, for example, has stipulated a parking time limit and strengthened parking fee charging models. New York has shifted delivery times outside of regular business hours, but the success of this initiative still remains rather limited in terms of an increased total number of off-peak deliveries, when compared to peak-hours. Temporary test runs for off-peak deliveries were successful in London during the Olympic Games in 2012 but were discontinued afterwards due to increased costs and low acceptance rates amongst businesses and retail clients, who preferred to receive goods during their normal opening hours. Therefore, even in the most innovation-friendly metropolises, the management of parking policies remains very challenging in general. Cities in these developed countries are continuing to actively implement various measures to alleviate the parking

difficulty of logistics vehicles and also meet the increasing demand for freight distribution.

(3) Lack of research on setting up temporary loading/unloading zones for NELVs.

From the practices of international cities, there is a lack of research on setting temporary loading/unloading zones for NELVs. For example, the Streetscape Guidance (Mayor of London, 2019) of London does not discuss NELVs. This study seeks to provide further research in this area.

2.3 Summary

From the practices of the examined domestic cities and international cities on their setting up of temporary loading/unloading zones for logistics vehicles, it is seen that there are certain similarities and differences:

(1) Both domestic cities and international cities regulate logistics vehicle behavior, such as by setting parking times and locations, based on logistics vehicle parking demand, traffic conditions, and road conditions.

At present, the methods of setting temporary loading/unloading zones for urban logistics vehicles in both domestic cities and international cities are basically the same. Temporary loading/unloading zones are firstly set in areas with strong delivery demand such as commercial areas, residential communities, and related locations. Secondly, logistics vehicle parking times, access allowance times, and allowed travel times are shifted to morning or off-peak hours, to reduce the impact on traffic flow. Thirdly, time-limited loading bays and loading/unloading zones are set up on road spaces, occupying motor vehicle lanes, bicycle lanes or sidewalks, where parking and street space resources are tight.

In brief, domestic cities and international cities select parking locations, and regulate parking and travel times of logistics vehicles reasonably, with the goal to increase their delivery efficiency, decrease their impact on other road users such as motor vehicles, pedestrians, and cyclists, and alleviate traffic congestion.

(2) Currently, domestic cities pay more attention to the location selection of temporary loading/unloading zones, and international cities emphasis focuses on the management of truck parking, with their penalty system for illegal parking behavior being more severe.

Some domestic cities are actively promoting the establishment of temporary loading/unloading zones for logistics vehicles in accordance with the requirements of the National Demonstration Project of Green Urban Freight. The relevant infrastructure construction is being strengthened, and related parking fee reduction/exemption policies are being implemented.

In terms of parking management, domestic cities do not impose high penalties on private cars occupying temporary truck loading/unloading zones, which is different than how penalties are approached by international cities. For example, London imposes a fine of €70 to €150 (£60 to £130) for parking violations. It is suggested that domestic cities strengthen parking management to ensure parking availability for logistics vehicles, and to regulate the parking behavior of logistics vehicles.

(3) International cities in developed countries have conducted more in-depth planning and research on truck parking than domestic cities, but there is still a lack of in-depth studies on the setting of temporary loading/unloading zones for NELVs.

Currently, domestic cities mainly focus on the planning of allocating space for temporary loading/unloading zones for logistics vehicles, but there is still a lack of relevant research on the methods used when setting these locations. Comparatively, the research in international cities on spatial planning is more systematic and in-depth. For example, London's Streetscape Guidance systematically discusses the setting principles, methods and management measures of temporary loading/unloading zones for the city.

With the development of global carbon reduction work, especially China's Carbon Peak and Neutrality Strategy, promoting NELVs is an important component of the carbon reduction measures of the transportation sector, and is of great significance to the realization of China's Carbon Peak and Neutrality Strategy. At present, neither domestic cities nor international cities have paid enough attention to employ a scientific method for the setting of temporary loading/unloading zones for NELVs. Therefore, this research focuses on the setting of temporary loading/unloading zones for NELVs, and findings from this study will contribute to not only the development of loading/unloading zones setting methods and theories, but also the promotion of NELVs.



Status Analysis

3

3.1 Overview of Urban Development

3.1.1 Location characteristics

Chancheng District is located in the center of the Pearl River Delta - one of the most flourishing economic regions in China. Chancheng District is also located in the central urban area of Foshan, West of the central urban area of Guangzhou, making Chancheng a junction in the Guangzhou-Foshan metropolitan area (see Figure 15). The Nanhai District of Foshan lies in the East, West, and North of Chancheng, and to the Southeast and South of Chancheng, the next District is the Shunde District of Foshan. The Chancheng District extends 15 km from North to South and 19 km wide from East to West, covering an area of 153.88 km². To provide a geographic comparison, this region is bigger than Paris, France (105 km²).

Chancheng District has three sub-districts and one town - Zumiao, Shiwan, Zhangcha, and Nanzhuang Town (see Figure 16). Among them, Zumiao is located in the old city area, the core area of Chancheng District, and the People's Government of Chancheng is on Dafu South Rd, Zumiao.

Chancheng District has significant advantages for transport as it is located along the Beijing-Guangzhou national transportation corridor and the coastal transportation corridor. Chancheng is located 20km away from Guangzhou, 105km from Shenzhen, 135km from Hong Kong and 110km from Macao (see Figure 17).

■ Figure 15 Location of Chancheng District



Source: NICTP

■ Figure 16 Sub-districts and town of Chancheng District



Source: NICTP

■ Figure 17 Distance to surrounding cities from Chancheng District



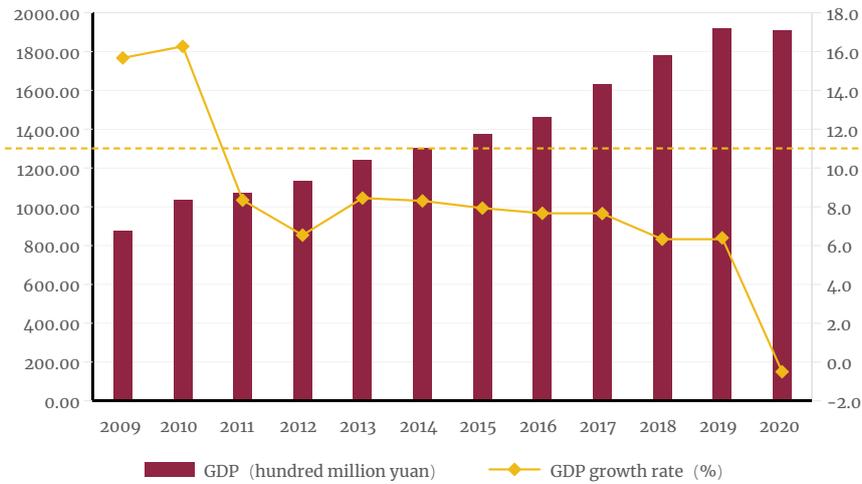
Source: NICTP

3.1.2 Economic development

The social economy of Chancheng District is growing rapidly. The GDP of Chancheng District exceeded €21.4 billion (¥150 billion) in 2017 and reached €27.1 billion (¥190.46 billion) in 2019. The per capita GDP of the district even leads over those of other cities in the Pearl River Delta. In 2019, the per capita GDP of the permanent population reached €22,975 (¥160,529). However, affected by the COVID-19 pandemic in 2020, the GDP declined slightly to €27.2 billion (191.179 billion), with a decrease of 0.5% over the previous year (see Figure 18).

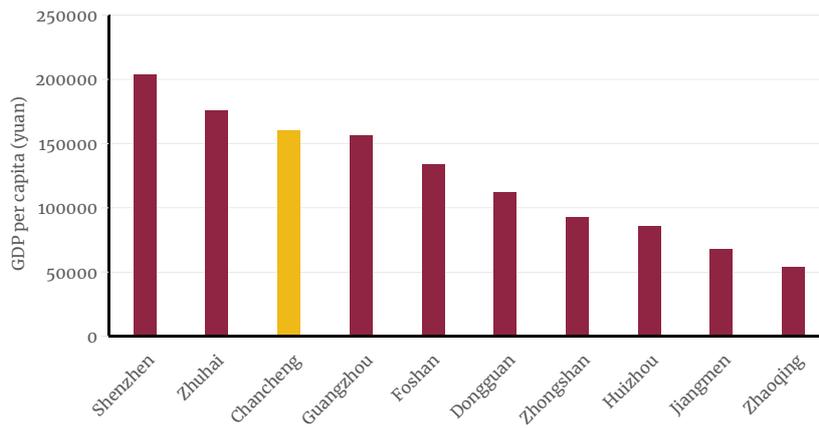
In 2020, the per capita disposable income of residents in the district was €7,857 (¥55,141), an increase of 3.6% over the previous year (see Figures 19 and 20).

■ Figure 18 Changes of GDP in Chancheng District



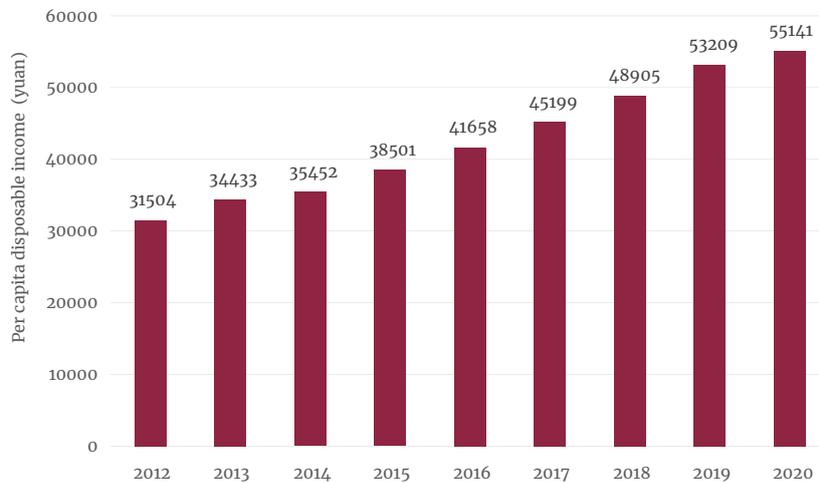
Source: NICTP

■ Figure 19 The GDP per capita in the Pearl River Delta in 2019



Source: NICTP

■ Figure 20 Changes in per capita disposable income



Source: NICTP

3.2

Analysis on the Status Quo of Urban Freight Distribution Development

3.2.1 Urban freight distribution demand

Foshan's social and economic development was greatly affected by the COVID-19 pandemic in 2020, and in that year, the statistical indicators of Chancheng freight transportation declined considerably compared to those of 2019. The highway freight transportation volume was 31.23 million tons (t) in 2020, with a decrease of 42.9% over the previous year. The transport performance of goods movements was 2.044 billion ton-kilometers (tkm), with a decrease rate of 44.8% (see Figure 21).

The total retail sale of social consumer goods was €10.8 billion (¥75.496 billion in 2020, with a decrease of 10.5% over the previous year (see Figure 22).

However, the e-commerce transaction volume of Chancheng District reached €40.2 billion (¥281.91 billion) in 2020, 5.0% more than in the previous year. Figure 23 shows a comparison of the e-commerce transaction volumes of Foshan and Chancheng in recent years, with a high annual growth rate of between 25-28% between the years of 2015-2019.

With the economy continuing to face the effects of the COVID-19 pandemic, the central government of China put forward the strategy of “a new pattern of development with a domestic cycle as the main body and a dual cycle of international and domestic mutual promotion” to accelerate the formation of a new pattern. With the development pattern established, the economy would recover, domestic consumer demand would expand steadily, and the demand for urban freight distribution would also consequently expand.

3.2.2 Urban logistics vehicles

The ownership rate of urban logistics vehicles in Chancheng District has maintained a steady growth trend in recent years. By June 2020, there were 29,627 conventional fueled logistics vehicles in Chancheng District, including 22,797 small cargo, 1130 medium cargo, and 5700 large cargo units. The number of NELVs has also grown rapidly, with there being 712 NELVs owned in the district in 2018, which rose to 898 by June 2020, including 786 pure electric logistics vehicles and 112 hydrogen energy logistics vehicles (see Figures 24 and 25).

Table 3 Truck fleet composition and ownership in Foshan city and Chancheng district shows the growth in the ownership rate of logistics vehicles in Foshan City and Chancheng District in recent years. Chancheng District alone accounts for the ownership of a high proportion of the NELVs in Foshan. By June 2020, pure electric logistics vehicles in Chancheng accounted for 54.06% of overall vehicles in Foshan, and hydrogen energy trucks accounted for 24.83% of this number.

3.2.3 Measures to facilitate the passage of new energy trucks

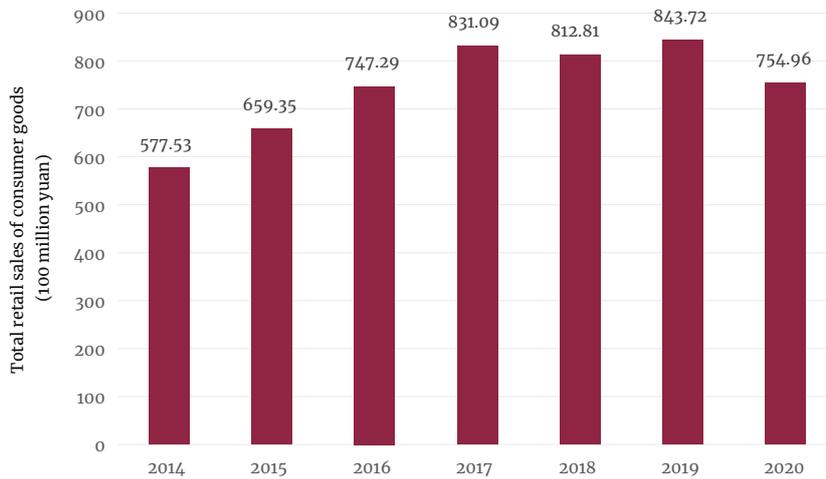
In response to difficulties for new energy trucks to enter the city, the Foshan Public Security Bureau issued the “Optimizing and Improving Plan on the Urban Delivery Truck Traffic Management” in March 2021. The plan cancelled travel restrictions for medium-sized Guangdong-licensed NELVs with a load-capacity of 5 tons or less, and allocated short-term loading/unloading zones for NELVs in coordination with relevant government departments to further alleviate the difficulties faced by urban logistics vehicles looking to travel and park in Foshan.

■ Figure 21 Road freight transportation volume and freight turnover of Chancheng District



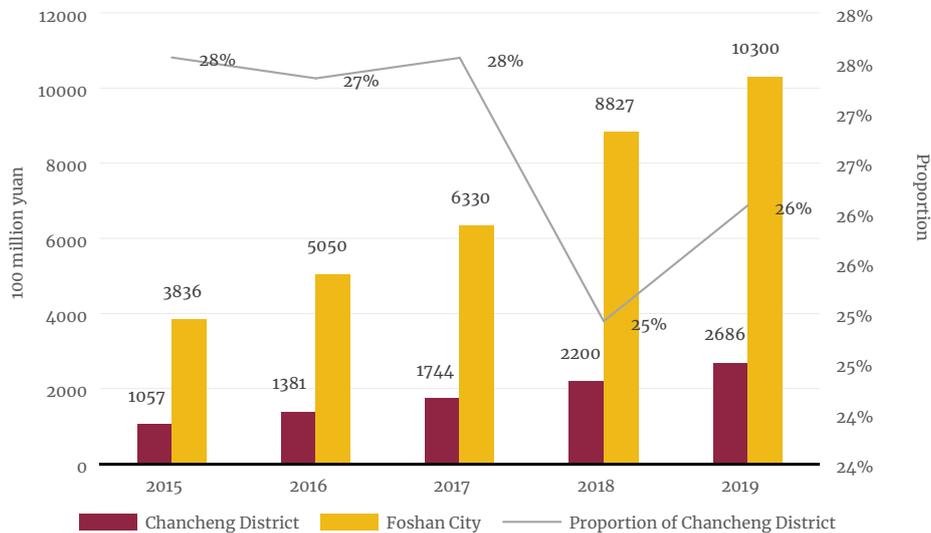
Source: NICTP

■ Figure 22 Changes in total retail sales of consumer goods of Chancheng District



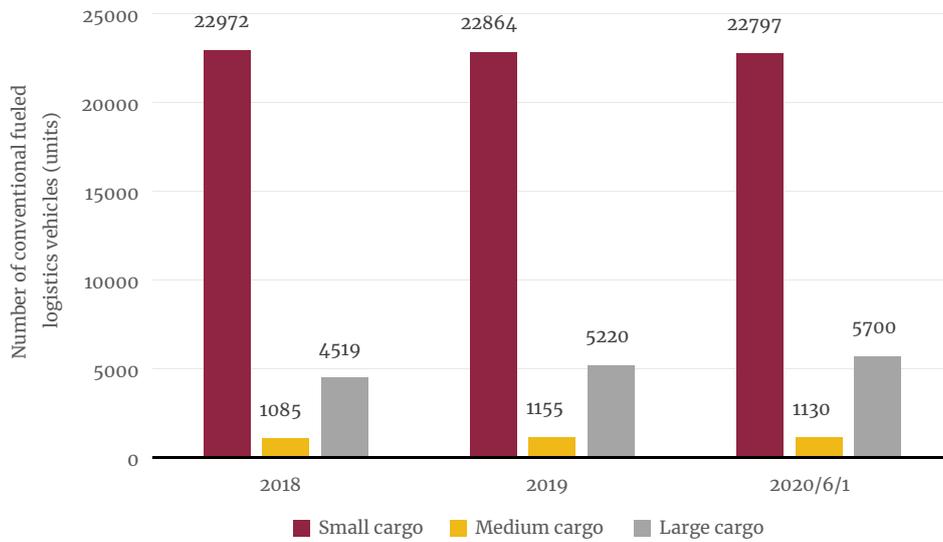
Source: NICTP

■ Figure 23 Comparison chart of e-commerce transaction volume between Foshan and Chancheng



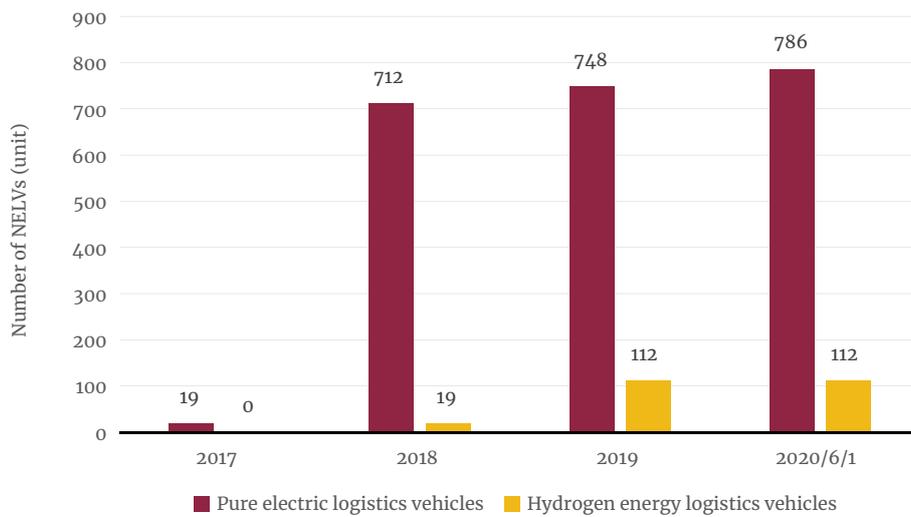
Source: NICTP

■ Figure 24 Conventional fueled logistics vehicles ownership in Chancheng District



Source: NICTP

■ Figure 25 NELVs ownership in Chancheng District



Source: NICTP

■ Table 3 Truck fleet composition and ownership in Foshan city and Chancheng district

Area	Conventional Fuel Trucks			Electric trucks			Hydrogen Energy Trucks		
	2018	2019	June 2020	2018	2019	June 2020	2018	2019	June 2020
Foshan city	208,766	219,994	227,118	1,101	1,241	1,454	35	451	451
Chancheng district	28,576	29,239	29,627	712	748	786	19	112	112
Share of Chancheng	13.69%	13.29%	13.04%	64.67%	60.27%	54.06%	54.29%	24.83%	24.83%

3.3 Development Status of Temporary Parking of Urban Logistics Vehicles

3.3.1 General Situation

(1) The distribution of loading/unloading zones for urban logistics vehicles

In order to meet the requirements of the National Demonstration Project of Green Urban Freight, Chancheng District set up the first 30 dedicated loading/unloading zones for urban logistics vehicles after a field survey of roadside land-use in mid-August 2021. The newly established spaces meet the basic delivery needs of stores along the respective streets. These dedicated loading/unloading zones are mainly in Zumiao, Shiwan, and Zhangcha street (see Figure 26 Spatial distribution of dedicated loading/unloading zones for urban logistics vehicles in Chancheng District).

(2) The layout and design of the loading/unloading zones

The 30 dedicated loading/unloading zones for urban logistics vehicles in Chancheng District are mainly set up on non-motorized vehicle lanes and sidewalks by converting existing roadside passenger loading/unloading zones to dedicated urban logistics vehicles loading/unloading zones and adding new roadside space.

The size of each loading/unloading zone is 6m×2.5m, with yellow markings and white words, or yellow markings and green words (indicating that the loading/unloading zones are to be used exclusively by urban logistics vehicles, see Figure 27). Some loading/unloading zones are slightly adjusted to 6m×1.8m or 6.2m×2.2m according to actual road conditions. The loading/unloading zones are only demarcated with parking berth markings on the pavement, without other indicating signs or monitoring equipment, as these and other supporting equipment are not yet completed.

(3) Parking management

At present, there is still a lack of relevant management measures for urban freight distribution vehicle loading/unloading zones. There are no parking fees for urban

logistics vehicles to use dedicated loading/unloading zones, but the same fee as for passenger cars applies for urban logistics vehicles who use other roadside loading/unloading zones. Furthermore, parking fee administrators do not have the right to take action when dedicated loading/unloading zones for urban logistics vehicles are illegally occupied by passenger cars, and the loading/unloading zones cannot be guaranteed to be available to delivery vehicles (see Figure 28).

3.3.2 Temporary loading/unloading zones in various areas

The parking modes of urban logistics vehicles differ according to the types of businesses and areas that they are used in. This report includes an analysis of the status of temporary parking of urban logistics vehicles in different geographic areas, including large commercial areas, commercial streets, and residential areas.

(1) Large commercial areas

Large commercial areas refer to the area where the city-level or district-level commercial facilities are concentrated, including large supermarkets, retail stores, and grocery stores, among which large supermarkets are generally equipped with their own cargo handling areas (located partly on-street, but mostly in off-street areas). Large commercial complexes are generally equipped with off-street, self-use cargo loading/unloading zones. Some commercial plazas are also equipped with urban freight distribution vehicle loading/unloading zones, which are generally located at the side or back of the buildings (see Figures 29 to 32).

(2) Commercial streets

Shops along commercial streets are mainly clothing stores, bars, and catering shops, which can have both regular and irregular delivery demands. However, due to the shortage of land in commercial streets, roadside shops usually do not have temporary loading/unloading zones available off-street for loading/unloading goods (see Figure 33). Delivery vehicles generally stop on-street and occupy motor vehicle lanes, bicycle lanes or sidewalks for loading/unloading operations.

(3) Residential areas

Residential areas refer to a relatively independent populated area with residential buildings, supermarkets, convenience stores, express delivery stalls, hotels, and catering shops, and related businesses. These daily life facilities generate delivery demands, and therefore parking demands, of delivery vehicles. There are usually relatively large loading/unloading zones located in front of roadside shops, and passenger car loading/unloading zones are generally designated in newly built residential areas due to their relatively wide building concessions. Using these convenient off-street facilities, delivery vehicles generally load/unload goods in the building concession spaces instead of the streets. In older residential areas however, urban logistics vehicles generally can still only load/unload goods on bicycle lanes and sidewalks, and even on-street in motor vehicles lanes, which seriously affects the safety and convenience of other road users (see Figures 34 and 35).

In some cases, private cars occupy the loading/unloading zones dedicated to urban logistics vehicles. The parking needs of urban logistics vehicles can therefore not be guaranteed with these frequent on-street stopping practices even taken by private vehicles.

■ **Figure 26 Spatial distribution of dedicated loading/unloading zones for urban logistics vehicles in Chancheng District**



Source: NICTP

■ **Figure 27 Dedicated loading/unloading zones for urban logistics vehicles**



Source: NICTP



Source: NICTP

■ **Figure 28 Dedicated loading/unloading zones occupied by passenger cars**



Source: NICTP

■ **Figure 29 Entrance of Loading/unloading area at Wal-Mart**



Source: NICTP

■ Figure 30 Loading/unloading area at China Resources Vanguard



Source: NICTP

■ Figure 33 Shops along Zumiao commercial street



Source: NICTP

■ Figure 31 Loading/unloading area at Huaqiang Plaza



Source: NICTP

■ Figure 34 Urban logistics vehicles occupying motor vehicle lanes



Source: NICTP

■ Figure 32 Loading/unloading area at Oriental Plaza



Source: NICTP

■ Figure 35 Urban logistics vehicles occupying the sidewalk



Source: NICTP

3.4 Main Problems

Following field investigations and the analysis of the current status of temporary loading/unloading zones for delivery vehicles in various types of areas in Chancheng District, Foshan City, it can be seen that the main existing problems are as follows:

(1) The location of special temporary parking spots for logistics vehicles need to be optimized, and parking management measures need to be strengthened.

Chancheng District set up 30 dedicated loading/unloading zones for urban logistics vehicles as required by the National Demonstration Project of Green Urban Freight, which greatly relieved the parking difficulties of urban logistics vehicles. However, the convenience and the specificity of the use of urban logistics vehicles loading/unloading zones are still yet to be promoted and guaranteed.

As far as the parking site selection is concerned, some dedicated loading/unloading zones are not close to delivery points or there are no shops around the dedicated loading/unloading zones, which is inconvenient to delivery vehicles (see Figure 36). As to parking management measures, some of the dedicated loading/unloading zones are often occupied by passenger cars and their availability cannot be guaranteed for delivery vehicles. Necessary parking management and penalties need to be strengthened to ensure these spaces remain available for deliveries.

(2) Random (illegal) parking of logistics vehicles is common, which affects road traffic safety and convenience

Currently, there are no requirements for constructing temporary loading/unloading zones for delivery vehicles in commercial areas, commercial streets, residential areas, or at large public buildings except for large supermarkets and industrial buildings, which are required to be equipped with loading/unloading yards. Although Chancheng has set up 30 temporary loading/unloading zones for delivery vehicles, the number of dedicated loading/unloading zones is still not enough to meet the area's actual delivery demand. Furthermore, the dedicated loading/unloading zones cannot be guaranteed for exclusive use by delivery vehicles due to a lack of necessary management. It is still a common phenomenon that delivery vehicles load/unload

goods while occupying motor vehicle lanes, bicycle lanes, or sidewalk spaces. These randomly parking delivery vehicles encroach on road space and negatively affect traffic operations and the safety of vehicles, pedestrians, and freight delivery vehicle loading and unloading personnel.

(3) A scientific and comprehensive method for setting up temporary loading/unloading zones has not yet been formed.

Although Chancheng District set temporary loading/unloading zones for urban logistics vehicles, it has not applied a scientific and comprehensive setting method or conduct any theoretical research to support effectively matching parking supply and demand, and developing a foundation of information that could help with responsible location selection of loading/unloading zones. The road markings for these locations also vary, a unified standard for these have not yet been formed and there are no corresponding parking signs or other supporting facilities at current loading/unloading zones.

The next step of this study proposes a reasonable method for site selection processes, through scientific research, and outlines pilot applications which can provide guidance for further steps and implementation.

■ Figure 36 Unreasonable parking site selection



Source: NICTP



Setting Methods and
Demonstrations of
Application

4

VOLVO TRUCK CENTER

Having identified and analysed the development status of urban freight distribution in Chancheng District and the temporary parking of urban logistics vehicles, this study demonstrated the necessity of researching the setting method (site selection methods) of temporary loading/unloading zones for NELVs in Chancheng District. The results of this research are presented in this section and include discussions relating to the determining of the layout of loading/unloading zones, determining the configuration mode of supporting facilities, and establishing a scientific and comprehensive method for setting temporary loading/unloading zones for NELVs. This part of the project will introduce the planning concept, the specific steps included in the setting method, and demonstrations of the application of this method in Chancheng District.

4.1 Planning Concepts

4.1.1 Planning positioning

Sustainable Urban Mobility Planning (SUMP) is a strategic planning methodology to satisfy the mobility needs of people and businesses in cities and their surroundings for a better quality of life, which is based on the existing planning practice and fully considers the principles of integration, participation, and evaluation. In principle, it solves the problem of efficient mobility and efficient distribution of goods in cities, but there is still a lack of specific guidelines. The complexity of urban freight distribution includes a wide range of various freight activities, the relationship between freight actors with different and often conflicting demands and objectives, and a series of negative environmental and social impacts such as congestion, air and noise pollution, and safety concerns. This also makes it difficult for policy planners to put forward standard measures suitable for different urban environments. At the same time, the continuous development of scientific research and practice of urban freight traffic (UFT) and urban logistics has introduced new solutions to solve the problems brought by urban freight traffic.

NOVELOG^[2] is a three-year research project focusing on gaining insight into UFT. 12 international cities and regions are involved in the project. The NOVELOG project fills the gap in the current SUMP method and puts forward specific guidelines for the authorities and governments on how to integrate urban freight transportation schemes, measures, and policies into sustainable mobility planning. Similarly to SUMP, these guidelines are entitled Sustainable Urban Logistics Planning (SULP)^[3].

The definition of SULP echoes the definition of SUMP, that is, “the overall planning strategy of urban freight to ensure efficient and sustainable logistics operation in urban areas.” Therefore, SULP is in line with the overall vision of SUMP. The development of SULP also reflects the development of SUMP, but it focuses more on the movement of freight and the use of UFT solutions.

4.1.2 Planning guidelines

The SULP planning cycle is formulated with reference to the SUMP planning cycle. At the same time, taking into account the difficulty of obtaining data related to urban freight transportation, the complexity of problems caused by multiple industry stakeholders and their decentralised operation environment, some planning steps of the SUMP are adjusted or reduced, resulting in the following six steps forming the SULP cycle.

■ Figure 37 Distribution map of countries and regions participating in NOVELOG project



Source: NOVELOG Guidelines
<http://www.noveleg.eu>

Step 1: Determine the city's potential for a successful urban freight planning process

The potential can be determined by first defining the team responsible for Sulp design and implementation in the local government, determining the key stakeholders of UFT, and organising a Sulp multi-stakeholder platform to analyse urban freight data and other resources, with the goal to evaluate and improve the city's understanding of UFT.

Step 2: Define the development process and scope of the plan

The determination of the scope of Sulp planning research needs to consider factors such as the type of urban logistics in the specific implementation city and allow stakeholders to participate in the planning process and formulate work plans, which include objectives, tasks, and corresponding timeframes.

Step 3: Analyse the current UFT situation

The current situation of urban UFT is usually analysed by quantifying the main freight traffic operation parameters, and the impact and externalities of the parameters. Based on this data, the existing problems of urban UFT are determined and future development opportunities can be evaluated.

Step 4: Develop a common vision and future improvement scenario

The formulation of vision objectives of Sulp needs a set of specific and measurable indicators. NOVELOG has developed a comprehensive evaluation framework (EVALOG), including primary and secondary objectives and relevant indicators, which can be used to measure the expected impact of the implementation of the overall Sulp and individual UFT measures. In addition, this step also suggests to formulate short-term and long-term development objectives under different development scenarios and reach consensus among stakeholders according to the previous analysis results of urban UFT.

Step 5: Set priorities and measurable targets

Determine key performance indicators according to the established vision and objectives and set related priority improvement actions with measurable targets.

Step 6: Identify and develop an effective package of measures

In order to facilitate the formulation of measures, NOVELOG project developed a toolkit containing 250 measures and summarized the sustainability impact of the cities implementing the measures. In addition, EVALOG is applied to the evaluation of implementation measures, and the index values before and after implementation are compared to evaluate whether the measures adopted "in advance" and "after" achieved their expected results.

4.1.3 Application of the Sulp concept

Referring to the six steps proposed in the Sulp planning guide, their application to this project can be summarised into the following six aspects:

- 1) Sulp begins by identifying the stakeholders involved in the sustainable logistics planning process, identifying the key participants among them, and organising them to better understand urban freight distribution. This project, referring to Step 1 of Sulp, establishes a research group with the government, the public, experts and other stakeholders, and clarifies the data that the project needs to obtain during the planning process and how to obtain it, so as to have a more comprehensive understanding of the status quo of urban freight in Chancheng District;
- 2) Secondly, Sulp defines the planning development process and the scope of the study, involving stakeholders in the planning process. This project refers to Step 2 of Sulp, proposes a clear research scope, and formulates research ideas and work plans, including project objectives, the research period, research content, and related steps;
- 3) Thirdly, after defining the planning and development process and research scope, Sulp proposes to analyse the status, problems and opportunities of urban freight transportation by quantifying the corresponding parameters and their impacts. In this project, referring to Step 3 of Sulp, it is proposed that after determining the research scope, research ideas, and work plan, on-the-spot research was to be conducted to obtain quantitative indicators, and analyse the current situation

and existing problems of freight distribution loading/unloading zones in Chancheng District;

- 4) Referring to Step 4 of Sulp, this project proposes to jointly formulate a vision and objectives with multiple stakeholders;
- 5) Referring to Step 5 of Sulp, this project determines key parameters according to the established vision and objectives, and conducts strategic analysis under different scenarios to clarify the priority of measures such as increasing supply and adjusting demand, and;
- 6) The final step of Sulp is to develop a toolkit to guide the development of measures. This project refers to Step 6 of Sulp and proposes to determine and develop a set of effective research methods for the setting of loading/unloading zones in transport and urban planning processes, which can be used for the setting of loading/unloading zones in each research location.

In addition, the vision and objectives of Sulp include economic, environmental and social aspects. The economic aspects include improving urban freight efficiency and cargo load factors. Social aspects include improving the accessibility of freight services, advocating sustainable freight behaviour, and reducing congestion. The environmental aspects are aimed at reducing carbon dioxide emissions. The promotion of NELVs is one of the key measures to be taken for reducing carbon dioxide emissions. The formulation of convenient measures for the passage, parking, and loading/unloading of NELVs is of great significance for the promotion of NELVs. As an important part of the last mile of urban distribution, the temporary parking point of NELVs plays a significant role in facilitating the parking of NELVs, energy conservation and emission reduction, cost reduction, and efficiency increase.

Therefore, based on the references of domestic and foreign urban cases and the analysis of the current situation for the setting of temporary loading/unloading zones for NELVs in Chancheng District, this project constructs a setting methodology of loading/unloading zones for NELVs. The method is based on the Sulp concept and aims to alleviate the parking difficulties of NELVs. In addition, 2 pilot locations were selected in Chancheng District to carry out the demonstration application of the setting of temporary loading/unloading zones for NELVs. Then, relevant management measures and suggestions

were put forward. Finally, the experience of the project is summarised in order to provide lessons for the setting of temporary loading/unloading zones for NELVs in other cities in China.

4.2

Research on the Setting of Temporary Loading/Unloading zones for NELVs

The objectives of this research include three aspects:

- 1) Develop a comprehensive and scientific methodology for allocating temporary loading/unloading zones for NELVs, including parking setting approaches, policies, designation, and the configuration of related facilities.
- 2) Develop an allocation plan for temporary loading/unloading zones for NELVs in Chancheng District and select pilot areas to implement the plan.
- 3) Through Sino-German cooperation, explore effective measures to alleviate the difficulties NELVs face with road access, parking and loading/unloading, as well as summarize these experiences, and provide demonstrations with transferability analysis for other cities in China.

According to the Sulp concept, this study puts forward the following research ideas:

- 1) **Necessity:** Analyse the necessity and feasibility of setting up dedicated loading/unloading zones in different scenarios.
- 2) **Method:** Combined with the road conditions and the supply and demand characteristics of shops along the street, the setting method of dedicated loading/unloading zones is studied, including the calculation of the number of dedicated loading/unloading zones and the determination of their location.
- 3) **Form:** Design signs and markings and improve the supporting facilities of the dedicated loading/unloading zones.
- 4) **Management:** Refine the management of urban logistics vehicles parking based on the Sulp concept, including parking time management, parking order

management, parking charge management, multi-party participation, and related actions.

4.2.1 Scenario analysis, freight demand survey and field observations

4.2.1.1 Land use

Under different land types, there are obvious differences in the operation characteristics of shops along streets and road traffic. It is therefore necessary to analyse the necessity and feasibility of setting up dedicated loading/unloading zones for different land-use scenarios.

1) Business areas

Business areas refer to the areas where the city-wide or district-level commercial outlets are concentrated. Business areas are generally located in urban centres or areas with convenient transportation networks and a large population. These areas usually have the city's large wholesale centres and large complexes at their core and are composed of dozens or even hundreds of professional or comprehensive commercial enterprises. A business area is characterised by many shops, a large scale, and a complete variety of goods.

Large commercial buildings are the core buildings of business areas, with a large demand for distribution. Usually, the building scheme is equipped with a proprietary loading/unloading area, and the property uniformly manages the loading/unloading times, locations, vehicle parking, and related processes. The shops in commercial streets are mainly food, clothing and electronic equipment stores, with high commercial activity along the street (examples of these streets are illustrated in Figures 38 and 39).

As the core of urban development, the special geographical location and high commercial value make the building density of business areas generally high, resulting in large road traffic flows and saturation in the business area. During peak periods, the street networks can be overloaded, and the phenomenon of traffic congestion is prominent. In addition, business areas have high development intensity, rich development formats, and a strong attraction to citizens.

2) Residential areas

Residential areas refer to relatively independent areas with a certain population and land scale, with a centralized layout of residential buildings, public buildings, green spaces, roads, and other engineering facilities, surrounded by urban streets or natural boundaries. There are many types and small scales of shops along the street in a residential area, such as convenience stores, postal express outlets, restaurants, fresh food stores, and other stores with strong distribution needs, as well as intermediaries, barber shops, education and training institutions, and other stores with negligible distribution needs.

Parking facilities are necessary to support service facilities in residential areas. For a newly built community, there are generally sufficient parking facilities, many building concessions, and large loading/unloading spaces in front of shops along streets (see Figure 40). For older communities, due to historical reasons, parking allocations in these areas are seriously insufficient, and the parking phenomenon of having vehicles occupying carriageways and pavements is prominent (see Figure 41).

The residents of residential areas mainly travel for commuting, and their travel times result in double peaks – of one in the morning and one in the evening. These traffic volumes are large during peak periods and smaller in other periods.

3) Tourism areas

Tourism areas refer to regional places with tourism and related activities as their main functions or one of their main functions, and as such, these locations need to meet such tourism needs as providing options for sightseeing, leisure vacations, recreation and fitness programs. Tourism areas must therefore need to have corresponding facilities and provide related services. Shops along streets around tourism areas often hold mainly restaurants, food stores, convenience stores, and shops selling goods and souvenirs related to the characteristics of the tourism area (see Figures 42 and 43 for examples of historic tourist locations). The size of tourist flows in tourism areas on weekends and medium and long holidays is much larger than on weekdays. Residents and tourists mainly travel through slowly moving traffic in tourism areas and surrounding sites, and therefore require good quality walking environments.

■ **Figure 38 Lingnan Station**



Source: NICTP

■ **Figure 42 Zumiao**



Source: NICTP

■ **Figure 39 Zumiao Road**



Source: NICTP

■ **Figure 43 Ancient Nanfeng Kiln**



Source: NICTP

■ **Figure 40 New community**



Source: NICTP

■ **Figure 41 Old community**



Source: NICTP

4.2.1.2 Store types, delivery characteristics and a survey of freight demands

There are many types of stores along streets in urban areas, such as convenience stores, supermarkets, postal express outlets, restaurants, fresh food stores, pharmacies, and related service outlets. The distribution requirements and the parking characteristics of urban logistics vehicles are different and may also change depending on if they are operating in tourist, business or residential areas. Through an investigation of the vehicle's distribution frequency and timing, loading/unloading duration and other characteristics of the needs of stores along the street, the project analysed the distribution and parking characteristics of deliveries for different stores. A description of how these individual indicators were considered is below:

Distribution frequency: the number of times the store needs distributed goods, times per day.

Distribution time: the time of day when goods are received or sent by the store.

Duration of loading/unloading activities: the duration of time from the arrival of logistics vehicles at temporary

loading/unloading areas to the completion of loading/unloading activities, which is generally determined by the type of distribution goods.

In this project, several roads were selected for the investigation, in business areas, residential areas and tourism areas (see Figure 44).

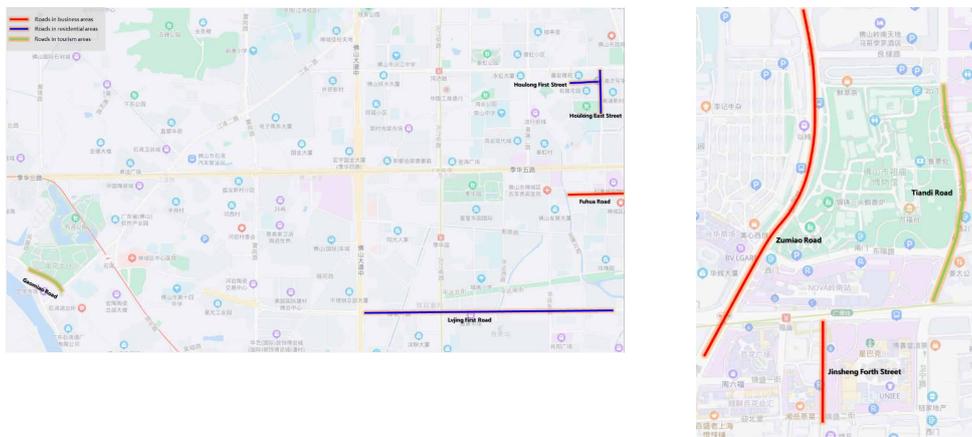
1) Roads in business areas: Fuhua Road, Zumiao Road, Jinsheng Fourth Street.

2) Roads in residential areas: Houlong First Street, Houlong East Street, Lvjing First Road.

3) Roads in tourism areas: Gaomiao Road, Tiandi Road.

Based on survey findings, the distribution demand characteristics of various stores along the surveyed streets are shown in the Table 4. The survey results are averages calculated from data collected across the different areas.

■ Figure 44 Schematic diagram of the location of the investigated road section



■ Table 4 Distribution demand characteristics of various stores: Survey results

Recipient Type	Facility surface (m ²)	Distribution Frequency (times/day)	Delivery time	Stop duration (minutes)	Characteristics
Convenience Store	20-100	1-2	Flexible	5-10	Wide variety of commodities, high frequency of deliveries, mainly delivered by commercial enterprises.
Supermarket	2500-5000	3-5	Fixed, after 22:00 or fixed time during the daytime	10-30	
Postal Express Outlet	20-100	3-4	Fixed time during the daytime	10-20	High frequency of deliveries, fixed delivery times, direct distribution or franchise outsourcing.
Restaurant	20-150	1	Fixed time 4:00-6:00 usually	5-10	Delivery during early morning, little impact on traffic, supplier distribution or operators purchase.
Fresh Food Store	20-100	3-5	Flexible	10-20	High frequency, flexible, self-operated distribution or supplier distribution
Pharmacy	50-100	0.3-1	Flexible	5-10	Average frequency with a certain degree of volatility
Others	/	Low frequency	Flexible	5-30	Low frequency.

The following conclusions can be drawn from the investigation:

- 1) Convenience stores, postal express outlets, restaurants, and fresh food stores have strong distribution demands. These stores receive deliveries at least once a day, and at most 3-5 times a day. Therefore, dedicated loading/unloading zones should be set near stores with strong distribution demand.
- 2) The delivery times of goods to various stores is inconsistent. The delivery time of shipments reaching supermarkets and postal express outlets is fixed, usually in the daytime. The delivery time for restaurants is fixed, usually in the early morning. The delivery time of other stores is not fixed, but falls generally in daytime and off-peak hours. Therefore, it is suggested that shops along the street can unify their distribution period, reasonably specify the parking time of dedicated loading/unloading zones, and allow other vehicles to park in other periods, so as to improve the utilisation and efficiency of dedicated loading/unloading zones.
- 3) The duration of loading/unloading time for most types of stores is generally less than 15 minutes, while the loading/unloading time of large supermarkets is longer, but not more than 30 minutes. Therefore, it is suggested that the parking time of dedicated loading/unloading zones should be appropriate to these durations, and not be too long.

4.2.1.3 Road conditions

The setting of dedicated loading/unloading zones for on-road logistics vehicles is affected by considerations of road

grades, function positionings, road width, road traffic volumes, and other conditions, and is done in accordance with standards such as the Guidelines for application of on-street parking management facility on urban road^[4] and Specifications for setting of on-street loading/unloading zones on urban roads^[5]. According to these standards, it can be determined whether loading/unloading zones can be set under the given road conditions (see Table 5).

Note: The road conditions in Table 5 are the setting conditions for the loading/unloading zones. For more specific loading/unloading zones setting conditions, please refer to the Guidelines for application of on-street parking management facility on urban road and the Specifications for setting of on-street loading/unloading zones on urban roads by MPS of China.

In addition, the setting of dedicated loading/unloading zones for urban logistics vehicle is related to the walking distance covered during goods distribution operations. The walking distance refers to the distance that distribution personnel travel to transport goods from the loading/unloading zones to the store. Whether the dedicated loading/unloading zones for urban logistics vehicles can effectively serve the stores along the street is affected by the walking distance that these goods must be transported over. Walking distances are also affected by road conditions (whether an isolation fence is set up), handling mode (manpower, trolleys), cargo characteristics (weight, volume), and related factors. According to the field survey, the maximum walking distance between vehicle stops and entrance door of the recipient (called the walking distance in the following sections) that would be acceptable to a driver, is 20 m.

■ Table 5 Setting conditions of dedicated loading/unloading zones for on-road logistics vehicles

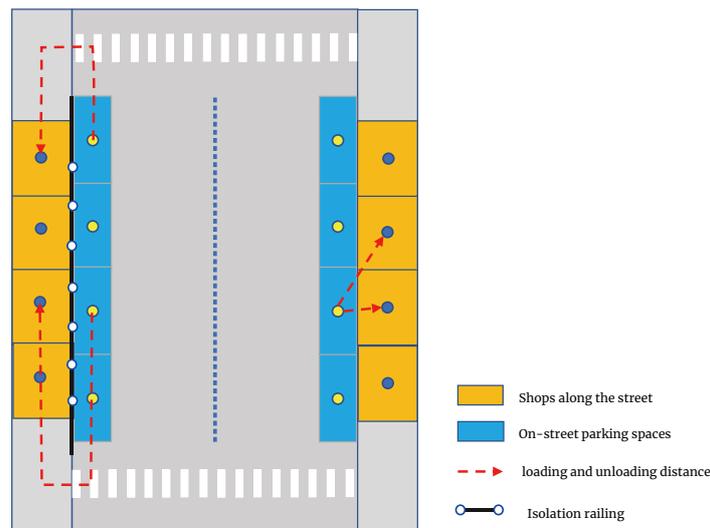
	Road condition
Road sections not allowed to set on-street loading/unloading zones	<ul style="list-style-type: none"> • Expressways, pavements, crosswalks, fire passages, wheelchair ramps, the functional area of intersections. • Roads with a single-direction motor-vehicle traffic saturation of 0.8 or higher during peak hours and a single-direction bicycle traffic saturation of 0.85 or higher during peak hours.
Road sections allowed to set on-street loading/unloading zones	<ul style="list-style-type: none"> • Where the remaining width of the bicycle lane after setting of loading/unloading zones is no less than 2.5m. • Where the remaining width of a two-way carriageway after setting of loading/unloading zones is no less than 6m. • Where the remaining width of a one-way carriageway after setting of loading/unloading zones is no less than 4m.

Based on the maximum walking distance acceptable to the driver, the maximum service radius of the dedicated loading/unloading zones is 20m, therefore a dedicated loading/unloading zone could effectively serve a road length for a total distance of about 40m (see Figure 45). Over the length of each road, it would then be necessary to study obstacles or other section factors when setting up the location of dedicated loading/unloading zones. In addition, considering the loading/unloading distance and the safety and convenience of loading/unloading operations, dedicated loading/unloading zones set on one side of a two-lane road could potentially serve shops on both sides, if the road did not have a central barrier. Dedicated loading/unloading zones set on one side of a two-way road with four and more lanes, however, could only safely serve shops on one side.

Even if the driving distance of a delivery round trip is high compared to the walking distance, a survey in London, England showed that on average 70-80% of the work time of a driver is spent on walking and waiting for a client, and 20-30% of their time is left for driving on the road. A more efficient design of walking distance would therefore trigger substantial time and economic benefits for drivers. Based on this analysis, a flow chart illustrating the necessity and feasibility of setting dedicated loading/unloading zones can be established as the analytical framework for setting dedicated loading/unloading zones (see Figure 46).

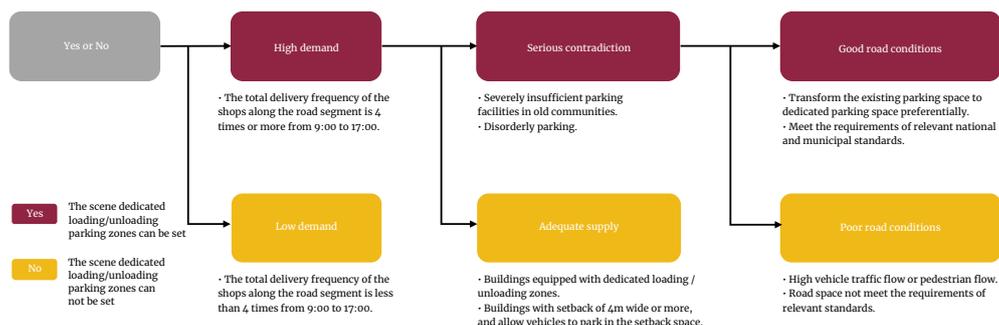
For scenario without dedicated loading/unloading zones, the demand for distribution and parking can be differentiated by optimising distribution times, the sharing of loading/unloading zones, a strengthening of parking management strategies, and other measures.

■ Figure 45 Schematic diagram of walking distances from stopping point to entrance doors



Source: NICTP

■ Figure 46 Flow chart of necessity and feasibility analysis of dedicated loading/unloading zones for urban logistics vehicles



Source: NICTP

4.2.2 Zone Setting Methods

4.2.2.1 Road segmentation

Considering the entire length of each road, it is necessary to identify and study individual road sections when setting up dedicated loading/unloading zones. The setting of a dedicated zone in one specific road section is mainly based on the distribution demands and loading/unloading distances of stores along the street. The steps of road segmentation are as follows:

Step1: Preliminarily select the stores with the largest distribution demands in each road section and take these as the reference points. Then take the maximum loading/unloading distance as the service radius (20m) and delimit a 40m long road section.

Step2: The section in Step 1 is used to serve stores up to both ends, and the value can be flexibly taken according to store's distribution demands. If the total number of deliveries to stores in the segment is not less than 4 times/day, the section can be divided into 40m. If the total number of deliveries to stores in the segment is less than 4 times/day, the section length can be extended, and the maximum length can be defined as 100m (see Figure 47).

Step3: For roads with two lanes, stores on both sides shall be segmented at the same time. Roads of four or more two-way lanes are divided into sections for shops on each side separately.

4.2.2.2 Demand estimation

'Distribution parking demand' refers to the amount of time that a parking space is used for temporary parking and loading/unloading operations (using either on-road loading/unloading zones or on-road available space) to meet the distribution requirements of stores along a street. The building setback area (area of space between the road and the store) of some stores can be large spaces, so urban logistics vehicles can be parked in this area in front of the building. As these building setback areas of each store are dedicated to a respective store, the parking demands of

such stores are not within the scope of demand calculation. In addition, commercial complexes with dedicated unloading sites are also not within the scope of demand estimation (see Figure 48).

According to field surveys conducted as part of this research, the distribution frequency and the duration of loading/unloading activities of each store can be identified and examined. In this study, a calculation method of distribution parking demand considering the above parameters is proposed, and its calculation formula is as follows:

$$D_M^k = \sum_{i=1}^m f_i^k t_i^k$$

D_M^k denotes the demand in the study area within the time period of k . M is the collection of all shops along the given street. m is the number of shops along the given street. f_i^k denotes the distribution frequency of shop i in the period k . Assuming that each delivery occupies a parking space, t_i^k then denotes the time duration for each loading/unloading operation of shop i in a parking space, in period k , which generally has a value of 15 minutes.

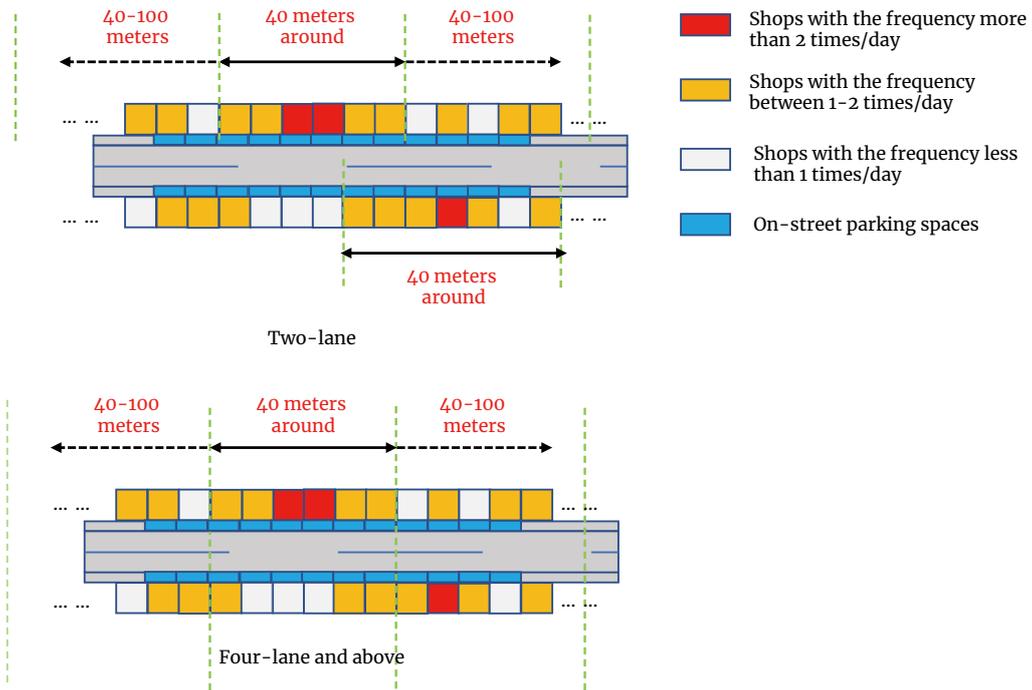
4.2.2.3 Calculation of the number of dedicated loading/unloading zones

According to field investigations conducted in the pilot area for this project, the duration of a single loading/unloading activity is generally completed within 15 minutes. Therefore, the duration of a single loading/unloading activity is calculated as 15 minutes when determining the demand threshold for setting up dedicated loading/unloading zones. The threshold is reached when the demand of shops for distribution and parking in a given section between 9:00 to 17:00 is at least 60 loading/unloading zones per minute, or the total number of distribution times of the shops in the daytime in each section reaches 4 times.

The calculation formula for the scale of dedicated loading/unloading zones is as follows:

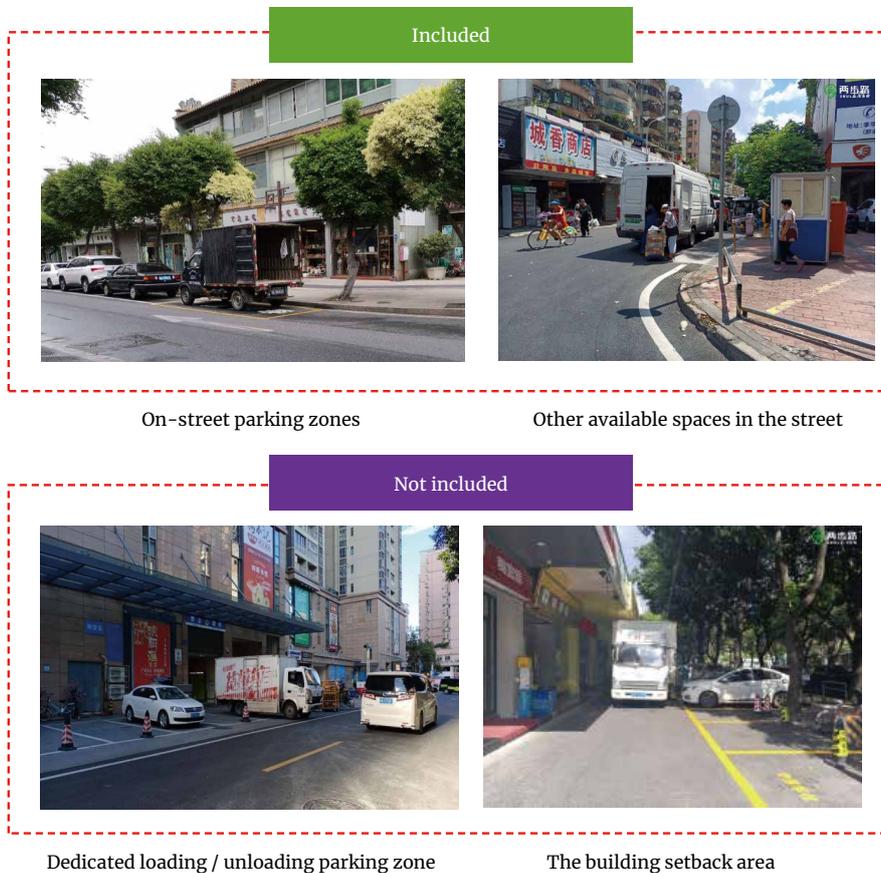
$$X_{add} = \max \left[\frac{D_M^k}{T_k} \right] = \max \left[\frac{\sum_{i \in M} f_i^k t_i^k}{T_k} \right] (k = 1, 2, \dots, n)$$

■ Figure 47 Schematic diagram of road segmentation adapted to demand and walking distance



Source: NICTP

■ Figure 48 Estimated scope of distribution parking demand



Source: NICTP

Where X_{add} denotes the number of dedicated loading/unloading zones needed to be added for urban logistics vehicles in the road segment. T_k denotes the time duration allowing delivery vehicles to use the space in the period k. n is the number of periods divided. Generally, a whole day can be divided into several time intervals such as early morning, morning, afternoon, and night. The other parameters are the same as indicated in the previous formula. In order to meet distribution parking demands, the supply capacity of dedicated loading/unloading zones can be increased by adding additional numbers of dedicated loading/unloading zones or by extending the parking time duration for urban logistics vehicles.

4.2.2.4 Location selection of dedicated loading/unloading zones

Based on the site selection principles, potential points of dedicated loading/unloading zones can be studied and then determined. The site selection model is established with the goal of maximising distribution parking demands and minimizing the comprehensive cost of each dedicated loading/unloading zone to each store. The best site selection scheme of dedicated loading/unloading zones can then be determined amongst possible locations.

1) Site selection principle

The site selection principle is determined according to such policy documents as the Guidelines for application of on-street parking management facility on urban road^[4], the Specifications for setting of on-street loading/unloading zones on urban roads^[5], and the Administration Measures for Loading/unloading zones in Foshan City^[6]. In addition, if there are existing loading/unloading zones in the study section, priority shall be given to considering the possible reconstruction of existing loading/unloading zones. If there are no loading/unloading zones in the current section, new loading/unloading zones can be selected at chosen locations (see Table 6).

Note: The table provides the key location selection principles for loading/unloading zones. For other details, please refer to the relevant documents and policies in the table.

2) Objective functions and constraints

Objective functions: The setting of dedicated loading/unloading zones shall first meet the parking demands of urban logistics vehicles, therefore giving these drivers the greatest convenience for loading and unloading. This project proposes a location model with the objective function of maximizing distribution parking demand, while minimizing comprehensive costs.

$$P = \max \frac{\sum_i \sum_j t_i f_{ij}^k}{\sum_i t_i f_i^k}$$

$$D = \min \sum_{i=1}^A \sum_{j=1}^B f_{ij}^k d_{ij}$$

P denotes the proportion of satisfied distribution parking demand in the total distribution parking demand in this period. D are the total comprehensive expenses for temporary parking of logistics vehicles. A is the number of shops along the street. B is the number of loading/unloading zones. f_{ij}^k denotes the number of stops from store i to loading/unloading zones j in period k. d_{ij} is the walking distance between store i and loading/unloading zones j. The other parameters are the same as illustrated in the formulas discussed above. The location of dedicated loading/unloading zones first aims to maximise the distribution parking demand. If the potential of each alternative location to meet the distribution parking demand is the same, the location is then determined with the goal of minimising comprehensive costs.

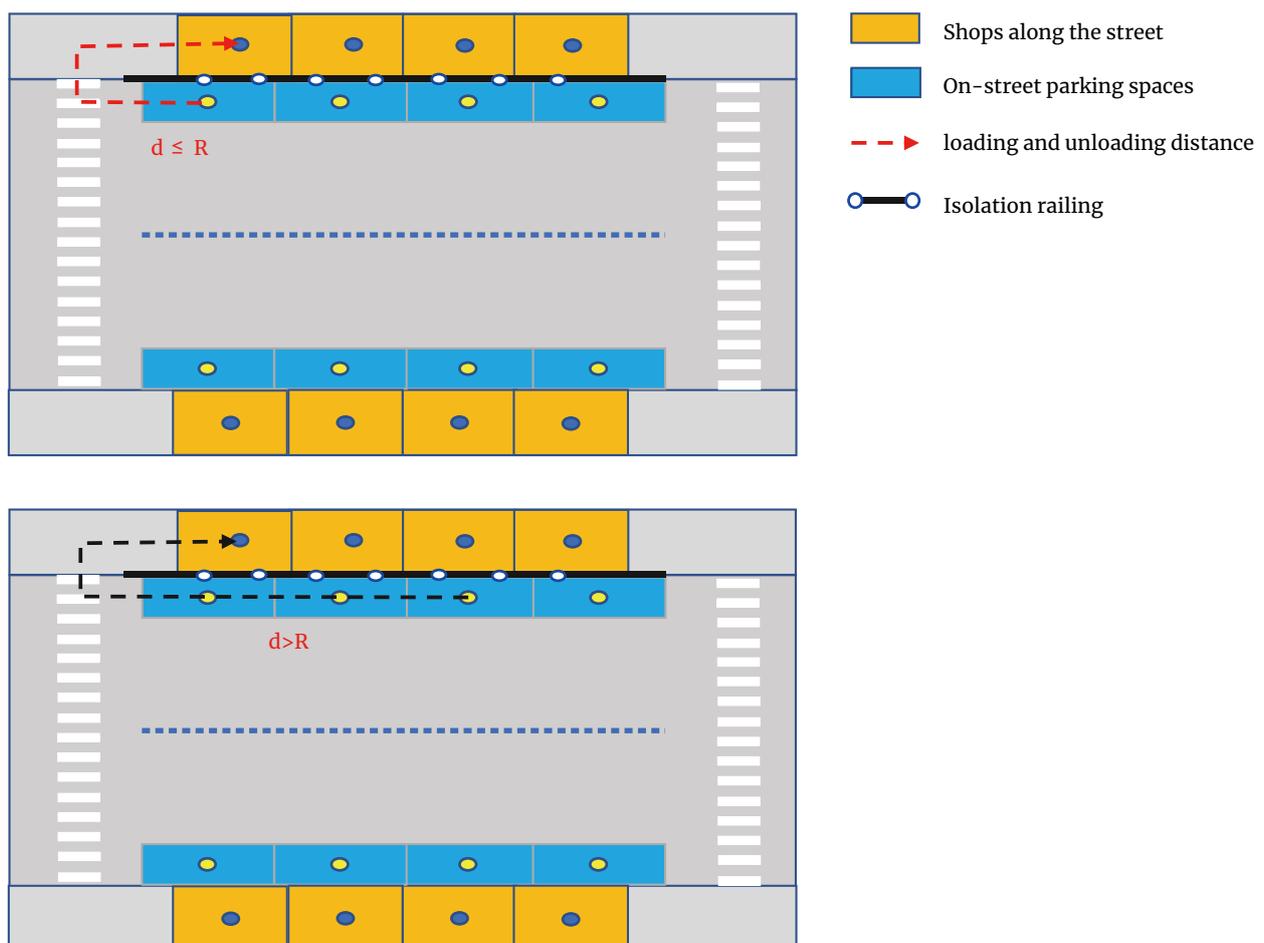
Walking distance constraint: Logistics vehicles can only be parked in loading/unloading zones that are within the walking distance acceptable to the driver. Whether the store I is parked in the loading/unloading zone j is indicated by setting 0 and 1 variables (see Figure 49). The mathematical expression of the constraint condition is as follows:

$$\begin{cases} a_{ij} = \begin{cases} 1, & d_{ij} \leq R \\ 0, & d_{ij} > R \end{cases} \\ f_{ij}^k = f_i^k a_{ij} \end{cases}$$

■ Table 6 Site selection principles

Relevant documents and policies	Content description
Specifications for setting of on-street loading/unloading zones on urban roads (GA/T 850-2021, 4.2)	<p>The following sections and areas shall not be provided with loading/unloading zones:</p> <ul style="list-style-type: none"> Sections beginning at the starting point of the transition section of the intersection of trunk roads and secondary trunk roads. If the intersection is not widened, then sections within 50m from the stop line of the intersection. Sections within 20m from the stop line of branch intersections.
Guidelines for application of on-street parking management facility on urban road (GA/T 1271-2015, 5.1)	<ul style="list-style-type: none"> Loading/unloading zones should not be set up within 200m-300m of off-street public loading/unloading zones If there is an organic non-separation belt on the trunk road and the width of the non-motorised lane is greater than 4.5m, on-road loading/unloading zones can be set in the non-motorised lane.
Administration Measures for Loading/unloading zones in Foshan City	<ul style="list-style-type: none"> Loading/unloading zones shall not be set on two-way traffic roads with a width of less than 8m and one-way traffic roads with a width of less than 6m.
Traffic policies of urban logistics vehicles	<ul style="list-style-type: none"> Urban freight distribution vehicle traffic policy, parking policy, charging policy, etc.

■ Figure 49 Walking distance diagram



Source: NICTP

Service duration constraint: The service duration of a single loading/unloading zone shall meet the distribution parking needs of parking to the area, and the service duration shall not exceed the maximum service duration that the loading/unloading zone can provide. The loading/unloading zone is a single loading/unloading zones or a parking section. The maximum number of loading/unloading zones provided by a single loading/unloading zone is 1, and the maximum number of loading/unloading zones provided by a parking section is determined according to the road conditions. The mathematical expression of this constraint is as follows:

$$\sum_{i=1}^A t_i f_{ij}^k a_{ij} \leq p_j T_j \leq p_{j_{\max}} T_j$$

p_j denotes loading/unloading zones provided by loading/unloading zone j . $p_{j_{\max}}$ is the maximum number of loading/unloading zones available in loading/unloading zone j . T_j is the service time of loading/unloading zone j . t_i is the duration of each loading/unloading in the shop i . The other parameters are the same as the formulas discussed previously in this section.

4.2.3 Design of dedicated loading/unloading zones

The design of dedicated loading/unloading zones mainly considers the development characteristics of NELVs, the size of NELVs, their relevant specifications and standards, and the size of existing distribution vehicle's loading/unloading zones.

4.2.3.1 Development characteristics of NELVs

As of June 2020, Foshan city had 1,905 NELVs, among which Chancheng District had 898, including 786 electric trucks and 112 hydrogen energy trucks. The ownership rate of pure electric trucks in Chancheng District has been growing at 5%-10% annually in recent years and is expected to continue growing. There was no increase in the number of hydrogen energy trucks between 2019 and 2020. In terms of vehicle types, as of the end of May 2021, there were 2699 NELVs in Foshan, including 6

mini NELVs, 2232 light NELVs, 459 medium NELVs and 2 heavy NELVs. Light NELVs accounted for the largest proportion, reaching 83%.

4.2.3.2 Size of NELVs

To illustrate the different sizes of NELVs in Foshan, Table 7 shows the main types of NELVs, their sizes, and examples of each vehicle type. The body length of mini and light NELVs is within 6m and the width is within 2.5m. The body of medium NELVs is 5.995m. The body length of hydrogen energy trucks reaches 7.63m.

4.2.3.3 Size of current loading/unloading zones for urban logistics vehicles

According to the Guidelines for application of on-street parking management facilities on urban roads, the size of a dedicated loading/unloading zone for urban logistics vehicles should be 6m×2.5m and be marked with the written designation "logistics distribution", with markings being in yellow and lettering in a white font (see Figure 50).

The size of loading/unloading zones for domestic urban logistics vehicles is an average of 6m×2.4m. These zones are demarcated in many forms, such as having yellow markings with a white font, green markings with a white font, and green markings with a green font (see Figure 51).

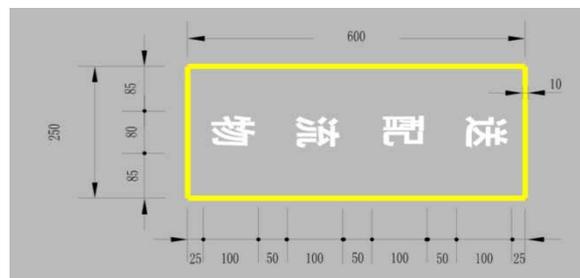
Chancheng District currently has 30 dedicated loading/unloading zones for urban logistics vehicles, with an average size of generally 6m×2.5m, marked with the words "logistics and distribution." Some loading/unloading zones are slightly adjusted in size according to actual road conditions, and there are different sizes such as 6m×1.8m, 6m×2.2m. Demarcation markings are yellow and with a white font.1

Taking into account the characteristics of NELVs, standard requirements, and current logistics and distribution loading/unloading zones in Chancheng District, this study suggests that standards for traffic markings as set out in the Guidelines for application of on-street parking management facility on urban road should be applied.

Table 7 Types and characteristics of NELVs

Vehicle types	Size (mm)	Example vehicles
Miniature enclosed electric truck	4430×1626×1930	
Light enclosed electric truck	5200×1700×2240	
Light van electric truck	4750×1670×2400	
Medium van electric truck	5995×2240×2890	
Hydrogen energy truck	7630×2370×3060	

Figure 50 Design of dedicated loading/unloading zones for urban logistics vehicles in the Guidelines for application of on-street parking management facility on urban road (unit: cm)



Source: Guidelines for application of on-street parking management facility on urban road

Figure 51 Examples of dedicated loading/unloading zones for urban logistics vehicles



Source: NICTP

4.2.3.4 Supporting facilities

In order to ensure the dedication of loading/unloading zones specifically for urban logistics vehicles, it is necessary to further improve the signs and the monitoring equipment of the road sections where loading/unloading zones are located (see Figure 52).

4.2.4 Management methods based on the Sulp concept

4.2.4.1 Management measures

1) Establish a stakeholder platform for setting temporary loading/unloading zones in a road section

Street and community members should take the lead to establish a stakeholder platform, with participants to include supply chain stakeholders (shops along the street and distribution enterprises), other stakeholders (consumers, surrounding residents) and experts. The responsibilities of each stakeholder are listed in Table 8.

2) Formulate the setting scheme of temporary loading/unloading zones

Project research teams should carry out investigations and research on the distribution characteristics of shops along their street, solicit the opinions of various stakeholders on whether to set up temporary loading/unloading zones, and check levels of support for their specific site selections and the setting time period. The research team should then provide stakeholders with a suggested scheme for the use of these zones, and again solicit opinions and readjust the plan as needed.

3) Implement the setting of temporary loading/unloading zones

Relevant government departments should carry out the construction and planning of temporary loading/unloading zones and implement various management measures. Relevant government departments should then carry out an evaluation to gauge the effects (negative or positive) of their implementation efforts.

4.2.4.2 Refined management measures

To ensure that dedicated loading/unloading zones are used exclusively by urban logistics vehicles and to improve the utilisation efficiency of loading/unloading zones, corresponding management measures should also be improved. These measures can mainly be improved in terms of managing the zone's usage times and space, managing their orderly use, and considering fee reduction policies (as further outlined in the following sections).

1) Time and Space Management

In green freight distribution demonstration areas, only NELVs are allowed to park during the daytime, and all urban logistics vehicles are allowed to park in other periods. A dedicated loading/unloading zone outside the green freight distribution vehicle demonstration area allows all other urban logistics vehicles to have a place to stop. According to the distribution demand characteristics of different sections, a special timeline for urban logistics vehicles can be flexibly determined (for example, the special time can be set for these vehicles to access their zones for 30 minutes each in the morning and afternoon, as it is not recommended to set dedicated loading/unloading zones for the duration of an entire day), and other vehicles are allowed to park temporarily in other periods.

2) Order Management

Vehicles that illegally occupy dedicated loading/unloading zones should receive penalties. It is suggested that management authorities designate an on-road parking charge administrator to allow them to dissuade other vehicles from the illegal behaviour of occupying dedicated loading/unloading zones meant for urban logistics vehicles. If a driver illegally occupying a space does not abide by requests to clear it from the parking charge administrator, the administrator can then record the driver's license plate number and submit the driver's information to the traffic management department, who will punish the driver according to law. If there are dedicated loading/unloading zones set for a specific store, urban logistics vehicles are not allowed to park in these locations, and any urban logistics vehicles that are parked there indiscriminately can be requested to clear the space or incur the appropriate penalty. If there are no dedicated loading/unloading zones on a road, these vehicles could be given a concession and be allowed to park for a maximum of 15 minutes, under the condition of not affecting traffic.

3) Fee Reduction Policy

There should be no charge for urban logistics vehicles to park in dedicated loading/unloading zones. NELVs should be allowed to occupy a shared loading/unloading zone free of charge for the first hour, and other urban logistics vehicles should be free for the first half hour, with extra time being charged according to the standard fees that apply to all other vehicles.

4.3 Pilot Application

The old community and scenic spot in Chancheng District was selected as the pilot area for the project. For the purposes of the pilot application, individual roads in the pilot area were selected as research objects, and the demand characteristics of road freight distribution on those roads

were then investigated and analysed, with subsequent pilot application research being carried out. The research pilot area included two roads: Houlong First Street and Gaomiao Road. Houlong First Street is located in the green freight distribution demonstration area, and Gaomiao road is outside the demonstration area (see Figure 53).

4.3.1 Houlong First Street

4.3.1.1 Status quo

1) Land use and road condition

Houlong First Street is located in a residential area in the old town, with postal express outlets, convenience stores, fresh food stores, pharmacies, and restaurants. The street is a two-way road with two lanes, with a road length of 210 meters, and on-street paid loading/unloading zones are located on the south side of the street (see Figure 54).

■ Figure 52 Examples of supporting signage and monitoring equipment

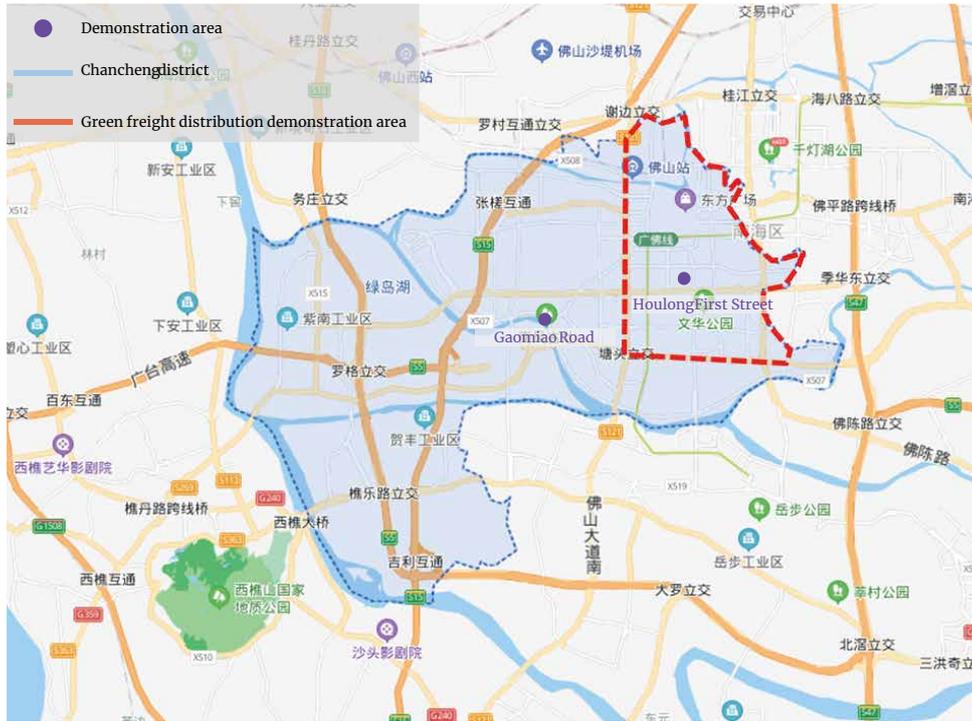


Source: NICTP

■ Table 8 Responsibilities of stakeholders

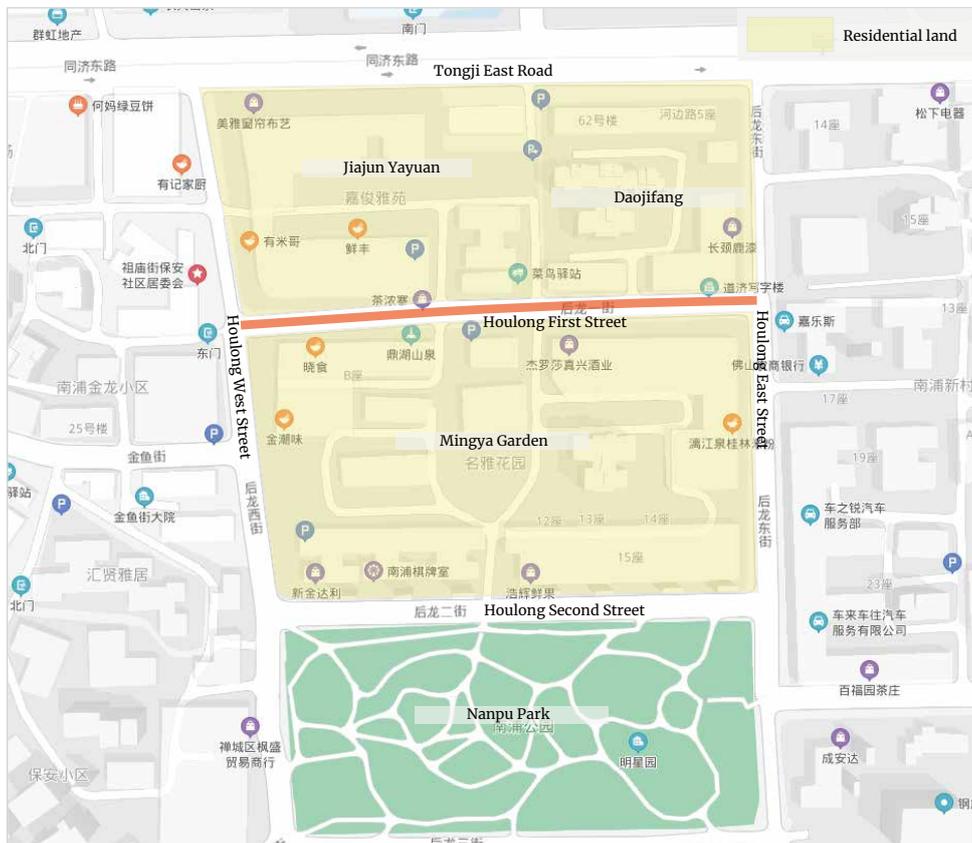
Stakeholder	Main responsibilities
Government	<ul style="list-style-type: none"> • Encourage unifying the delivery service provider or delivery time. • Establish a dynamic evaluation mechanism. • Strengthen publicity and guidance.
Distribution companies	<ul style="list-style-type: none"> • Improve distribution efficiency. • Strengthen the parking order.
Shops along the street	<ul style="list-style-type: none"> • Efficient and intensive distribution. • Encourage interactive feedback.

■ Figure 53 Location diagram of pilot zone



Source: NICTP

■ Figure 54 Schematic diagram of geography of research scope area



Source: NICTP

2) Demand analysis

According to the research survey, the distribution demand of shops along Houlong First Street mainly comes from the Cainiao postal station (Postal Express Outlet) and Xianfeng Fruit Store (Fresh Food Store), with each having a distribution demand of 2 times/day and 4 times/day,

respectively (see Table 9). In addition, the distribution demand and distribution period of restaurants on the street is also relatively fixed, while the distribution period of other stores such as teahouses, clothing stores, and pharmacies are more flexible. The freight demand for parcels or meal deliveries for residents was not included in the survey.

■ **Table 9 Distribution demand characteristics of stores along Houlong First Street**

Store	Frequency	Delivery time	Average loading/unloading duration
Tmall shop	1 time/day	09:00-11:00	10min
Golden Wonton Noodles	1 time/day	04:00-06:00	5min
Sugar Fun Garden Dessert Shop	1 time/day	04:00-06:00	10min
Baiyou specialty	1 time/month	flexible	10min
Houchun Teahouse	1 time/month	flexible	5min
Junsheng Teahouse	1 time/month	flexible	5min
Cha Nong Village	1 time/month	flexible	5min
Little Thai Pepper Gourmet	1 time/day	04:00-06:00	10min
Qianwen Office	1 time/day	flexible	5min
Cainiao Post Station	2 times/day	Once in 09:00-11:00 Once in 12:00-13:00	15min
Xianfeng Fruit Store	4 times/day	Once in 09:00-10:00 Once in 10:00-11:00 Once in 15:00-16:00 Once in 19:00-21:00	15min
Zhengye Advertising	1 time/day	flexible	5min
Feiyan clothing	2 times/month	flexible	15min
Zen Xingxing	1 time/week	flexible	10min
Huahuajia	2 times/month	flexible	15min
Welhaoke Store	2 times/day	09:00-11:00 14:00-16:00	10min
Pinyi Tobacco Shop	1 time/week	flexible	5min
Anlong Tea Company	1 time/month	flexible	5min
Chuxiong Tobacco and Wine	1 time/week	flexible	10min
Dinghu Spring	1 time/day	09:00-10:00	15min
Royal Pharmacy	1 time/day	flexible	5min
Akatsuki	1 time/day	04:00-06:00	10min
Others	Low frequency	flexible	—

3) Problem analysis

No loading/unloading zones for urban logistics vehicles: Current parking allocation in the surrounding communities for these vehicles is insufficient. The full day occupancy rate of paid loading/unloading zones in the road is basically 100%, and there are almost zero areas allocated for the loading/unloading zones of urban logistics vehicles (see Figure 55).

Random parking: Urban logistics vehicles stop at random locations on pavements, roadways and fire escapes in the community, affecting the normal passage of vehicles and pedestrians, and adversely affecting the safety of the community (see Figure 56).

Lack of parking management or penalties: The parking charge administrator only manages the paid loading/unloading zones on the road and has no management authority over the random parking of urban logistics vehicles.

4) Necessity and feasibility analysis

Through the status quo investigation and problem analysis, the contradiction between supply and demand issues relating to loading/unloading zone availability on Houlong First Street is prominent. There is a large demand for distribution in stores along the street (12 times in 09:00-17:00, see Figure 57), and urban logistics vehicles consistently are parked disorderly, therefore it is necessary to set up dedicated loading/unloading zones for urban logistics vehicles. Furthermore, Houlong First Street has a lane width of 10m and two-way lanes. According to the Specifications for setting of on-street loading/unloading zones on urban roads^[5], on-road loading/unloading zones can only therefore be set on one side.

In conclusion, it is necessary to set up dedicated loading/unloading zones for logistics vehicles in Houlong First Street, and the location meets the road conditions for the setting of loading/unloading zones. In addition, on-road loading/unloading zones have been set on one side of Houlong First Street, so this project would suggest that the area first considers the reconstruction of existing on-road loading/unloading zones, rather than immediately adding new ones.

■ Figure 55 Supply of parking facilities in Houlong First Street



(a) Supply of parking facilities during the day



(b) Supply of parking facilities at night

Source: NICTP

■ Figure 56 Current situation of the random parking of urban logistics vehicles in Houlong First Street



Source: NICTP

4.3.1.2 Setting of dedicated loading/unloading zones

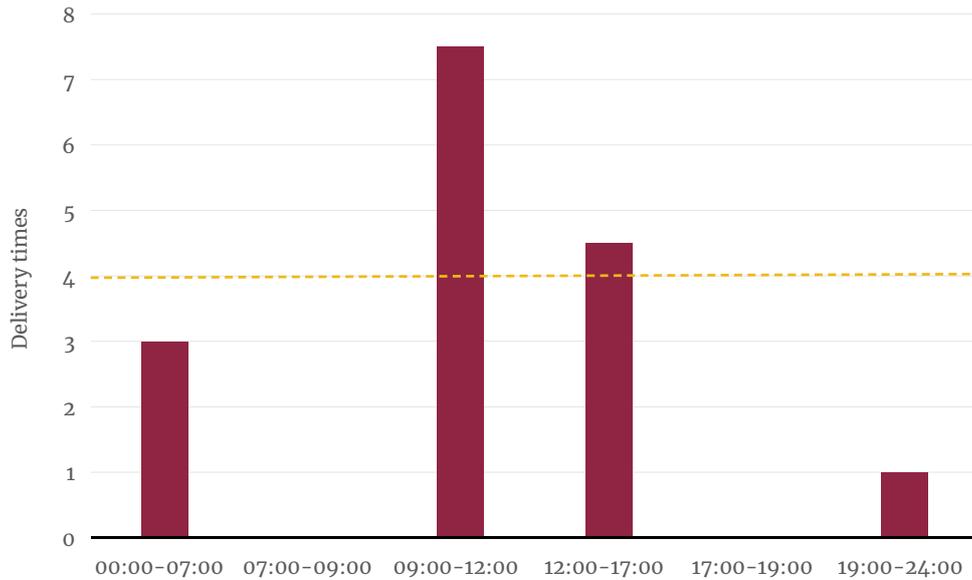
1) Create a coordinate system

Taking Lixiang Decoration Engineering Co., Ltd. on the Houlong First Street as the origin point, a coordinate

system for loading needs can be established according to the relative position of the shops and loading/unloading zones (see Figure 58).

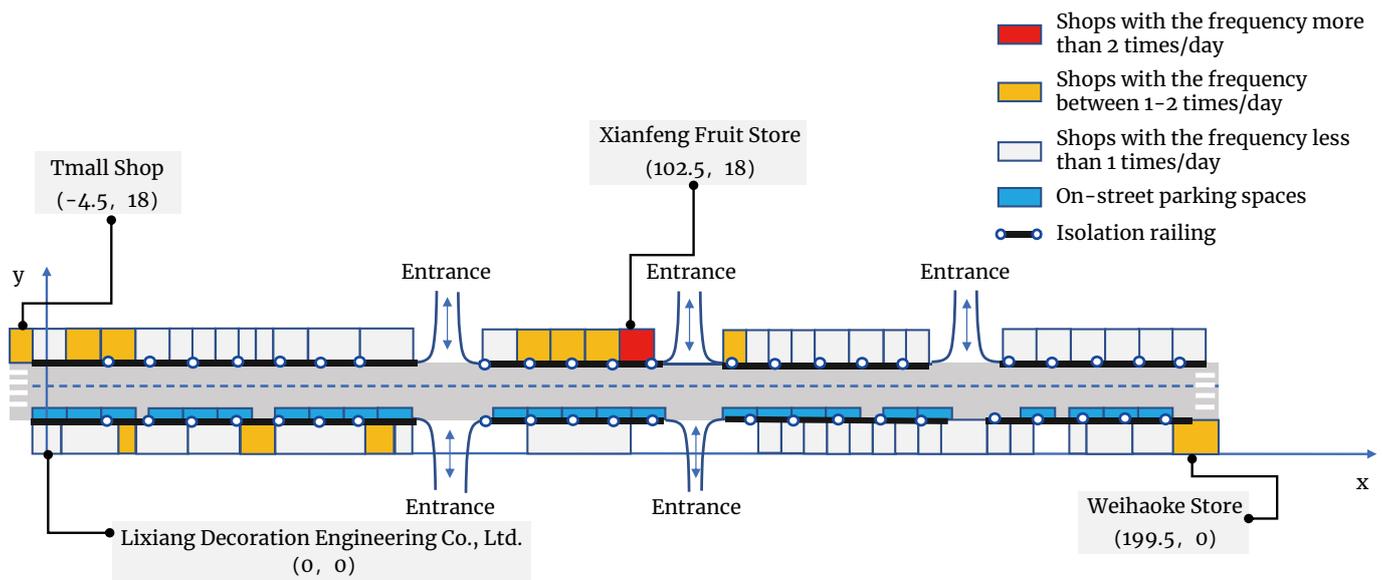
The coordinate values of each store and existing loading/unloading zones are shown in Table 10.

■ Figure 57 Distribution times of shops in Houlong First Street



Source: NICTP

■ Figure 58 Shop coordinates of Houlong First Street



Source: NICTP

■ Table 10 Coordinate values of shops along Houlong First Street

No.	Store name	Coordinate
1	Lixiang Decoration Engineering Co., Ltd.	(0, 0)
2	Akatsuki	(14, 0)
3	Royal Pharmacy	(36.5, 0)
4	Dinghu Spring	(58, 0)
5	Chuxiong Tobacco and Wine	(62, 0)
6	Anlong Tea Company	(132.5, 0)
7	Pinyi Tobacco Shop	(179, 0)
8	Welhaoke Store	(199.5, 0)
9	Golden Wanton Noodles	(4.5, 18)
10	Sugar Fun Garden Dessert Shop	(10.5, 18)
11	Baiyou specialty	(16.5, 18)
12	Houchun Teahouse	(33, 18)
13	Junsheng Teahouse	(36, 18)
14	Cha Nong Village	(60.5, 18)
15	Little Thai Pepper Gourmet	(84.5, 18)
16	Qianwen Office	(90.5, 18)
17	Cainiao Post Station	(96.5, 18)
18	Xianfeng Fruit Store	(102.5, 18)
19	Zhengye Advertising	(119.5, 18)
20	Feiyan clothing	(123.5, 18)
21	Zen Xingxing	(147.5, 18)
22	Huahuajia	(151.5, 18)

■ Table 11 Coordinate values of loading/unloading zones along Houlong First Street

No. of loading/unloading zones	Coordinate
1	(0.5, 7)
2	(6.5, 7)
3	(12.5, 7)
4	(20.5, 7)
5	(26.5, 7)
6	(32.5, 7)
7	(42.5, 7)
8	(48.5, 7)
9	(54.5, 7)
10	(60.5, 7)
11	(80.5, 7)
12	(86.5, 7)
13	(92.5, 7)
14	(98.5, 7)
15	(104.5, 7)
16	(120.5, 7)
17	(126.5, 7)
18	(132.5, 7)
19	(138.5, 7)
20	(148.5, 7)
21	(154.5, 7)
22	(172.5, 7)
23	(180.5, 7)
24	(186.5, 7)
25	(192.5, 7)

2) Road segmentation

Houlong First Street is a two-way road with two lanes, and a road length of 210 meters. The dedicated loading/unloading zones on one side of the street can serve shops on both street sides. Houlong First Street can be divided into three segments based on the reference point of Xianfeng Fruit Store, and the actual distribution characteristics of the stores (see Figure 59).

3) Calculation of the number of dedicated loading/unloading zones

It is estimated that the number of delivery times needed by Segment 1 and Segment 3 (as shown in Figure 59) are 3 times and 2 times respectively from 09:00 to 17:00, which does not reach the starting threshold of setting dedicated loading/unloading zones (4 times), therefore the setting of dedicated loading/unloading zones cannot be considered in the geographic areas of Segment 1 and Segment 3.

From 09:00 to 17:00 in Segment 2, the number of distribution times reaches 7, and the distribution parking demand reaches 85 loading/unloading zones per minute. It can therefore be considered to set up dedicated loading/unloading zones in this section (see Figures 60 and 61).

The number of dedicated loading/unloading zones for a given Segment is calculated according to the following calculation formula:

$$X_{add} = \max \left[\frac{D_M^k}{T_k} \right] = \max \left(\left[\frac{50}{120} \right], \left[\frac{35}{120} \right] \right) = 1$$

T_k denotes the duration of time for allowing delivery vehicles to use the loading/unloading zones in the period k . To improve the utilisation rate of dedicated loading/unloading zones, this time should not be too lengthy. The dedicated time for urban logistics vehicles to use these zones in the morning and afternoon should be two hours respectively. It is calculated that dedicated loading/unloading zones for urban logistics vehicles should be implemented in Segment 2.

4.3.1.3 Location selection of dedicated loading/unloading zones

Location models need to be set by basing them on the period with the greatest demand. In this case, it is solved based on the data from 09:00 to 12:00, which is the peak demand period.

According to the location model, the enumeration method is used to solve the determination of the location of dedicated loading/unloading zones, while taking into account the impact of loading and unloading operations on adjacent loading/unloading zones and the convenience of parking. According to calculation results, except for the dedicated loading/unloading zones selected in Figure 62, other alternative points cannot meet all distribution parking demands within a 20m service radius. Finally, it is determined that the preferred loading/unloading zones for reconstruction is located facing the Xianfeng Fruit Store. The reconstruction of dedicated loading/unloading zones in this location could meet 100% of the distribution parking demand of Segment 2 of Houlong First Street. Furthermore, this location is close to the road opening, which is convenient for loading/unloading.

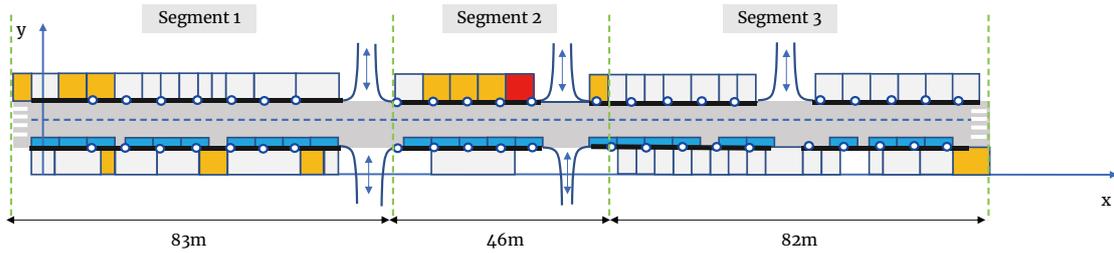
4.3.1.4 Management measures

In order to improve the utilisation efficiency of dedicated loading/unloading zones and taking into account the distribution characteristics of the stores in this segment (see Figure 63), the dedicated loading/unloading zones in Segment 2 are designated exclusively to NELVs in the periods of 9:00-11:00 and 14:00-16:00. A single loading and unloading operation is limited to 15 minutes. Other vehicles can park in this loading/unloading zone only during other times.

During the dedicated use times for NELVs, other vehicles occupying dedicated loading/unloading zones are required to clear (leave) the space or incur penalties. At the same time, in this section, urban logistics vehicles parked illegally will be required to clear the area or incur penalties.

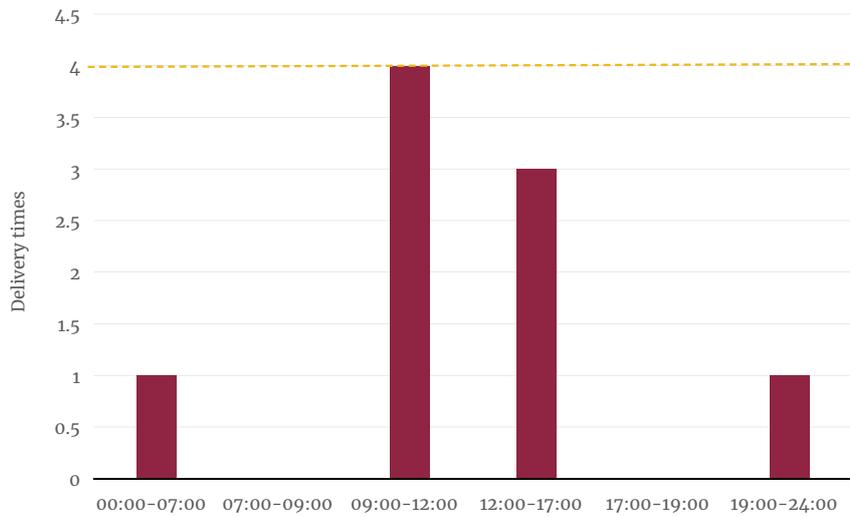
For Segment 1 and Segment 3, it was recommended to conduct deliveries at night or in off-peak hours. Under the circumstances of not affecting the normal operation of traffic, NELVs are allowed to park temporarily (without penalty) on the general no-parking section for a limited time of 15 minutes.

■ Figure 59 Section diagram of Houlong First Street



Source: NICTP

■ Figure 60 Distribution times of stores along the street in Segment 2



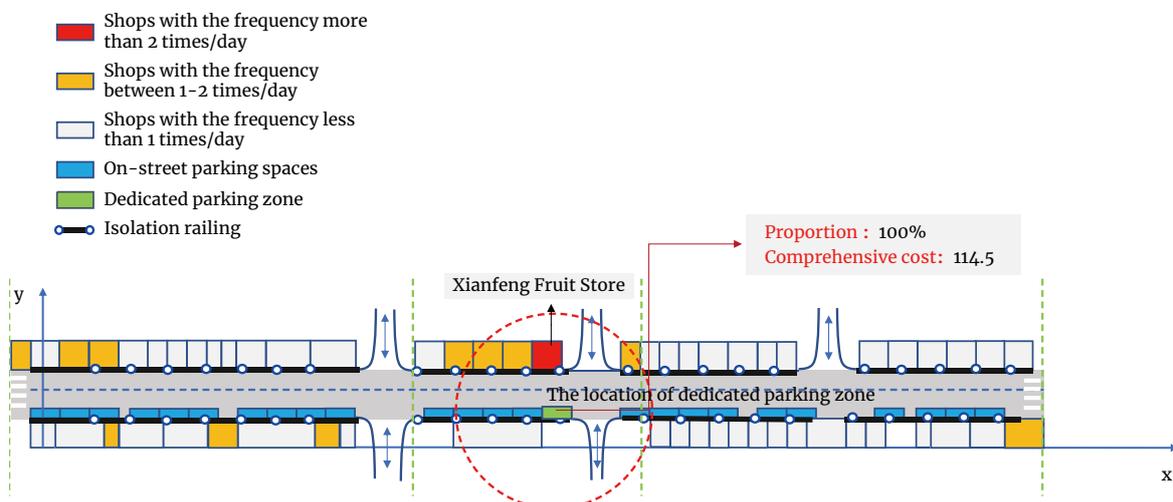
Source: NICTP

■ Figure 61 Distribution parking demand of stores along the street in Segment 2

Distribution parking demand/spaces · min	10	0	50	35	0	15
Time of day	00:00-07:00	07:00-09:00	09:00-12:00	12:00-17:00	17:00-19:00	19:00-24:00

Source: NICTP

■ Figure 62 Schematic diagram of location selection for dedicated loading/unloading zones



Source: NICTP

4.3.2 Gaomiao Road

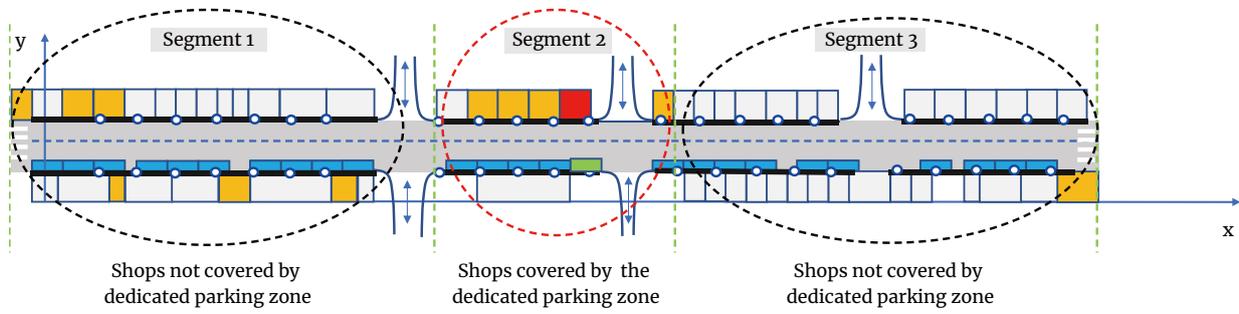
4.3.2.1 Status quo

1) Land use and road condition

Gaomiao Road is located close to the Nanfeng Kiln Scenic Spot and the old residential area (see Figure 64). It has a total length of approximately 290 meters and hosts one-way traffic which runs from east to west. Gaomiao Road is divided into east and west segments by Gongzai Street.

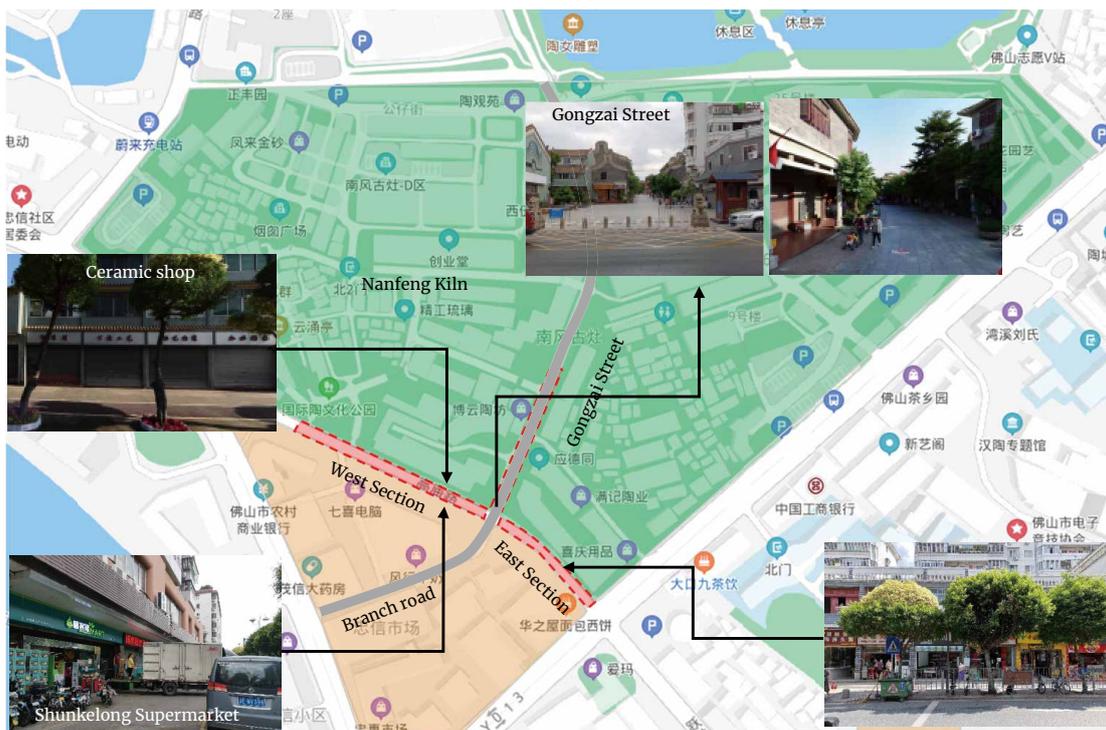
There are many ceramic shops along the street in the west section of Gaomiao Road, mainly use for exhibition functions, and there is almost no demand for distribution. There is only one Shunkelong supermarket in this location, which has a large distribution demand and concentrated delivery reception times. There are many restaurants and fresh food stores in the eastern section of Gaomiao Road, and which also have a large distribution demand and require a variety of distribution types. Gongzai Street is a pedestrian street which is open to vehicles for a limited time to meet the distribution demand of stores in Nanfeng Kiln.

■ Figure 63 Schematic diagram of the coverage of each segment of stores by the dedicated loading/unloading zones



Source: NICTP

■ Figure 64 Land around Gaomiao Road and shops along the street



Source: NICTP

2) Distribution characteristics of the west section of Gaomiao Road

The distribution demand of the west section of Gaomiao Road mainly comes from Shunkelong Supermarket. The distribution frequency for this store is 5 times a day, and its peak distribution time occurs in the morning. The rest of the stores in this area have low distribution frequency or no distribution demand (see Table 12).

At present, the west section of Gaomiao Road has 12 on-street paid loading/unloading zones and one dedicated loading/unloading zone for urban logistics vehicles. There is a building setback area in front of the Shunkelong Supermarket for temporary parking, which has a certain degree of specificity for the supermarket (see Figure 65).

Table 12 Distribution demand characteristics of stores along the west section of Gaomiao Road

Store	Frequency	Delivery times	Average loading/unloading duration
Shunkelong Supermarket	5 times/day	Once in 09:00-10:00 Twice in 10:00-11:00 Once in 14:00-15:00 Once in 19:00-20:00	15min
Delian Pharmacy	1 time/day	flexible	5min
Shuixiang Caiji Branch	1 time/week	flexible	15min
Qiulong Fashion	2 times/month	flexible	15min
Others	Low frequency	flexible	—

Figure 65 Layout of the loading/unloading zones along the west section of Gaomiao Road



Source: NICTP

Shunkelong Supermarket uses its building setback area to meet its own basic parking and loading needs, and there is already a dedicated loading/unloading zone also in this section, which can meet the distribution demand of other stores along this road area. Therefore, adding dedicated loading/unloading zones is no longer considered as required in this location, but relevant measures to improve the management level of current zones need to be adopted.

The main proposed management measures are:

- Upgrade traffic signage for the existing dedicated loading/unloading zones for urban freight distribution and monitoring facilities, strengthen parking order management, and ensure exclusive use of the dedicated loading/unloading zones by urban logistics vehicles.

- Set 10:00-11:00 as the dedicated time for urban logistics vehicles to use the existing dedicated loading/unloading zones. A single loading/unloading operation is limited to 15 minutes and other time periods are open to other vehicles to improve the utilisation of the dedicated loading/unloading zones.

3) Distribution characteristics of the east section of Gaomiao Road

The distribution demand of the east section of Gaomiao Road is mainly from Guanfang Foods (fresh food store), whose distribution frequency is 5 times/day. The remaining stores in this location mainly include restaurants and pharmacies, with distribution frequencies of basically 1 time/day (see Table 13).

■ Table 13 Delivery demand of stores along the east section of Gaomiao Road

Store	Frequency	Delivery time	Average loading/unloading duration
Shaxian snacks	1 time/day	04:00-06:00	5min
Xuxiangyuan Siu Mei	1 time/day	06:00-07:00	10min
Yukang Pharmaceutical Co., Ltd.	1 time/day	09:00-17:00	5min
Liyuan Farm	1 time/day	09:00-10:00	10min
Pork feet rice	1 time/day	09:00-10:00	5min
Rong Kee Claypot Rice	1 time/day	04:00-06:00	5min
Convenience food	1 time/day	19:00-24:00	5min
Shrimp and Fish Fu	1 time/day	04:00-06:00	10min
Lanzhou Ramen, China	1 time/day	04:00-06:00	5min
Guanfang Foods	5 times/day	Once in 04:00-06:00 Twice in 09:00-11:00 Twice in 12:00-17:00	10min
Weiwang Shaowei	1 time/day	06:00-07:00	10min
Wallace	1 time/day	09:00-10:00	15min
Huazhiwu Bread	2 times/day	Once in 04:00-06:00 Once in 14:00-15:00	10min
Li Ge Wantan Noodles	1 time/day	04:00-06:00	5min
Maoxin Pharmacy	1 time/day	09:00-17:00	5min
Northern Bund	1 time/day	04:00-06:00	5min
Others	Low frequency	flexible	—

At present, there are two open loading/unloading zones and two dedicated loading/unloading zones for taxis at the entrance and exit of Gongzai Street in the east section of Gaomiao Road. Among them, the loading/unloading zones are dedicated zones for use to service Gongzai Street, and the loading/unloading zones for taxis are also dedicated to this specific area (see Figure 66).

According to an analysis of research findings, the main problems in the east section of Gaomiao Road are as follows:

- **Lack of loading/unloading zones for urban logistics vehicles:** The supply of parking facilities for urban logistics vehicles to shops in the east section is almost zero, and the current loading/unloading zones are far away from most shops in the east section, making them inconvenient to use.
- **Random parking:** Urban logistics vehicles occupy the crosswalk to stop, which adversely affects road traffic operation, pedestrian crossing safety, and the scenic environment (see Figure 67).

■ **Figure 66 Layout of the loading/unloading zones along the east section of Gaomiao Road**



Source: NICTP

■ **Figure 67 Current situation of random parking of urban logistics vehicles on the east section of Gaomiao Road**



Source: NICTP

According to the status quo investigation and problem analysis, the necessity and feasibility of setting up dedicated loading/unloading zones for urban logistics vehicles was analysed. The first findings from this research were that the contradiction between parking supply and demand in the east section of Gaomiao Road is prominent, and the distribution demand of shops along the street are large (the number of distribution times reaches 10 between 09:00-17:00, see Figure 68). Secondly, Gaomiao Road has one-way traffic, and the width of the east section of the road is 6.5 meters. According to the Specifications for setting of on-street loading/unloading zones on urban roads^[5], on-street loading/unloading zones can therefore only be set up on one side.

In summary, it is necessary to set up dedicated loading/unloading zones for urban logistics vehicles on the east section of Gaomiao Road, and the east section of the road meets the conditions for setting up loading/unloading zones. It is suggested that existing loading/unloading zones

could be used, or new loading/unloading zones could also be allocated on existing roads.

4.3.2.2 Setting of dedicated loading/unloading zones

Dedicated loading/unloading zones have already been set up on the west section of Gaomiao Road, which meet the distribution parking demand. Therefore, this research will study the setting of dedicated loading/unloading zones on the east section of Gaomiao Road.

1) Create a coordinate system

A coordinate system was established based on the relative position of the shops and loading/unloading zones (see Figure 69).

The coordinate values of each store and existing loading/unloading zones are shown in Tables 14 and 15.

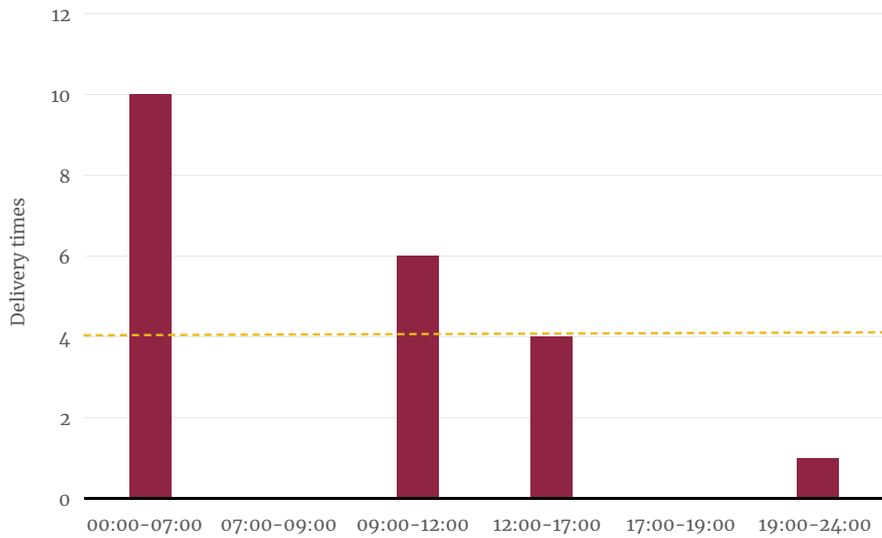
■ Table 14 Coordinate value of shops along the street on the east section of Gaomiao Road

No.	Store Name	Coordinate
1	Shaxian snacks	(2, 16.5)
2	Xuxiangyuan Siu Mei	(6, 16.5)
3	Yukang Pharmaceutical Co., Ltd.	(10, 16.5)
4	Liyuan Farm	(16, 16.5)
5	Pork feet rice	(22, 16.5)
6	Rong Kee Claypot Rice	(26, 16.5)
7	Convenience food	(30, 16.5)
8	Shrimp and Fish Fu	(34, 16.5)
9	Maoxin Pharmacy	(33, 0)
10	Northern Bund	(26, 0)
11	Lanzhou Ramen, China	(38, 16.5)
12	Guanfang Foods	(42, 16.5)
13	Weiwang Shaowei	(46, 16.5)
14	Wallace	(60, 0)
15	Huazhiwu Bread	(54, 0)
16	Li Ge Wantan Noodles	(48, 0)

■ Table 15 Coordinate value of loading/unloading zones in the east section of Gaomiao Road

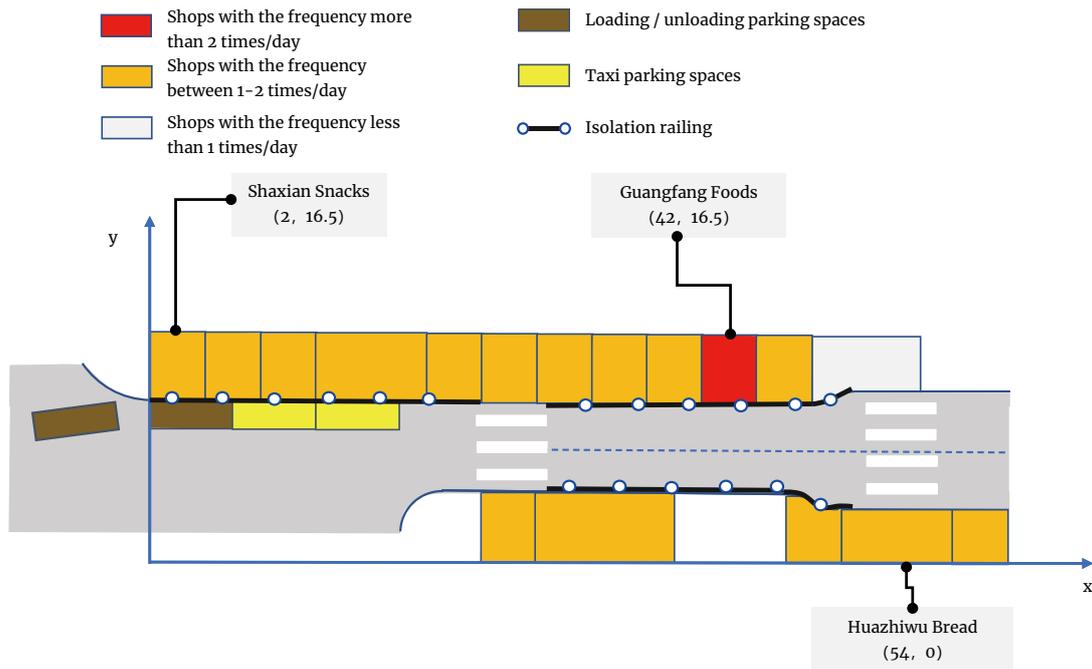
No. of loading/unloading zones	Coordinate
1	(-5, 10)
2	(3, 10.5)
3	(9, 10.5)
4	(15, 10.5)

■ Figure 68 Time distribution of shop delivery needs on the east section of Gaomiao Road



Source: NICTP

■ Figure 69 Coordinate map of shops in the east section of Gaomiao Road



Source: NICTP

2) Road segmentation

The east section of Gaomiao Road is a one-way, two-lane road. If a dedicated loading/unloading zone is set on one side of the road, it can serve the shops on both sides of the road at the same time. In addition, the length of the road section is about 90m, so it is necessary to study it in sections. The east section of Gaomiao Road is divided into two segments based on the reference point of Guangfang Foods and the distribution characteristics of the stores (see Figure 70).

3) Calculation of the number of dedicated loading/unloading zones

According to status quo investigations for this project, the number of distribution times in Segment 1 is 3 times, between 09:00-17:00, which does not reached the threshold for the setting up of dedicated loading/unloading zones. The number of distribution times in Segment 2 is 7 times, between 09:00-17:00, and the distribution parking demand reaches 70 loading/unloading zones per minute. Dedicated loading/unloading zones can therefore be considered for Segment 2 (see Figures 71 and 72).

The number of dedicated loading/unloading zones for a given Segment is determined according to this calculation formula:

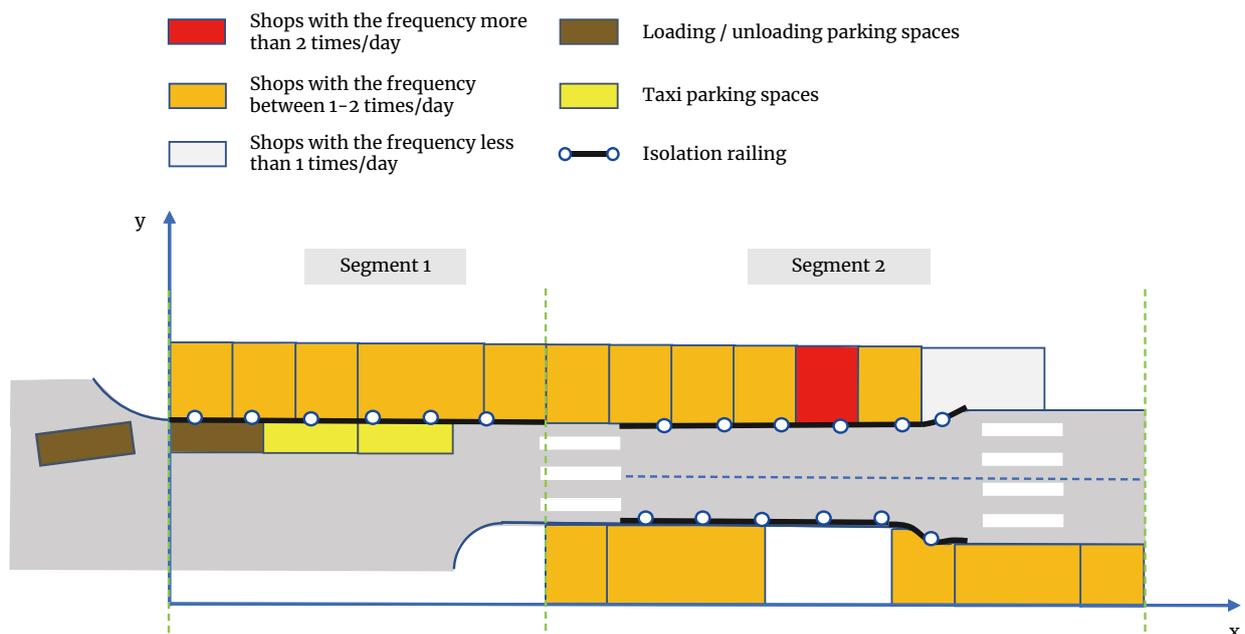
$$X_{add} = \max \left\lceil \frac{D_M^k}{T_k} \right\rceil = \max \left\lceil \frac{37.5}{120} \right\rceil, \left\lceil \frac{32.5}{120} \right\rceil = 1$$

T_k denotes the duration of time allowed to delivery vehicles to use the loading/unloading zones in the period k. To improve the utilisation rate of dedicated loading/unloading zones, this duration should not be longer than needed. The dedicated time needed for zone usage by urban logistics vehicles in the morning and afternoon is two hours respectively. It was therefore calculated that a dedicated loading/unloading zones for urban logistics vehicles should be set in Segment 2.

4.3.2.3 Location selection of dedicated loading/unloading zones

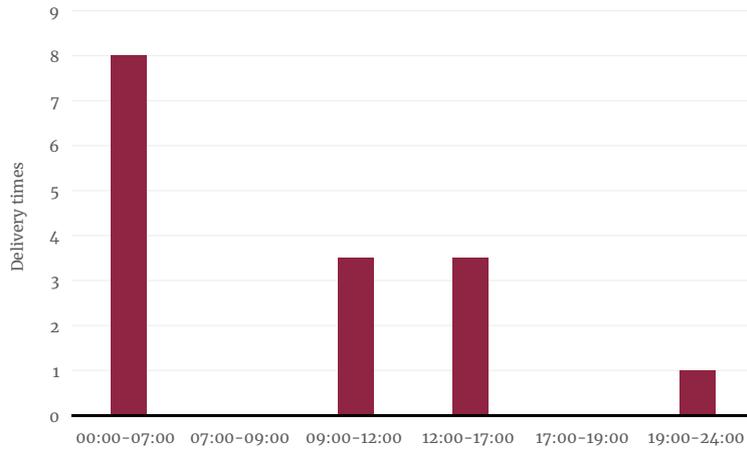
Considering the location selection principles and the isolation fences set up on both sides of the road, this project selected 4 alternative loading/unloading zones, 2 of which are 2m away from the left pavement, and 2 alternative loading/unloading zones are at the end of the transition section on the right (see Table 16 and Figure 73).

■ Figure 70 Section diagram of the east section of Gaomiao Road



Source: NICTP

■ Figure 71 Distribution times of stores along the street in Segment 2



Source: NICTP

■ Figure 72 Distribution parking demand diagram of stores along the street in Segment 2

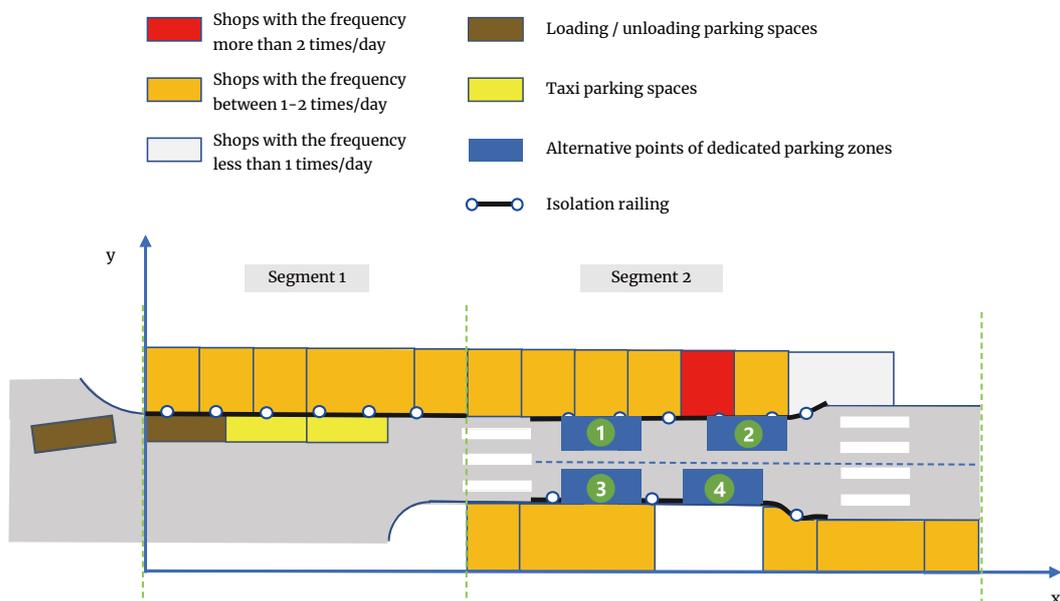
Distribution parking demand/spaces · min	60	0	37.5	32.5	0	5
Time of day	00:00-07:00	07:00-09:00	09:00-12:00	12:00-17:00	17:00-19:00	19:00-24:00

Source: NICTP

■ Table 16 The coordinate value of alternative loading/unloading zones

No.	Coordinate
1	(33.5, 10.25)
2	(45, 10.25)
3	(33.5, 6.25)
4	(43, 6.25)

■ Figure 73 Schematic diagram of the location of the alternative loading/unloading zones



Source: NICTP

According to the location model, the comprehensive cost is minimised on the basis of maximising the proportion of fulfilled distribution parking demands, and the alternative loading/unloading zone Number 4 (seen in Figures 73 and 74) is selected as the best location for the newly designated loading/unloading zone.

4.3.2.4 Management measures

In order to improve the utilisation efficiency of dedicated loading/unloading zones and take into account the distribution characteristics of the stores in this section, 09:00-11:00 and 14:00-16:00 are set as the dedicated times for urban logistics vehicles to access these zones. Logistics vehicles are then not allowed to park in the dedicated loading/unloading zones at other times during the day. A single loading/unloading operation is limited to 15 minutes. At the same time, private cars are prohibited from parking in the zone throughout the day to prevent impacting road traffic.

During the dedicated times for urban logistics vehicles to access the zones, other vehicles occupying these dedicated locations will be required to clear the zone or incur

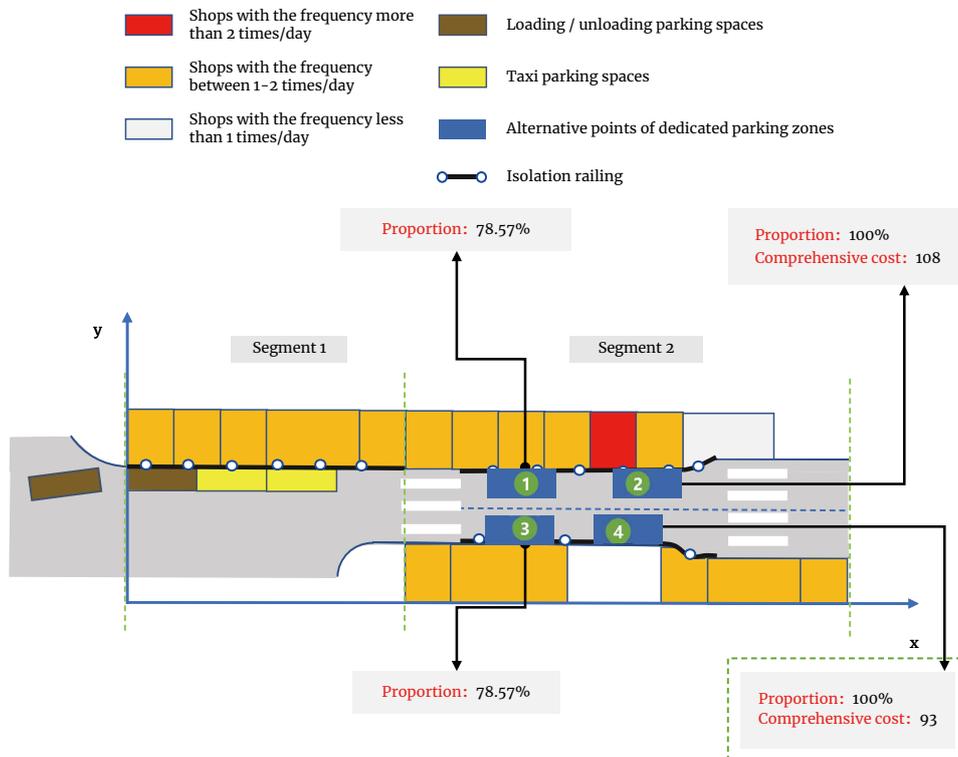
penalties. At the same time, in this area, urban logistics vehicles parked illegally will also be required to clear the area or face penalties.

For stores that are not covered by dedicated loading/unloading zones in Segment 1, it is suggested to change their distribution times to the evening or allow urban logistics vehicles to use nearby taxi loading/unloading zones for a limited time of 15 minutes without penalty (see Figure 75).

4.3.3 Implementation

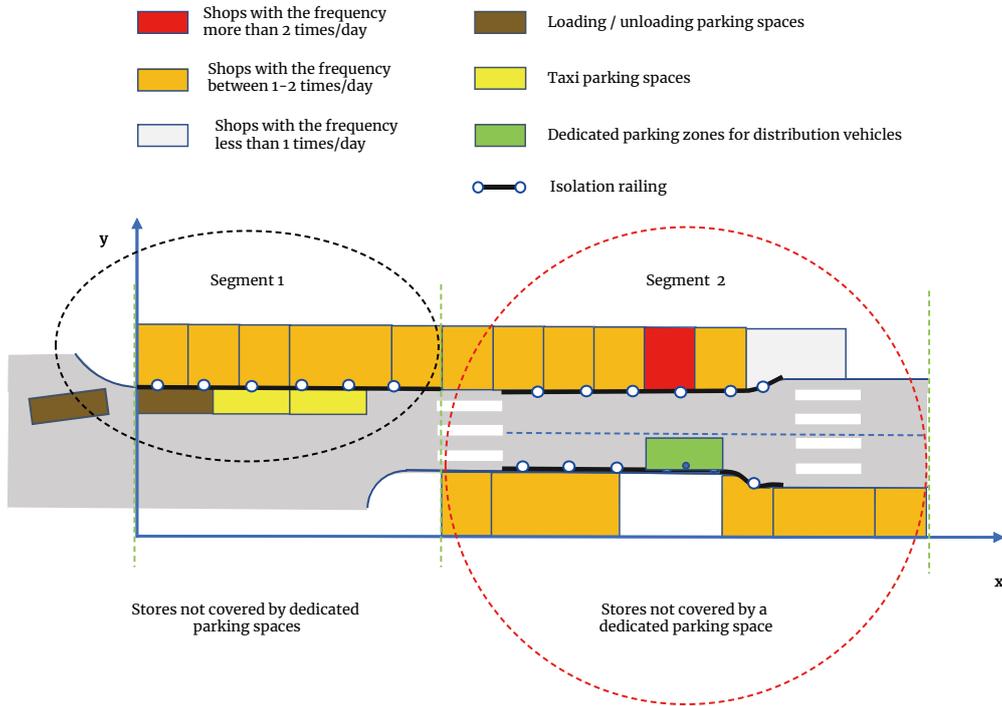
Houlong First Street currently has temporary loading/unloading zones and related signage for logistics vehicles, according to findings of this research (see Figure 76). To make the original temporary loading/unloading zones more efficient, Gaomiao Road has added signs, which stipulate that the period from 10:00 to 11:00 is the special time for logistics vehicles to use these locations, and non-distribution vehicles can stop to use them temporarily, during other time periods (see Figure 77).

■ Figure 74 Schematic diagram of location selection for dedicated loading/unloading zones



Source: NICTP

■ **Figure 75 Schematic diagram of the coverage of each segment of stores by the dedicated loading/unloading zones**



Source: NICTP

■ **Figure 76 Current situation of temporary stop in Houlong First Street**



Source: NICTP

■ **Figure 77 Current situation of temporary stop in Gaomiao Road**



Source: NICTP

4.4 Benefit Evaluation

4.4.1 Implementation effect evaluation

The proposed planning initiatives for the setting and effective usage of loading/unloading zones has been implemented on Houlong 1st Street and Gaomiao Road. The project team has carried out a post-implementation effect evaluation of the project through on-site surveys, interviews, and investigations.

(1) Interviews and investigations

The subjects of this survey and interview were shop operators and NELV drivers along Houlong 1st Street and Gaomiao Road. Through the survey of store operators along the street, it was found that 82% of the operators were satisfied with the provision of temporary loading/unloading zones for freight distribution, of which 37% were very satisfied. The operators of stores with a strong demand for freight distribution, such as supermarkets and fresh food stores, expressed the need to up-scale temporary loading/unloading zones for freight distribution and extend the dedicated distribution times, while the operators of stores with small distribution needs, such as print shops and clothing stores, had no immediate demand to up-scale the temporary zones.

Through the interview to NELV drivers, respondents generally reported that the previous freight distribution system had difficulties in parking. Under the new system, more than 90% of drivers were satisfied with the provision of dedicated loading/unloading zones for freight distribution, however 60% of drivers still expressed the need to further up-scale dedicated loading/unloading zones, and 80% of drivers said that the management of dedicated loading/unloading zones for freight distribution needed to be strengthened, and private cars should be prohibited from occupying dedicated loading/unloading zones.

(2) Achievements

- The research plan was implemented on Houlong 1st Street and Gaomiao Road and was highly affirmed by store operators along the street and drivers of freight

delivery vehicles, who expressed satisfaction with the provision of dedicated loading/unloading zones for urban logistics vehicles.

- The parking order of NELVs has been standardized, with overall loading and unloading efficiency being improved, and the phenomenon of parking in motor vehicle lanes and non-motor vehicle lanes has been reduced.
- Store operators along the street and drivers of logistics vehicles put forward good suggestions on the scale, specific locations, time limit requirements and management methods of dedicated loading/unloading zones for urban logistics vehicles, and the public participation in the project and its follow up was high.

(3) Problems

- Proper management of dedicated loading/unloading zones is still lacking. The loading/unloading zones continue to be temporarily occupied by social vehicles during the dedicated parking time that they should be used by NELVs. Unfortunately, parking administrators have no current right to punish these illegally parked vehicles.
- Publicity on how to use the zones needs to be strengthened. Some drivers of logistics vehicles do not understand the setting and usage of dedicated loading/unloading zones for urban logistics vehicles, and as a result, there is a continued phenomenon of random parking practices.

4.4.2 Evaluation and Prospects

This project focused on the needs and contexts of important road sections in typical areas of Chancheng District, and carried out a pilot application of temporary loading/unloading zones for NELVs. This section of the report evaluates the carbon reduction and socio-economic benefits of the pilot application, and analyses the common problems found during the pilot phase.

Under the “dual-carbon” strategic goal, this project first proposes an evaluation of the benefits of carbon reduction. Replacing conventional logistics vehicles with NELVs can reduce carbon emissions. The conversion of conventional

logistics vehicles to NELVs also reduces vehicle fuel consumption, resulting in carbon reduction benefits. Therefore, the carbon reduction benefit evaluation indicators proposed in this project were the contribution rate on NELV promotion and fuel consumption reduction.

In addition, the provision of dedicated loading/unloading zones for urban NELVs must meet certain socio-economic benefits, which are mainly reflected in their impact on fuel cost, the level of road traffic service, parking convenience, and road safety. Therefore, the socio-economic benefit evaluation indicators proposed in this project were

fuel cost reduction, the level of road traffic service, the convenience of loading/unloading processes and the safety of traffic operations (see Table 17).

Taking into account the comprehensiveness and complexity of an evaluation of carbon reduction and socio-economic benefits, this project only proposes the content involved in the evaluation of carbon reduction and socio-economic benefits. Specific evaluation content and evaluation methods which could be used for further studies can be further expanded in future research.

■ **Table 17 Benefit evaluation index**

Content	Indicator	Explanation
Carbon reduction benefits	Contribution rate of NELV promotion	<ul style="list-style-type: none"> Assess the influence on the ownership growth of NELVs after setting up dedicated loading/unloading zones for urban logistics vehicles.
	Fuel consumption reduction	<ul style="list-style-type: none"> The conversion of conventional logistics vehicles to NELVs reduces vehicle fuel consumption, resulting in carbon reduction benefits.
Socio-economic benefits	Fuel cost reduction	<ul style="list-style-type: none"> Assess the reduction in fuel consumption after conventional logistics vehicles are converted to NELVs. The transformation of conventional logistics vehicles to NELVs means that the consumption of gasoline and diesel is changed to electricity consumption, which also contributes to CO₂ reduction.
	Level of road traffic service	<ul style="list-style-type: none"> Assess the reduction in road congestions (number of vehicle stops, duration of idling) after setting up dedicated loading/unloading zones for urban logistics vehicles as road congestion alleviation contributes to CO₂ reduction.
	Convenience of loading / unloading	<ul style="list-style-type: none"> Assess the improvements in the convenience of loading/unloading operation after setting up dedicated loading/unloading zones for urban logistics vehicles.
	Safety of traffic operation	<ul style="list-style-type: none"> The setting of dedicated loading/unloading zones for urban logistics vehicles and the supporting policies and facilities will regulate the parking behaviour of urban logistics vehicles, and thereby improve road traffic safety.



5 Suggestions on Policies and Measures



Based on the research methods and findings outlined in this report, this section contains a consideration of, and suggestions for, executable policies and measures to promote the relevant departments of freight distribution and stakeholders to further improve the implementation and application of methods to set up temporary loading/unloading zones for NELVs. Policy and measure recommendations are mainly considered from the aspects of departmental coordination, planning guidance and public participation.

Suggestions 1: Departmental coordination

It is suggested that the competent transportation departments, in conjunction with traffic management departments, city management departments, and representatives of individual streets and communities, set up a working group for the setting of dedicated loading/unloading zones for urban logistics vehicles, and jointly promote the planning and implementation of dedicated loading/unloading zones, plans for their supervision and law enforcement, dynamic evaluations, feedback and other related work.

- **Bureau of Transportation:** Will take the lead in the setting of dedicated loading/unloading zones and be specifically responsible for the planning and implementation of dedicated loading/unloading zones, and their dynamic assessment.
- **Traffic Management Bureau:** Responsible for the traffic and parking management of urban logistics vehicles, the strengthening of law enforcement management, and the investigation and punishment of social vehicles that occupy dedicated loading/unloading zones and urban logistics vehicles that do not park in accordance with regulations.
- **Urban Management and Law Enforcement:** Responsible for the management of shops along the street, the investigation and punishment of the shops that occupy the road space not according to law and working with the transportation department and the traffic management department to do a good job in supporting the planning of dedicated loading/unloading zones and parking management systems.
- **Communities and streets:** Cooperate with relevant departments to do a good job in the investigation and research of dedicated loading/unloading zone planning, to collect feedback, opinions and suggestions on the distribution of stores along the street and do a good job in the communication and coordination of related zone setting and management.

Suggestions 2: Planning guidance

Cities should pay attention to research on relevant planning and specifications when setting up temporary loading/unloading zones for NELVs, and better ensure the scientific foundations for, and effectiveness of, the setting schemes under the support and guidance of relevant planning, specifications and standards models and authorities.

- It is recommended that the municipal transportation department carry out Research on special planning of urban green freight distribution, coordinate the green freight distribution infrastructure, convenient traffic policies, distribution organization modes, and promote advanced transportation tools, and related infrastructure and methods, and also promote the transformation of urban freight distribution to green freight distribution.
- It is suggested that all districts, towns, and streets, in light of their own development demands, carry out Research on the setting of dedicated loading/unloading zones for urban logistics vehicles, and scientifically guide the setting of dedicated loading/unloading zones for urban logistics vehicles in their areas.
- It is recommended that relevant departments promote the formulation of local or industry standards for the setting of dedicated loading/unloading zones for urban logistics vehicles.

Suggestions 3: Public participation

The most direct beneficiaries of the setting of dedicated loading/unloading zones are the users of the zones. It is recommended to strengthen corresponding publicity and guidance work after the dedicated loading/unloading zones are set up to promote public participation.

- It is recommended to carry out green freight distribution publicity work through multiple channels, and encourage enterprises to adopt advanced distribution organization modes such as centralized distribution, night distribution, and joint distribution methods.
- Encourage the use of NELVs to carry out distribution work, improve loading/unloading tools needed for their service, and improve related loading/unloading conveniences.
- It is recommended to consider the community as a unit to strengthen targeted public awareness campaigns on the use and setting of zones for the shops along the street in different sections, to coordinate the joint delivery or unified delivery times for the merchants along the street, to improve the utilization efficiency of dedicated loading/unloading zones, and therefore reduce the impact deliveries have on road traffic.

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