



GEF City Cluster Eco-Transport Project

**ET/CP6 Brief Report : Key Planning Techniques Study on the Bus
Network and Facilities Optimization in Metropolitan Area
(Final report)**

Client: Ministry of Transport of the People's Republic of China

Project undertaking organization: Shenzhen Urban Transport Planning & Design
Institute Co., Ltd. (Leading firm)

Jinan Urban Transportation Research Center
(Member)

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GEF City Cluster Eco-Transport Project (P121263)

ET/CP6 General Report

**Key Planning Techniques Study on the Bus
Network and Facilities Optimization in
Metropolitan Area**

The brief report

**Shenzhen Urban Transport Planning & Design Institute Co.,
Ltd.**

**Jinan Urban Transportation Research Center
June 2016**

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Research Background

Under the support of GEF, Ministry of Transport, P. R. China, Transportation Services Division and Comprehensive Planning Division, set up a “City Cluster Eco-Transport Project” contract package 6 “Key Planning Techniques Study on the Bus network and facilities Optimization in Metropolitan Area” in October 2015.

This project includes three case studies: “Urban bus line network setup and adjustments regulations”, “Urban bus passenger station facilities function requirements”, and “Urban bus station construction standards and design guidance”. Under the Metropolitan Background, the establishment of this subject embody the public transportation priority, aims to the bus industry develop work of preliminary standardization and related technical reserves in the three thematic studies.

After Expert Consultation in Jinan on 9 January 2016 and Inception Accreditation Council on 26 January 2016, the scope of the study is based on a clear definition of metropolitan, urban public transport as the main part. Three key tasks correspond with the object of study, as follows:

- Task 1: Urban regular bus network setup and adjustment rules study

City regular public transport network as the main part, to carry out research work in terms of line network hierarchy, technical specifications, layout method, adjustment mechanism and fare, taking into account the route network demands under the metropolitan trip features.

- Task 2: Urban bus spot facilities function study

In accordance with national standard, “the Classification and City Division of City Public Transport Stations”, combined with local cities and practical works. Urban passenger bus station generally include hubs, terminus, bus spots etc. For the general bus station facilities function of independent area, domestic regulations refer to “Code for design of urban road public transportation stop, terminus and depot

engineering”(CJJ/T15-2011).Task 3 of this study "Urban bus station construction standards and design guidance study", and the designing of non-independent area supporting stations as the research focus.For these reasons, the experts determined in Inception Accreditation Council, task 2 study focus on the bus spot facilities Function.

■ Task 3: Urban bus station planning standards and design guidance study

According to the mission statement requirements, combined with the views of the experts assessed in Inception Accreditation Council, the task 3 focuses on urban bus station (terminus, hubs, parking lots and maintenance sites) planning standards and with the construction type of urban bus station (terminus, hubs, parking lots) design guidelines.

Section 1: Urban Bus Line Network Setup and Adjustment Rules Study

1 Contents

Based on the metropolitan transport development environment, this subject will research predominantly urban bus development demand. Through research, combing and refining, forming a bus route network with setting principles, requirements and quantifiable index system. Which can proposed the optimization of organizational structure and working mechanism, and provide technical reserves and accumulation for government industry management, provide technical support for the development of standards. The main contents are as follows:

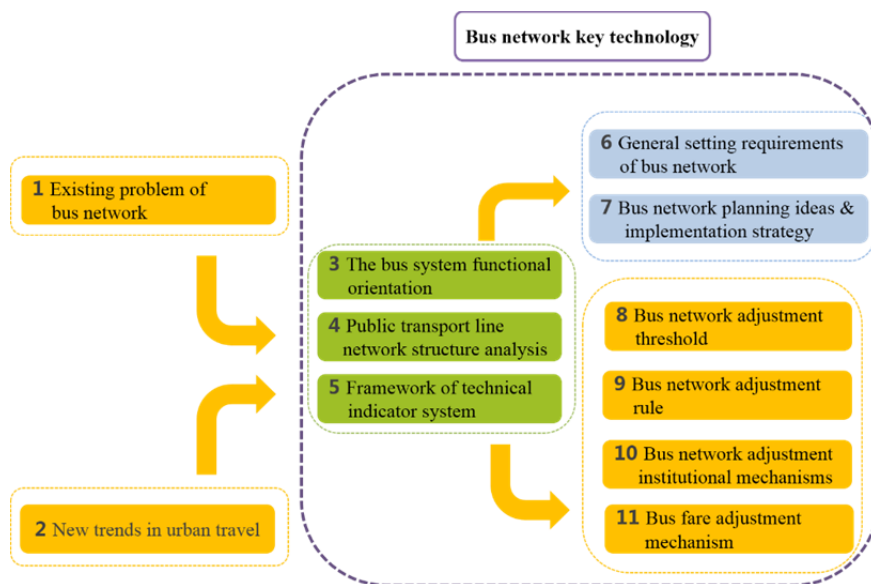


Figure1-1 The contents of study mainly

2 Research basis

- Urban Transportation Planning Guide Public (2012)
- GBT22484 “City Bus(trolleybus) Passenger Services (2008)”
- Jiangsu Province Urban Public Transport Planning Guide (2014)
- Jiangsu Province Urban Bus Route Network Optimization Guide (2012)
- Suzhou Bus Route Network Optimization Technical Guidelines (2015)
- DB11/T-648 “Beijing Bus(trolleybus) Passenger Services Specification
- Hangzhou Bus Route Network Optimization Technical Standard (2015)
- Shanghai Bus(trolleybus) Passenger Services Specification (2009)
- Shanghai Public Bus(trolleybus) route optimization guidelines
- Shenzhen Urban Planning Standards and Guidelines (2014)
- Shenzhen Bus Service Specification (2013)
- Shenzhen Bus Line Planning Standards and Implementation Guidelines
- "Shenzhen Bus Route Network Functions be Divided into Three Levels and Norms be Setted " (Trial)
- Qingdao Bus Route Network Planning Standards and Implementation of Conditions (draft)
- Wuhan Bus Route Network optimization and adjustment of the planning and implementation of program (2015-2020)

3 The functional orientation about bus

During the construction of rail transit and bus route network, the change process of their functions, mainly into three phases:

- The first stage (no rail transit and rail transit network has not been formed):

Rail transit construction in the initial stage, but not yet formed rail network. Regular buses still plays the main role in public transportation. At this stage, mainly reflected in some large cities, representative cities such as Chongqing, Chengdu, Wuhan.

- The second phase (rail transit into net basically, but the capacity and demand do not match):

Rail taking shape, substantially network operation, but compared with the level of development of foreign rail transit system, domestic rail transit affected by such factors as standard, capacity is still difficult to meet the actual demand. Therefore, regular bus assumed triple role, include the bus and rail transit convergence feeding, shunt tension capacity of the rail traffic passenger along, and uncovered rail trip area.

Therefore, at this stage, the basic formation of public transportation system is the rail transit as the backbone and the regular bus as the brace, which play an important role together. The main representative cities such as Beijing, Shanghai.

- The third phase (rail network ,capacity is match with demand):

Rail transit construction into a network, rail capacity is matched with demand. Long-distance trip assumed by the rail transport gradually, the functions of regular bus service will gradually transfer to the short-distance trip. With the continuing optimization of the public transport system, rail transit gradually occupy the dominant position in urban passenger trip, buses mainly play a supporting and complementary role. Major cities such as Tokyo Metropolitan representative.

4 Bus network structure

Conventional bus is an important role in the public transport system. Experience of international cities shows that it is necessary to build a bus line network with clear structure, functions and tiers to satisfy the transportation demands of different groups with different distance and function requirements, and to improve the overall operational efficiency.

It is proposed that urban bus lines be divided into the following 5 classes in accordance with their position and role in the line network and their ability to serve the areas along with way:

- **Class 1: Express lines;**

With long line lengths and stop distances, these lines are designed to provide rapid transportation service for urban communities located in the same or different districts. As the backbone of the bus line network, they have a number of distinct identities, including long line length, smaller stop numbers, faster speed and direct access.

- **Class 2: Trunk lines;**

These lines are intended to provide long/medium-distance services for communities located in the same or different districts, as well as distribution services along key passenger corridors, and trunk roads. Such lines generally have high passenger volumes, and direct access to destinations.

- **Class 3: Branch lines;**

These lines are designed primarily to provide short-distance transportation service for communities. In addition, they also provide passenger distribution service for secondary roads and branch roads in the city, as well as transfer and feeding service for Rail, BRT and trunk lines. Such lines generally have shorter stop distances and and less direct access to destinations.

- **Class 4: Micro (micro-circular) lines;**

These lines are intended to provide transportation service within small areas, including communities and plants. They generally have shorter stop distance, more stops, and flexible operation models. They mainly make up the contradiction between travel demand and the road network conditions, and darn bus network blank area.

■ **Class 5: Diversified lines (Tourist lines, student lines, night lines, custom bus, bus of Internet,etc).**

These are lines operated during special hours, or to meet special transportation demands, usually with special operation models, e.g., special line, tourist line, student line, and night line.

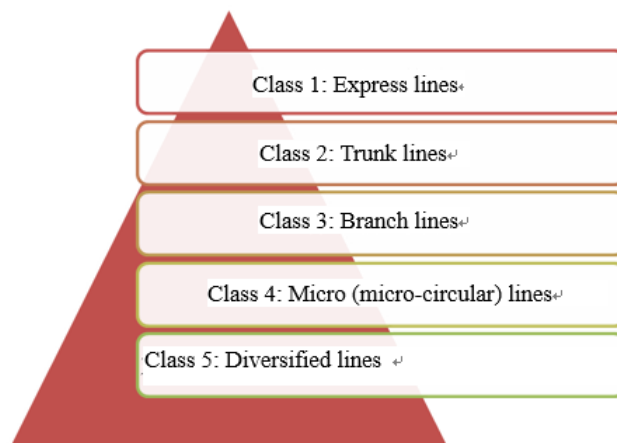


Figure 4-1 5-type Line Network Structure

Bus line networks shall be set up in accordance with the **size, spatial structure, road grade and public transport development status** of specific cities to meet the following requirements:

- a) Super/ultra large cities may maintain a bus line network consisting of all 5 classes, i.e., BRT, trunk, branch, micro and diversified lines;
- b) Large cities may maintain a bus line network consisting of all 5 classes, i.e., BRT, trunk, branch, micro and diversified lines; or one that contains 4 classes, i.e., trunk, branch, micro and diversified lines;
- c) Medium/small cities may maintain a bus line network consisting of 3 classes, i.e., trunk, branch and diversified lines; or one that contains 2 classes, i.e., trunk and branch lines.

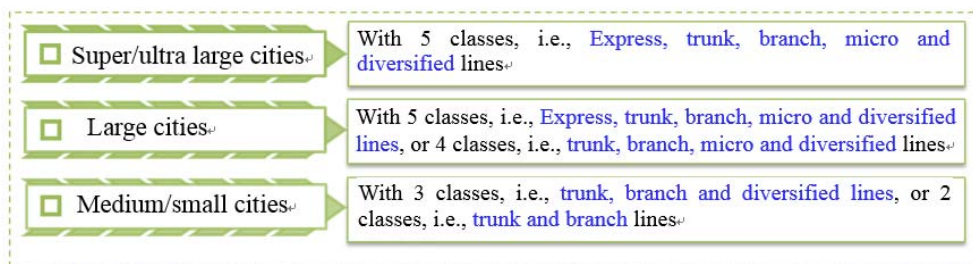


Figure 4-2 Proposal for Bus Line Network Structures of Different Types of Cities

5 Technical Indicator System of Bus network

5.1 Technical Indicator Architecture

The following is a framework of technical indicator system for bus line networks of class I (Beijing, Shanghai and Shenzhen) and class II (Suzhou, Wuhan and Jinan) cities. In general, the bus line networks of these cities include lines of several classes: express, trunk, branch and micro lines. Technical indicators for the line networks include line feature indicators, operational feature indicators, and line-network relationship indicators.

- line features indicators including line length, stop distance, number of stops, non-linear coefficient, extent of overlapping and underlying road;
- operational feature indicators include operation hours, operating speed, peak hour load, peak hour departure frequency, transfer coefficient and transfer distance;
- Line-network relationship indicators include relationship with conventional bus, and rail transport.

5.2 Index System Recommendation

Line network at all levels should be distinguished with key technical and economic indicators. Based on their own characteristics and passenger demand, Cities should have reasonable selection and layout for bus network on local conditions. Key technical and economic indicators values recommended of different functional levels of bus network are as shown in the table below.

Table 5-1 Table key technical and economic indicators recommended values for different functional levels route network

	Index Name	express route	main route	branch route	micro-circulation route	Diversified route
Route pattern	Functional orientation	Mainly serve the long-distance services between the clustered cities and cross-district travel, connecting the city's major clusters, cities function points and major transport nodes, realizing the quick connection between the city's major clusters, large passenger distribution points and large hubs.	Mainly serve the travel within district, long-distance cross-district travel, assume the complementary role in medium-distance clustered cities travel, to achieve the connection between cross-district, major distribution points within the district, and large hubs.	Mainly serve the medium-long distance travel between districts and the rim of clustered cities, or area with sparse public bus and trolleybus network coverage, fill up for blind spots of bus service, increase route network coverage, and assume the role of connecting with feeder express route and main route.	Mainly serve the regional travel within smaller range, can be used as feeder line with the rail station, district bus operation mode, the route is shorter and flexible in operation	Mainly serve some special time and purpose bus travel demand, adopt some of the more special way in the operating mode
	route length (km)	15~30 (or over 30)	12~20	8~15	3~8	Not required
	The average station	1~2	0.5~0.8	0.3~0.5	Not required	Not required

	Stops	Stop at large hub station, transfer station and passenger distribution point	Stop at all stops or main passenger distribution point	Stop at all stops	Not required	Not required
	underlying road	Mainly in the high-speed road, the road, the main road	The main city in the main roads and secondary roads running	In the main city roads and branch operation	The main operation in the area, or the Street Road Branch	Do not require
Operation mode	Operation time	The service time is connected with the railway and other transportation means.	No later than 6 pm, not earlier than 23, and commuting and living in long distance travel demand.	Appropriate to extend based on Business Hours Express	According to the demand of passenger flow	According to the demand of passenger flow
	Average Passenger Volume per	>2	1-2	0.3-1	<0.3	According to the demand of passenger flow

	Departing interval (min)	3-10	5-15	According to the passenger flow and models to determine	According to the passenger flow and models to determine	According to the passenger flow and models to determine
	Average operating speed (km/h)	≥ 18	15-20	Determined according to the vehicle mode and road	Determined according to the vehicle mode and road	Not required
	Operation vehicle type selection	Extra-large, large vehicle	Extra-large, large vehicle	Medium-size vehicle	Small-size vehicle	Not required
Network relation	Relationship with conventional public transport	The repetition rate of the road with other routes is not higher than 75%;	The repetition rate should not be higher than 75% in the way of the other lines;	The repetition rate should not be higher than 75% on the other routes;	According to the passenger flow and models to determine	Do not require

	Relationship with rail transit	And the principle of repeating the site should be less than 9 (except for the emergency line).	And the principle of repeating the site should be less than 9 (except for the emergency line).	And the principle of repeating the site should be less than 9 (except for the emergency line);	According to the passenger flow and models to determine	Do not require
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6 Bus Network Layout

6.1 Bus Network Layout Principles

The bus network layout should be taken into consideration the history and culture, urban planning, land use, travel demand, road conditions and other factors. Overall, bus network layout should mainly adhere to the following principles:

- **Consider the Urban differences:** route network settings should be in accordance to different cities size, status, stages of development and other differences, design according to local conditions.
- **Due consideration of the history and current situation:** retain the reasonable existing routes, and take due consideration of original route's connectivity of the regions it passes and travel habits of passengers.
- **Meet the needs of city development:** bus route network should try to adapt to urban development and redevelopment, particularly the needs of bus service in new regional.
- **Ensure the coordination of the route network structure and urban development status:** the route network should be in accordance with land-use patterns of different properties, strength and modes, promote the smooth implementation of the urban planning, on the other hand, while meeting the basic needs of public transport travel, taking full account of the counter effect that the route network plan has on urban land use to guide urban development;
- **Try to meet the needs of passengers.** Bus route plan should make alignments that are consistent with mainstream, prioritizes the route layout of the road sections with large passenger flow, so that there are conventional bus routes connections or direct bus routes between major passenger distribution points to reduce transfer times of travel.
- **Take full advantage of road conditions, balance distribution of passenger flow in support of road construction:** on the one hand, the route alignments should be consistent with the main passenger flow direction; on the other hand, it should ensure appropriate route network density, making even distribution of routes within the area, reducing bus blind spots, realize good accessibility.

- **Perfect connection:** improve the connection between the various modes of public transport and connection between public transport systems with the other passenger transport system.

6.2 Bus Network Layout Factors

The key factors affecting route network layout are proposed:

- Urban layout and Land use analysis: determined the residents travel demand and travel direction;
- Hub and bus terminal station layout analysis: determined the route network structure and morphology;
- Road network: determined the route network coefficient, coverage and efficiency;
- Service: determined the attractiveness and optimization of bus system is success or not;
- Operational efficiency: determined the sustainable development of bus system.

6.3 Bus Network Layout Method

6.3.1 The change of bus network planning ideas

The new situations of the development of Metropolitan have put forward new requirements for bus network planning. We should break the traditional working mode, which focus only on network or relying mainly on model technology. To strengthen the collaborative relationships between “the road authorization, bus stop, hub” and “bus route network”, implement integrated collaborative optimization for bus route network, build in "hub as the core, division and classification" bus network and service system. Mainly aspects as follows:

(1) Transition of traditional route planning to Hubs planning

Bus transfer hub is the core of the organization bus network, is the basis of promoting the rational distribution of traffic and ensuring the efficiency of public transport. Based on planning ideas of hub transfer are gradually replacing the traditional method of planning directly. The idea will be more conducive to realize the synergies of hub and bus network, can effectively promote the habit of passengers’

traveling transit from use the line to use the bus network. Under the circumstances of certain capacity to achieve more efficient transport services.

- **The traditional route planning:** Bus routes mainly around channel organization, pursuit route laying directly, and arrange the lines along the main traffic corridors interwoven repeated. In this structure, on the one hand, passenger trip dependent on direct lines, and transfer willingness is difficult to produce, the complementary relationship is difficult to form between lines; on the other hand, the line laid pursuit of "a line pluripotent", acts as both backbone and offshoot, causing the system presents extensive, inefficient patterns of development.
- **Based on transfer hub planning:** The bus route network based on hub organization, so that the hub with good spatial accessibility, which effectively attract passengers in collection, conversion. Forming a passenger conversion behavior, and further promote the complementarity between the lines, and out the best. Strengthen the function of line integration organization relationship and the line-level clarity, further improving the transfer conditions and enriching the choice of services, enhancing the hub attraction to passengers, and distribution capabilities, thus consolidating the integration and intensive network form.

(2) The change of passenger flow service model

Passenger flow service mode changes from serves solely all passengers flow to serve the specific passengers flow. Namely, all lines serve all passenger flow turn to express Lines serve long distance passenger flow, trunk lines serve middle-long distance passenger flow, Branch routes serve short distance passenger flow.

- **Serves solely all passengers flow model:** represents as the homogenization of all types of operational line service indicators. There is only a distinction in length, no transport characteristics or transport standard, the operating characteristics and passengers flow service object are the same in actual operation. In the background of the increasingly civilian-oriented of car-using threshold, the simplified bus service product can hardly maintain the overall attractiveness and competitiveness of public transport
- **Serves respectively specific passenger flow model:** represents that the different levels lines provide differentiated, personalized public transport services, express, trunk and branch routes sever separately long, middle and

short distance passengers flow. Individuation and differentiation is the main trend of current residents' travel demand.

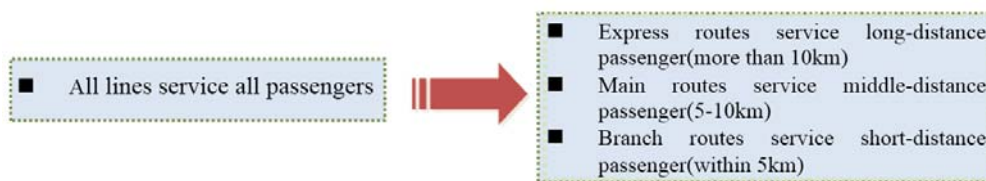


Figure 6-1 The change of passenger flow service model of Public transportation network planning in Metropolitan Area

(3) The change of public transportation network organization morphology

The public transportation network organization morphology changes from mixed-function to hybrid hierarchical and combining point and surface. It achieves the transfer from simply using the line to using convenient and efficient transfer station for the passengers.

- **Functional hybrid network model:** represents that public transportation network presents the characteristics of single, flat, extensive, low efficiency, the function of each component is mixed, operators are always excessively pursuit the efficiency of one single line, while ignoring the efficiency of the entire network operations. This model is becoming more and more uncomfortable to the development requirements of the future and the future.
- **Functional subdivision network model:** represents that each part of the network has Clear function, reasonable division, transfer hub provides efficient transfer system, different level network serves different customer groups to achieve the maximum efficiency of public transportation network working. This model has become the trend of future development.

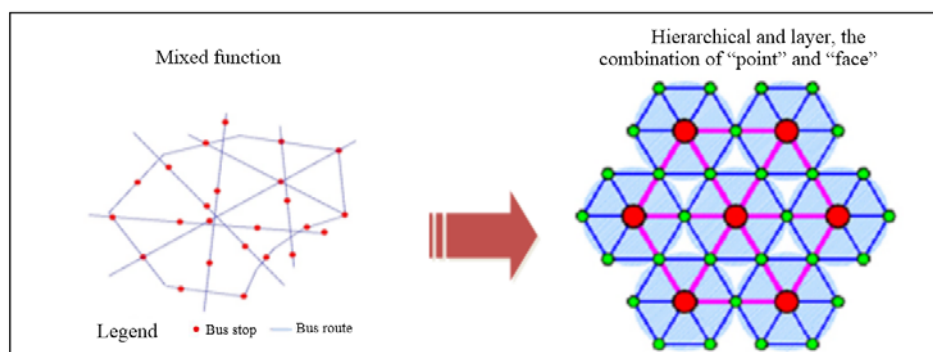


Figure 6-2 The change of public transportation network organization morphology of Public

transportation network planning in Metropolitan Area

(4) The change of the transport capacity resources distribution morphology

The distribution morphology for transport capacity resources changes from the decentralized and unbalanced model to the balanced development model.

- **The decentralized and unbalanced model:** the difference of transit resource distribution is significantly greater than the difference of regional traffic demand, transit resource are often excessive concentration on urban core areas and arterial roads, but other areas and roads was less distributed.
- **Balanced Development Model:** the urban regional development differences determine the different levels of public transport network development, in a reasonable state, differences in the distribution of transportation resources should be roughly the same with traffic demand development gap.

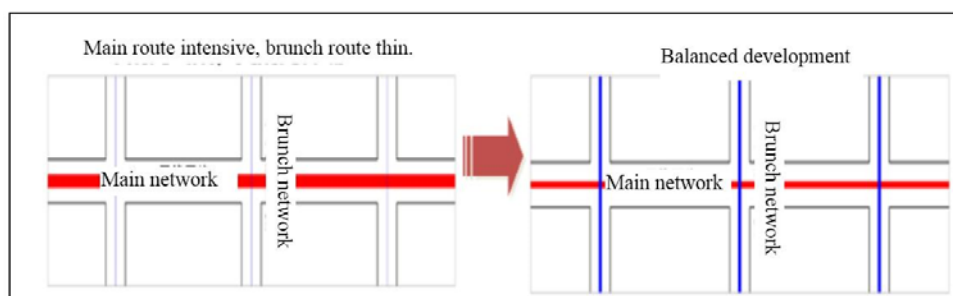


Figure 6-3 The change of the transport capacity resources distribution morphology of Public transportation network planning in Metropolitan Area

(5) The change of the delivery speed model

The delivery speed model changes from single speed to speed classification, on the basis of public traffic network with partitioned, layered, graded, with the station express and short distance, Strength Coverage model, to achieve that the delivery speed model changes from single speed to speed classification.

- **Single transport speed model:** represents that different levels bus speed has no significant difference, the speed of long distance line is lower than short distance line, which is unable to meet the more efficient demand for long distance passengers.

- Transport speed classification model:** For individual, long distance travelers want to travel more quickly, High income people need comfort and privacy travel environment. Work Commuting Trips are much more sensitive to travel time, short distance travelers always hope as much as possible to avoid trouble.

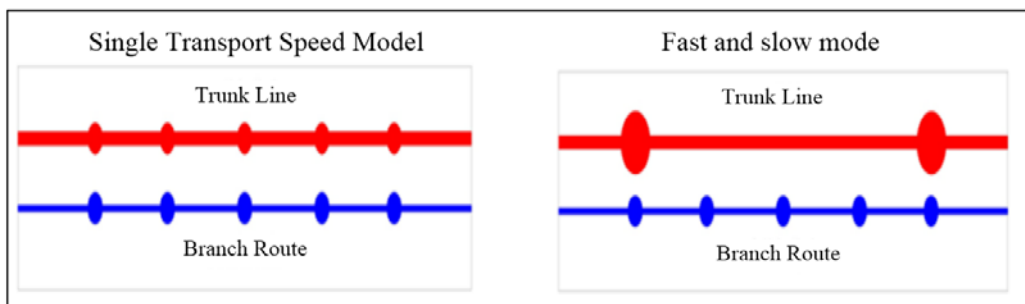


Figure 6-4 The change of the delivery speed model of Public transportation network planning in Metropolitan Area

6.3.2 Bus route network planning layout method

6.3.2.1 Bus network planning mode with classified levels and areas

In order to establish the public transport service that is suitable for travel needs of residents, establish public transport network that is suitable for the urban development characteristics, by drawing on the experience of domestic and foreign cities, this plan proposes a hierarchical network planning model with classified levels and areas; the planning concept is as below.

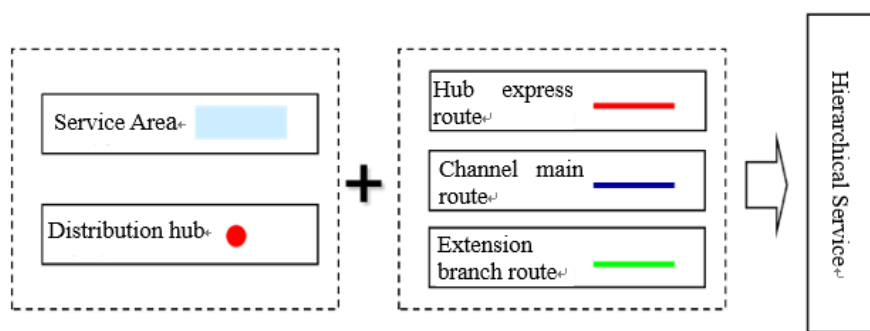


Figure 6-5 Classified areas-levels planning concept diagram

(1) Transit hub determination

According to the overall urban planning and other basic data, establish bus service areas, forecast bus passenger corridor and large passenger OD demand. Based

on bus demand, around bus service area and traffic distribution center to determine the transit hub.

(2) Construction of express route and main route

Based hub as the core, lay express route with feature of "point transport" and provide long-distance and fast service for bus service areas; lay the "station express" route cover corridor, to achieve the fast services for passengers to corridor distribution.

(3) Branch route network layout

Based on bus service areas analysis "face", in order to ensure the overall service level of all bus service areas as the purpose, construct short distance and wide coverage of the branch route network. Eventually, it's formed the combination of "point" and "face", and structured city public transport network.

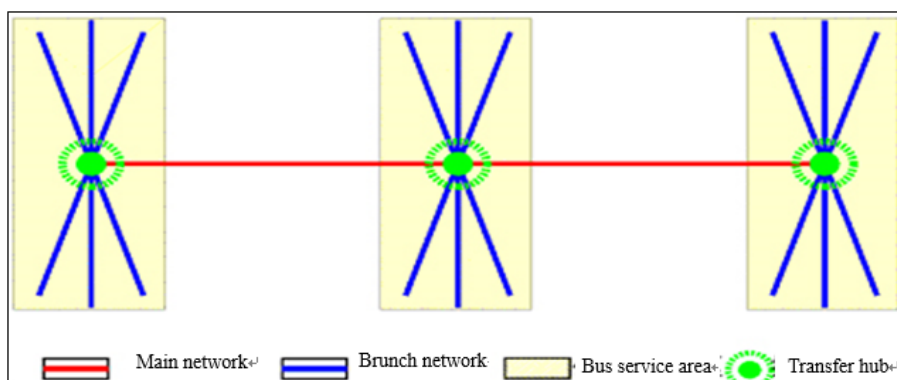


Figure 6-6 Combination of "point" and "face" in public transport network diagram

6.3.2.2 Bus transfer hub planning

Public transportation hub is an important urban infrastructure, public transport hub planning is also an important part of urban public transport planning. It determine the coordination of the public transport system. The hub planning should matches with public transport scale of urban, and coordinate urban land use.

For the public transportation network, the bus transfer hub is the core of bus route network, is the basis of promoting the rational distribution of passenger volumes and ensuring effectiveness and efficiency of public transport, play the role of public transport network riveting point. The basic principles of planning can be summarized as follows:

- Closely with the existing large passenger distribution point;

- With urban developments, identify potential large passenger distribution point, hub planning should be included consideration;
- For the skeleton of bus route network plays a central role in the organization of passenger distribution point, should be included in hub planning consideration.

Transfer hubs hierarchy as follows:

According to the importance for the route network, this plan will divide the transfer hub into two levels: municipal transfer hubs and regional transfer hub. Bus transfer hub and passenger distribution point (center) differences are as follows:

Municipal transfer hub: mainly serve the city's large-scale passenger flow occurrence and gathering source; it is the organization points for the construction of the city's bus backbone network, especially the express route network.

Regional transfer hubs: mainly serve the regional passenger flow occurrence and gathering source; provide a connection platform for express route, main route and branch route network.

Passenger distribution point: to serve the small-scale distribution of passenger flow and part of the transfer passenger flow, organization points for the construction of bus service area of all sub-regions.

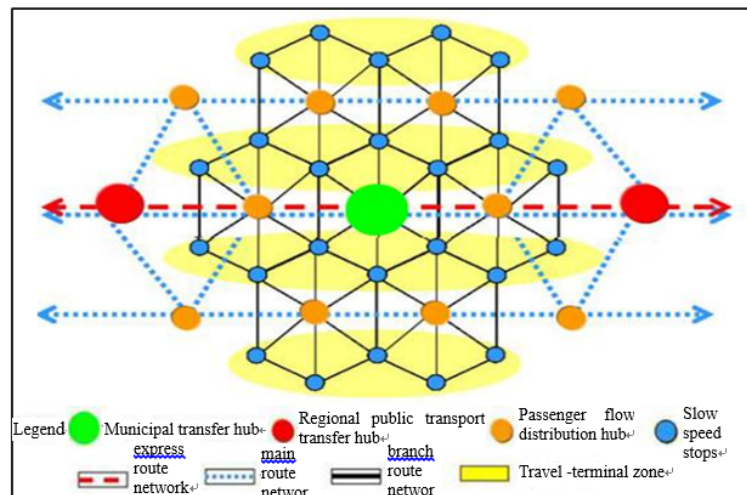


图 6-7 Public transit transfer hub hierarchy diagram

6.3.2.3 Route levels layout-related factors

➤ Express route layout-related factors

In the layout of express route, we cannot simply connect important nodes, it's necessary to also consider the following relevant factors:

- a) While laying express route in cities with existing rail transit or has rail transit project under and awaiting construction, it is necessary to consider interchange and connection with the rail transit.
- b) Express route layout should be consistent with medium-long distance travel passengers flow; in particular, it should be consistent with the passenger flow and direction between the large passenger flow source and attracting areas.
- c) During the layout of express route, taking into account both the passenger flow benefits and the road conditions, try to choose the existing transport corridors and alignment should be kept as straight as possible, to avoid too much bypass, reduce the difficulty of construction and investment, make fully use of their favorable conditions, to enhance operation speed.

➤ **Main route layout related factors**

Features of main route layout are flexibility, convenient for residents, large network coverage, matching with express routes, suitable for medium and short distance travel. So when laying the general routes, on one hand, it's necessary to give full play to its own role, taking on lots of public transport passenger flow; one the other hand, it's necessary to gradually change their functions to shuttle transport, bearing the backbone passenger flow in the regions that the express route cannot covers.

The main route layout should take into account the following factors:

- a) Make full use of the existing reasonable routes, coordinate new routes and existing routes, improve network density, balance distribution of passenger flow, and ease some main roads buses operating pressure.
- b) The route is set along the large-medium distribution points, large-medium residential areas, stop settings should well connected with express route and can rapidly transfer express route passenger.
- c) Considering both the residents' travel conditions and operating units' benefit, under certain conditions, properly increases detour rate of the routes, to provide service for more passengers.

➤ **Branch route layout related factors**

Branch route is different from the first two routes; its main function is not to take a lot of passenger flow instead of reducing the residents' walking distance, filling the bus route network blind spots in small streets, connecting express routes and the main routes, enhancing the attractiveness of public transport. Branch route layout should take into account the following factors:

- a) Enter the residential area in depth, increase density of public transport network, improve the coverage and quality of service of the bus system to facilitate resident's travel; while connect with express route, main route and passenger flow hub layout for easy transfer.
- b) Be consistent with the direction of community bus passenger flow, cover new community in a timely manner, and improve community transport conditions to avoid passenger flow transfer to non-bus transport modes.

7 Bus network adjustment study

7.1 Bus network adjustment method

7.1.1 Conventional bus network adjustment

1. Bus network optimization method

Common method of bus route network optimization: route retention, route cancellation, route extension, route truncation, route diversions and route merge and other methods.

(1) Route retention

Completely retained route has one or more of the following characteristics:

- The route assume large amount of passenger flow, and passenger flow is even on various points along the route;
- A traditional route that the majority of city residents are familiar about and accept, and has operated for a long time;
- Appropriate length of route that connects the outlying areas or suburban and the inner-city areas;
- Bus route that plays a connecting role in region with public transport low density.

(2) Route cancellation

Routes that have smaller passenger flow demand and poor operation effect, and are inconsistent with passenger flow directions could be considered canceled.

(3) Route extension

When the extension of the route can meet one or more of the following purposes, may consider extending the route:

- Eliminate the blind spot of public transport service, expand public transport service range;
- Connecting with rail transit(including BRT) or large transportation hub;
- Completely replace some short routes and reduce route overlap.

(4) Route truncation

For routes that contact outlying areas or suburban and inner city areas, if the route length is too long, and pass through the city center, usually the route can be truncated in bus terminal with close proximity to the city center, and re-connect with city center by interchanging to other routes.

(5) Route diversions

Downtown overcrowded bus routes can be modified to other parallel routes; for routes with high speeds or direct bus routes requirements, consider modified into expressway to fill the bus blind spot, or peripheral areas with sparse bus coverage.

(6) Route merger

For routes with high route overlap rate, consider merging some of the replaceable routes to facilitate scheduling, reduce operating costs and improve operational efficiency.

(7) Route Interception

When the routes are too long, with function area or transfer hub in the middle, and render particularly evident large passenger flow at both ends, consider intercept the route.

2. Adjustment and optimization of route network

(1) Intercity bus

Whether intercity bus into the city center is the focus of urban and rural public transport planning. It is to be determined based on actual urban spatial structure. In the current new situation, it proposed inter-city bus not enter city center. Combined rail and BRT, to plan hubs at the edge of the city. It means to achieve intercity bus by the "urban core area - the towns" mode to the "urban core area - urban fringe hubs - key towns periphery" paradigm shift. Optimization method usually laid intercity express route between key towns and the central area, and laid connecting route between key towns and normal towns. It will achieve the integration of urban and rural public transportation resources.

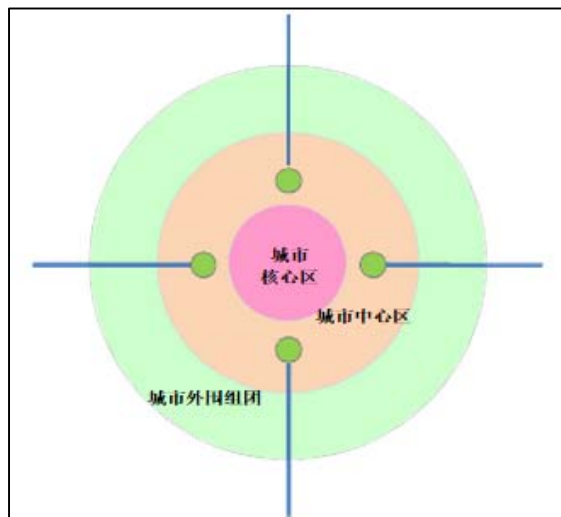


Figure 7-1 the concept of intercity bus

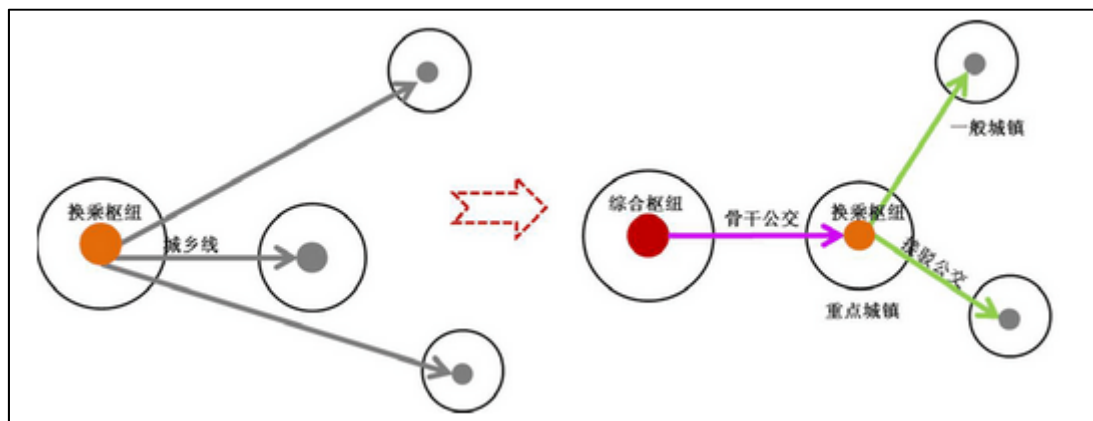


Figure 7-2 Intercity bus optimization idea

(2) Express route optimization

Construct the express route network in accordance with the concept that BRT service should be provide between every two bus service areas. Fitted through the route network, screening viable route networks, taking into account the express route support for strategic development area, Supplement with recent express route implementation network. Based on the implementation network, carry out renovation of existing network to get the recent express route program.

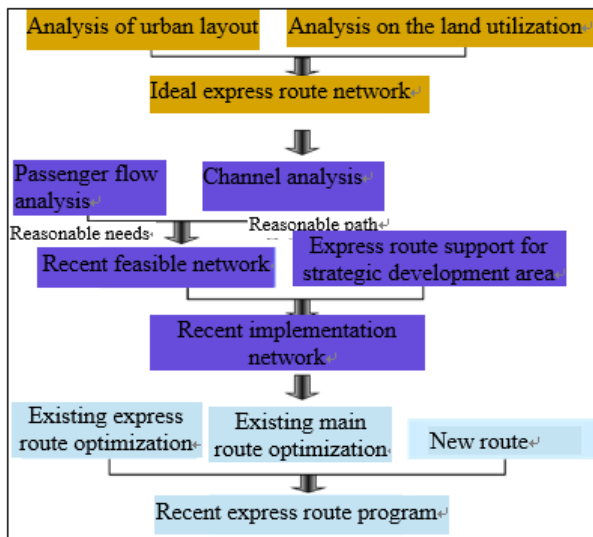


Figure 7-3 express route planning approach

(3) Main route optimization

According to the analysis of urban layout, land-use, passenger flow, select major transit corridors, check the cross-section supply and demand of major transit corridors or route overlap factor. Adapt to current status of city highway, express route, main route and branch route road network, select an available hubs and stations, refer to main route setting standards, develop main route design scheme. According to the route design scheme, organize existing main route network, giving priority to transformation and optimization of main route network, consider addition of new route where there is shortage.

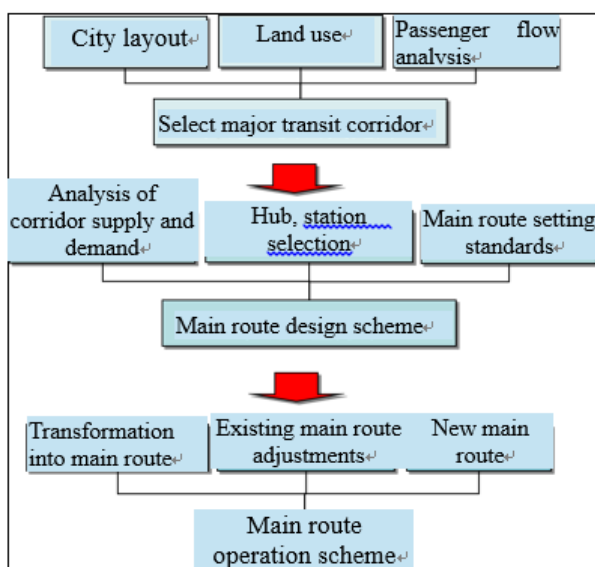


Figure 7-4 main route planning approach

(4) Branch route and micro-circulation route optimization

Combine passenger flow survey, passenger complaints and related department feedback, based on full communication with the enterprises and authorities at all levels, select branch route pilot area that has implementation conditions in recent future. Adapt to current status of branch route and extension route network, select neighboring transfer hub, develop branch route design scheme According to the route design scheme, sort out the existing route network, give priority to route adjustment of similar routes, consider addition of new routes where needed.. micro-circulation route optimization approach that refers to the branch route.

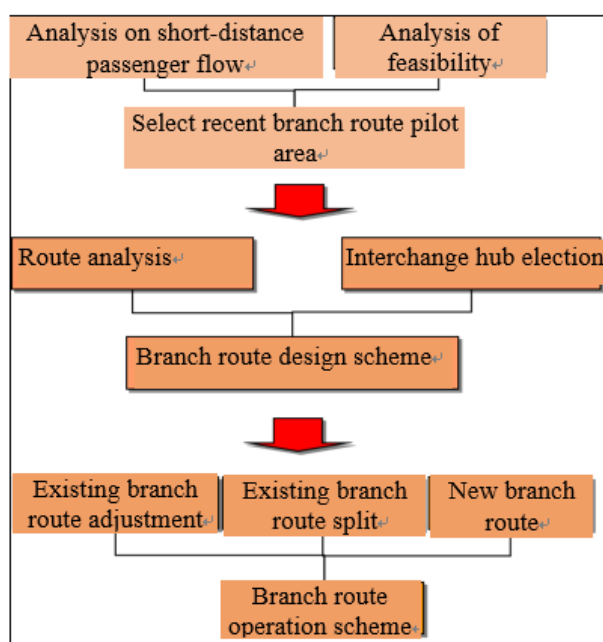


Figure 7-5 branch route planning approach

7.1.2 Bus route network adjustment based on large volume public transport

In urban rail transit as the representative, it will expound interchange relations between the regular bus lines and large volume public transport. It includes BRT network, urban rail transit network and inter-city rail transit network.

To strengthened cooperation of rail transit and conventional bus, promote the "rail transit + bus + slow speed" integrated public transport system. By adjustment, "strengthen the interchange and reduce competition" to expand the rail transit secondary attraction range, so that rail transit and ground bus complement each other

for smooth interchange, improve operation efficiency of public transport. Major work includes:

(1) Feeder route optimization

Based on the urban rail transit network layout, rail transit function and characteristics of passenger flow, implement a regional integration program of urban rail transit and bus transit.

In the neighboring trail transit station bus feeder service area: bus routes that have few same stops with rail transit a strong complementarity with trail transit, it's suggested to retain overlap section of the bus and rail network and properly extend at both ends, expanding the scope of trail transit feeder service area, to improve passenger travel structure, improve the efficiency of transport along the route.

The area without trail transit coverage: through the establishment of new routes, or adjust the existing routes to connect with trail transit starting and terminal station. In the area without trail transit coverage, bus travel is changed from "depend entirely on the bus" into "conventional bus + rail transit" mode. .

Rail transit feeder bus route optimization mode is as the following table:

Table 7-1 feeder routes adjustment table

trail transit stations Classification	Traffic features	Passenger flow characteristics	Appropriate mode of transport interchange
Integrated hub	An important railway interchange station with other urban passenger transport modes, large-scale comprehensive passenger transport hub of external traffic hub; transfer function for multiple modes	large initial/terminal passenger flow	A large number of the originating route
Transport interchanges	interchange station for rail transit routes or integrated transport hub for rail transit and conventional bus; focus on regional transport service and interchange function	Secondary passenger flow attraction	A large number of the originating route
Regional feeder station	Rail transit stations and conventional bus hubs, and passenger transport hub for large commercial centers, large dense residential areas, public buildings; focus on regional transport service function. Transfer	Some secondary passenger flow attraction	Pass-through routes + few originating routes

	as the supplement		
General transfer station	transfer point for general rail transit mid-way station and other modes of transportation such as conventional bus, mainly provide regional transportation services	Large amount of direct attraction of passenger flow, less transfer passenger flow	majority of pass through routes

(2) Competitive routes optimization approach

If trail transit and bus routes share too many stops, then there is competition between these two transport modes, which is not conducive to the improvement of efficiency of the public transportation system as a whole. Adopt the four adjustment modes: stop skipping, truncation, decrease density and cancellation to reduce overlap, weaken competition between trail transit and bus, even out passenger distribution, and improve the efficiency of public transport system as a whole.

Table 7-2 competition route adjustment mode table

adjustment mode	Adjustment Objects...	Route characteristics	passenger flow impact
skip stops	General alternative routes or highly alternative routes	It is alternative with part of the trail transit shared stop section, but also has greater complementarity between non-stop road sections.	Very little impact on travel, service can be covered by rail transit
Truncation	General alternative routes or highly alternative routes	At least one end is alternative with the trail transit, and relatively few Passenger distribution amount	Very little impact on travel, and service can be covered by conventional bus
decrease density	Highly alternative routes	alternative with trail transit in the middle section, and passenger flow in the sector account for a small amount of the whole route	Has some impact on travel, but relatively less impacted total number of passenger flow, the transport service can be covered by conventional bus
Cancellation	Highly alternative routes	Route is located on major transit corridors, and shares a long section with trail transit, passenger flow volume mainly focuses on the trail transit	Route cancellation has some impact on travel, but can be compensated by trail transit or other conventional bus services

adjustment mode	Adjustment Objects...	Route characteristics	passenger flow impact
		shared section.	

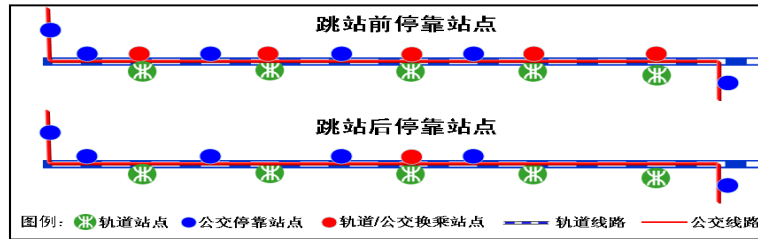


Figure 7-6 route stop-skipping before and after comparison diagram

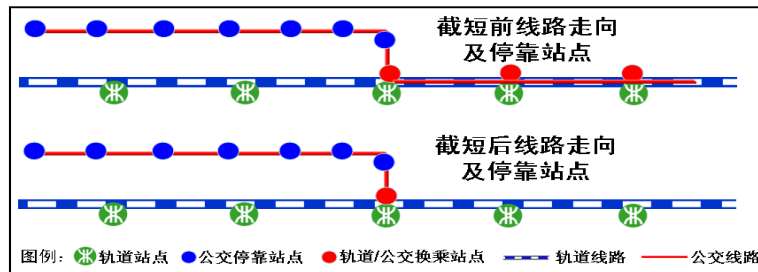


Figure 7-7 route truncation before and after comparison diagram

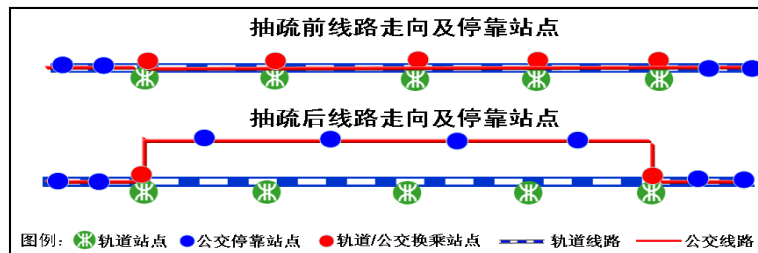


Figure 7-8 route density reduction before and after comparison diagram

(3) Route adjustment program implementation schedule

In accordance with the "firstly add then adjust, step by step, station synchronization" principle, carry out a phased implementation plan, give priority to implementation of addition or adjustment of feeder bus routes program, expanding coverage of the subway. Competitive routes are accordingly adjusted in accordance with the "slower" principle, once in a stable operation stage, reduce bus service frequencies according to operational situation, in addition, synchronization of construction of the mid-way stations platform and route adjustment, to ensure the continuity and reliability of bus services.

7.2 Urban route network adjustments launch threshold proposal

The bus network adjustment start thresholds of typical cities have been combed. Due to the differences of the economic development, population, urban form, and traffic characteristics of different types of cities, it has been found that the start thresholds of different types of cities are quite different. For example, in Shenzhen, for operating mileage of 12-16 km, grid interval of 5-6 minute express route, the passenger sizing standard is 683 passengers / day. In Qingdao, for operating mileage of 15 kilometers, grid interval of 5 minutes express route, the passenger sizing standard is 3224 passengers / day, a huge difference between them. Therefore, this subject will provide the basis and calculation methods to determine traffic conditions for the bus network adjustment. Different cities should be based on their own characteristics, the value of local conditions.

(1) Newly added routes

Newly added routes planning implementation conditions include infrastructure and passenger flow conditions, in principle, it should meet both the facilities and passenger flow conditions before the implementation.

■ Passenger flow conditions

Passenger flow condition is the sufficient indicator for newly added routes and route adjustment, the minimum passenger flow of the newly added route should meet certain threshold. Setting of the threshold is related to urban public transport development goal, including 3 specific measurable metrics: the management base, green environmental base and bus-leading base. Passenger flow conditions demand size specific calculation method:

Passenger flow demand scale = $\text{Min}\{\delta * R1, \varepsilon * R2, \theta * R3\}$; among them, δ , ε , θ ranges from 1 to infinity, representing different cities can select one, two or three from the R1, R2, R3 three indicators to combine and calculate the smallest route launch passenger flow threshold.

The minimum size of passenger demand based on operational characteristics (R1): Based on the sustainable development in order to balance of

financial revenue and expenditure for the purpose of sustainable management, calculation formula as follows:

$$\text{The minimum size of passenger demand (R1)} = \frac{\text{daily average operating revenue of planned route}}{\text{route average fare} \times 2}$$

$$\text{Daily average operating revenue} = \text{daily operating costs} = \text{route capacity scale} \times \text{single vehicle daily operating cost}$$

$$\text{route capacity scale} = \frac{\text{route round-trip mileage}}{\text{Average speed} \times \text{departure interval}}$$

The minimum size of passenger demand based on green environmental protection (R2): Based on environmental protection, use less energy consumption to meet more people's travel needs, namely, per capita carbon emissions generated by public transport should not be higher than that of the car traffic. α . Calculation formula is as follows:

$$\text{The minimum size of passenger demand (R2)} = \frac{\text{Planned route daily average total carbon emission}}{\text{Bus per capita carbon emission} \times 2}$$

$$\text{route average daily total carbon emission} = \text{route daily total operating mileage} \times \text{average bus fuel consumption} \times \text{carbon emission factor}$$

$$\text{Bus per capita carbon emission} = \text{cars per capita carbon emission} \alpha$$

$$\text{Cars per capita carbon emission} = \frac{\text{Planned route length} \times \text{car fuel consumption per kilometer} \times \text{carbon emission factor}}{\text{The average passenger number of car}}$$

Among them, α value is chosen between 0 and 1, depending on the specific circumstances in different cities, for example, the value of Shenzhen is 0.273;

The minimum size of passenger demand based on public transit (R3): Based on bus-leading, generate less traffic on less road resources, while satisfy more people's travel demand, per capita traffic generated by public transport should not be higher than that of cars. β . Calculation formula is as follows:

$$\text{The minimum size of passenger demand (R3)} = \frac{\text{Planned route daily average traffic}}{\beta}$$

$$\text{route daily average traffic} = \left(\frac{\text{route roundtrip mileage} \times \text{per capita bus traffic} \times 2}{\text{The average departure interval}} \times \frac{\text{operation hours}}{\text{conversion factor}} \right)$$

$$\text{per capita bus traffic} = \text{per capita car traffic} \times \beta$$

$$\text{per capita car traffic} = \frac{\text{route length} \times \text{conversion factor of equivalent car}}{\text{The average passenger capacity of car}}$$

Among them, β value is chosen between 0 and 1, depending on the specific circumstances in different cities. For example, the new town or new residential areas, due in early development or lower occupancy rates, passenger demand is small. But if it is to provide public transport services, when car travel habits are formed, it will be difficult to transfer to the public transport. Such Area should reflect the leading role of the public transit. It may be appropriate to reduce the β values to reflect travel heterosexual.

■ **Facility condition**

Facility condition is the basic premise that supports route operation, including station facilities and road conditions. In principle, newly added route facilities should meet the minimum facilities requirements, specification is as in the following table.

Table 7-3 Minimum facilities Requirements Table

	route type	branch route	express route	main route
Stations Facilities	Station area	Set up 2 parking spaces, area should be 130m ²		
	station space	Scheduling space and washroom	station space includes inter-station management and monitoring, control room, temporary lounge, facilities, utility room	Station space includes inter-station management and monitoring, control room, temporary lounge, facilities, utility room, material room, night security duty room, restaurant, conference room
Road Facilities	Number of lanes	Number of one-way lane should not be less than 1, the number of non-one-way lane should not be less than two		
	Turning curve radius	Turning curve radius should not be less than 12m		

Height Limit	Net height should not be less than 3.8 m (single), 4.8m (double)
Slope	Ramp gradient should not be more than 1:10

(2) Adjust or cancel the route

Public bus and trolleybus routes adjustment or cancellation should meet both the launch conditions and constraints:

Routes adjustment launch conditions: the launch of the routes adjustment should meet any of the following condition.

- routes do not meet the technical requirements in the planning standard;
- passenger flow shows a declining trend, resulting in waste of social resources;
- Constrained by rigid external conditions (stations, roads, etc.)

Route adjustment constraints: route adjustment should meet all of the following conditions, in case of force majeure such as road construction; it is advised to try to satisfy all of the following conditions.

- Not deviate from the route planning standard technical requirements;
- Meet the Infrastructure requirements in the planning conditions;
- Not create new empty bus service area;
- The proportion of people who has to interchange for one time should be within certain limits;
- Alternative route service time should include the service time of the adjusted route;
- Alternative routes fare should not be higher than that of the original routes during the adjustment period.

Route cancellation: If any of the following conditions is met, the route cancellation can be launched.

- New route has been opened for less than 1 year, after trial operation evaluation, actual passenger flow scale does not meet the minimum standards;

- Existing route passenger flow continue to show a downward trend, resulting in waste of social resources;
- Constrained by rigid external conditions (stations, roads, etc.).

Route cancellation constraints: route cancellation should meet all of the following conditions, in case of force majeure such as road construction; it is advised to try to satisfy all of the following conditions.

- Not create new empty bus service area;
- Should not result in over 1000 people who has to interchange for one time, and no more than 300 people who have to interchange for over 2 times (including 2 times) .
- Alternative route service time should include the service time of the adjusted route;
- Alternative routes fare should not be higher than that of the original routes during the adjustment period.

Public bus and trolleybus network optimization network adjustment and cancellation should have a clear launch threshold, when the said evaluation indicator reach the launch threshold within a certain period of time, it is necessary to launch the public transportation network optimization program. Therefore, the route adjustment launch threshold should be in accordance to the specific circumstances of the city, and should be scientific, reasonable and representative, and to constantly update according to the development of cities and public transport during the implementation process.

7.3 Route network adjustment settings

7.3.1 Recommends that bus network adjustment agency

(1) Characteristics of bus network adjustment agency

Through the analysis of typical city route networks adjustment agency, it's found that setting up professional organization to be responsible for route network planning and optimization is the most common practice in the world's public transport cities, although different cities setting in the related organization, in general, the professional organizations have the following characteristics:

- **Independence**

The agency reports to the government, but usually it is independent of government agencies and operators to ensure fairness and impartiality of the development of the program. In the case of cross-administrative regions, representatives of the various administrative regions will join the agency.

■ **Professionalism**

Route planning functions is carried out by designated professional agency by the government, to ensure that route planning is scientific and systematic, to avoid vicious competition, operators obtain the route management right by competition and negotiation, etc.

■ **Combination of route planning, design and operational monitoring and evaluating**

Assuming the route planning and design, while carry out supervision and evaluation of the operating companies on behalf of the government, for unqualified operating companies, the government is entitled to eliminate it.

(2) **Recommends that bus network adjustment agency**

Adjustment of metropolitan area / urban agglomeration public transit network requires setting a scientific and reasonable institutions. A reasonable set of institutions can achieve relatively efficient public transportation network optimization and adjustment, as well as to reflect the Government's cooperation and consultation with the public. As to the institutions responsible for the public transportation network adjustment, the suggestions is mainly as follows:

■ **Government supervision and evaluation**

Government is not directly involved in the bus operation, but need to provide operation capital allowance, implement the macro monitoring management, and play a role of market regulation and promoting free competition. Governments should develop evaluation system to evaluate regularly public transport service level. And the unqualified operators after evaluation should be punished, promoting public transit health, positive and sustainable development.

■ **Professional advisory institutions to develop schemes**

The main responsibility of professional advisory institutions is to use professional scientific theory, scientifically analyzing and evaluating the public

transportation network operational level of the status quo and adjusted. Based on this, formulate an optimization and adjustment scheme of public transit network, and submit to the government for approval.

■ **Operators responsible for program implementation**

Operators responsible for the implementation of the final line network optimization adjustment program. Based on the balance of income and cost, operators should ensure public transport service level meet the evaluation criteria established by the government.

7.3.2 Recommends that bus network adjustment mechanisms

(1) Principle of route network adjustment

In order to ensure the program is systematic, scientific and sustainable, metropolitan public bus (trolleybus) routes (including city bus and inter-city bus) optimization and adjustment mechanism should be guided by the following five principles:

- Government-led;
- Professional organizations decision support;
- basic data and professional tool as support;
- Operating companies participation;
- public participation;

(2) bus network adjustment system processes

With the city's comprehensive transportation system continue to be improved especially the rapid construction of rail transit, public transportation network optimization work will gradually render normalization; public transportation network optimization work involves a wide range of complex issues facing the need to form a complete planning research system, progress the work by levels and stages in an orderly way, from the planning of macro route network to the scientific decision-making of route setting in operational phase, according to the requirements of different stages, carry out the public transportation network optimization in 3 parts: program design, post evaluation and annual report.

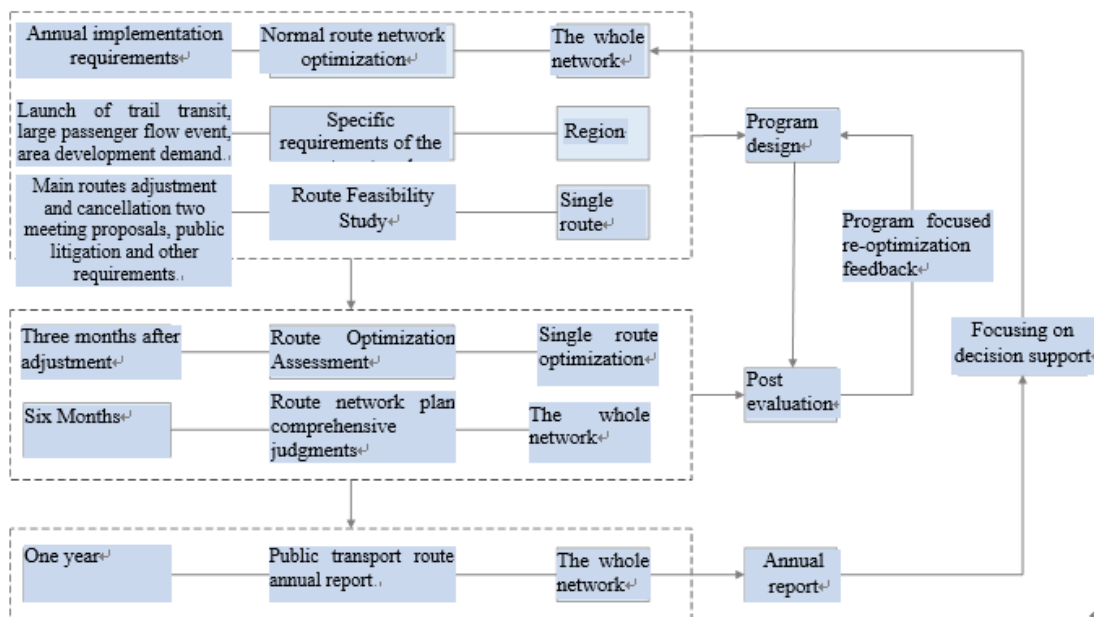


Figure 7-9 route network adjustment system flow diagram

(3) Route network adjustment mechanism proposal

① Improve public transport basic data statistics systems and mechanisms

Comprehensive, real statistical data is a prerequisite for improving public transportation network. It is the premise and conditions for macro traffic decision-making, but also the basis for public transport management. It is recommended to establish the current public transportation network database based on GIS, to help future public transportation network indicator update to better reflect the public transportation network before and after the adjustment to ensure science and rationality of the optimization technology.

② Standardize route network optimization method, strengthen emphasis on the traffic model

Based on traffic model means, the running horizontal of bus network will have the scientific and rational assessment. It will form the adjustment programs, and the effect before and after adjustment will be clearly displayed. Line regulation is necessary to ensure scientific and rigor, but also to ensure the credibility and operability of the adjustment effect.

③ Establish a more scientific and standardized route network adjustment mechanism

■ route network adjustment launch mechanism

Firstly, adjust the bus routes based on passenger flow, route service improvement as the evaluation standards. Secondly, the adjustment of bus routes should be considered at the perspectives of overall convenient travel in the region, considering the whole process of people's travel, and combine the rail transit, bus lanes, etc., to carry out simultaneous adjustment of the regional route network.

The route network should have both "growth" mechanisms, but also a "metabolic" mechanism: At present, the rapidly changing urban form and the rapid development of rail transportation and other factors are accelerating the reconstruction of resident travel characteristics. Relying solely on increasing routes to meet needs cannot adjust timely to the stock of resources, making the system increasingly bloated, difficult to achieve intensive development.

■ Implementation of route network adjustment evaluation mechanism

Bus route optimization adjustment program evaluation methods also need to be further improved and perfect the program adjustment compensation mechanism, enhance the rationality and persuasion of the optimization and adjustment of bus routes.

④ Public communication and coordination mechanism

It is necessary to build public communication and coordination mechanism, enhance communication with the masses and publicity. Adjusting urban public bus and trolleybus network should not be the only announcement of the adjustment program, but at the same time announce the field research, scientific analysis results clearly to the public, the change of time cost and transfer cost, expenses cost should also let the public know.

⑤ Cross-regional route network adjustment mechanism

The biggest difference between inter-city public transportation network adjustment and inner-city public transportation network adjustment is the different agencies in charge and various stakeholders that need to coordinated. Therefore, the urban route network adjustment institutional mechanisms not only face the problems in the metropolitan level, but also need to consider cross-regional route network adjustment coordination mechanism.

Metropolitan Planning Organizations (MPO) is mainly responsible for the metropolitan transportation planning and planning and coordination for related applications for funds. Currently, the nation has a total of more than 300 metropolitan planning organizations, such as the New York metropolitan area MPO. There are various stakeholders in the MPO organization, they should be coordinated, so that the interests is balanced, which would be more complicated. Therefore, the main decision-making tools of MPO in the United States, is a mathematical model based on quantification foundation, namely a traffic demand model. It can effectively help the MPO to make better decisions, and anticipate the impact that their decisions have on transport systems, nature and human environment.

8 Bus fare adjustment mechanism

8.1 Bus operating mode suggestions

With the deepening of market economic reforms, bus companies operating market has become an inevitable trend. Therefore, we must combine the targeting of our social welfare and public transport companies and national policy environment, combined with the specific situation of the city, promote market-oriented reform of public companies.

(1) rationally define government role in the development of public transport

Government's regulation is a necessary condition for the development of public transport. Public transportation is funded by the state or private investment through competitive bidding, or subsidized by the government or operated commercial fully, is a very controversial issue. Each country has different models and practices. Whatever approach the mode, the government has the responsibility to provide a good road network conditions and improve public transport facilities, to ensure good operation of the bus.

Singapore has proved that to supervise the quality of the bus service by an independent regulatory develop reasonable rule, more effective than government direct intervention. In the bus operator services regulation, it should reasonably define the management authority of the government. Combining the characteristics of different cities, it should moderate transformation of government functions, and create favorable conditions for improving transit service levels.

(2) Clear the role of bus companies in market-oriented reforms

Franchise system refers to, the government awarded bus companies at a certain time and scope of the right to operate bus services in the public transport sector. That is franchise. Franchise mode should be compete limited with bus companies in the government monitoring. Competition is not only economic, but also the quality of service, social benefits.

Singapore, for example, bus companies plan bus routes through research, design, etc., and are responsible for the bus operation in designated area, provide integrated public transport services to meet service standards developed by public regulatory authorities.

(3) Establish independent regulatory agencies.

Establish independent regulatory agencies to safeguard the public interest, ensure that there are adequate public transport services and affordable fares, and the financial viability of bus companies sustainable. The main responsibility is to approve new bus lines, standardize services, improve the existing bus services, rail and public transport approved fares.

Singapore, for example, the establishment of a Public Transport Council (PTC), managers from all levels of society. PTC periodic audits to ensure that bus companies to comply with these service standards. PTC invite public feedback directly through the network, polls and other means, thereby determining the quality of service of each bus company. If the bus company does not meet the requirements, such as waiting too long or too crowded, PTC is entitled to penalties and sanctions.

8.2 Bus fare formulation and adjustment suggestion

(1) The fare adjustment should be developed rationally and based on the public's affordability as the main basis.

Bus pricing policy involves the vital interests of the citizens, especially the interests of working-classes and low-income groups. Bus fare policies should take full account of this, in order to better play the fares to guide and leverage.

In examining the public can withstand capabilities, it is recommended to determine the reference to Singapore's affordability index (Singapore affordability index shows that typical household expenditure spent on public transport accounted for 4.7% -8.9% of monthly household income). Affordability index is an important symbol for measuring fare increase whether is reasonable. We should closely monitor the following indexes: (1) the average monthly spending on public transport accounts for a monthly household income, (2) the average per monthly expenditure on public transport in the proportion of total household expenditure.

In keeping relatively stable between fares and the disposable income, maintain transit ridership steady growth, according to the actual situation of household income growth, dynamic fare adjustment, in accordance with the principle of competitive prices, perfect pluralistic vote, and meet the traffic demand under different service level.

(2) Under the premise to meet the benefits of social contribution, taking into account the economic and social benefits, readjust fares based on

cost-based pricing.

Pricing microeconomic theory: lax subsidies will be the motivation of corporate pursue microeconomic efficiency, resulting in low efficiency of business management and excessive investment and distorting the allocation of resources, so this view holds that bus companies should be self-financing, the level of taxation applied to subsidize all operating expenses and capital expenses of enterprises. Pricing macroeconomic theory: transport prices should benefit mainly the macro setting goals and should be based on low fees even at a loss, to reflect social welfare. The more lines, the more convenient. At the macro level greater contribution to society. As for the loss of transportation can be offset by government subsidies.

Singapore fare adjustment cap model integrated use of microeconomic and macroeconomic pricing theory, minimize costs while ensuring operators provide a certain level of service. While considering the contribution of social benefits, also taking into account enterprise should have economic benefits.

Advice on formulation method of bus fares, first, pricing by the social welfare service-oriented; then, re-adjust fares based on cost pricing. Even if cannot achieve operating income greater than operating costs to ensure a reasonable profit like Singapore, but you can try to reduce the cost of reducing losses at least.

(3) Diversified bus ticket system

In December 2014, "Urban Public Transport Planning Guide" issued by the Ministry of Transport said: establish a multi-level differentiated urban public transport fare system based on operating costs, according to the masses acceptable, finance affordable, enterprises sustainable principle, determine the urban public transport fares.

Therefore, adjustment of urban fare should be in accordance with the principle of good price for good service, and expert the price's role in regulation, change the singular ticket system, establish a multi-level, differentiated fare system, enhance the attractiveness of public transport. Establish integrated transfer discount policy, by eliminating additional costs for interchange, meet present and future requirements of the current levels of public transport, and improve people's travel habits to enhance the overall network efficiency.

Specific suggestions are as follows:

To establish a multi- fare system. According to whether workday or not, peak periods and different distances to set different fares. Strengthen the government's ability to regulate different travel ways through the fare system. In particular, we can increase the security research about fare mechanism in commuter peak periods, ensure that more commuter by bus travel proportion in rush hour.

Implement bus interchange ticket discount. Further analysis of the public transport passenger flow time distributions and the supply and demand situation, formulate reasonable policies, and improve the efficiency of public transport. Implementation of the transfer discount system, in the case of transfer between rail transit and bus, bus and bus, adopts concessions based on the total fare; realize a public transport liaison fare of the rail transit and bus, bus and bus.

Section 2: Urban Bus Passenger Station Facilities Function Requirements Study

1 Term of reference

(1) Domestic and international data collection and field surveys will be conducted to gain a better understanding about bus passenger station facilities and related standard. Existing problems in bus passenger station facilities will be analyzed. Practical application of existing standards for bus passenger station facilities and demand for standards of bus passenger station facilities will be fully understood.

(2) Analyze development trends and new characteristics of bus and trolleybus, and propose new requirements for urban bus passenger station facilities in combination with practices and methodology of bus passenger station facilities. Propose new requirements for new energy bus stations in combination with practices of new energy buses.

(3) Study and put forward classification, location requirements, platform requirements, service facility requirements, and maintenance requirements.

(4) Finish Urban Bus Passenger Station Facilities Function Requirements Study, which will provide technical basis for developing related standard.

2 Research scope

The study focuses on bus and trolleybus stops facilities.

3 General requirements

The general requirements of the passenger station facilities mainly includes the following aspects:

- Meet the requirement of bus parking
- Meet the requirement of passengers waiting the bus

- Meet the requirement of passengers get in and off the bus and transfer
- Provide relevant traffic information to the passengers
- Provide other relevant services to the passengers
- Meet the requirement of operation

4 Station Categorization

■ Categorization according to the location: Intersection upper stream bus stop, intersection downstream bus stop and road section bus stop.

■ Categorization according to the setting method: bus stop setting along the zone that separates the motorized and non-motorized vehicles, bus stop setting along the central separation zone, and bus stop setting along the pavement. In which, the first setting method is the most commonly used in many cities in China.

■ Categorization according to the platform type: the linear type bus stop and the harbor type bus stop.



Figure 4-1 Linear type bus stop

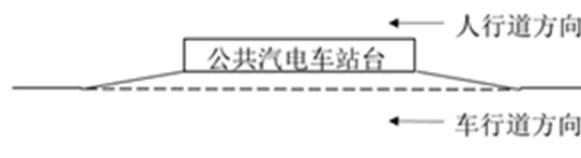


Figure 4-2 Shallow harbor type bus stop

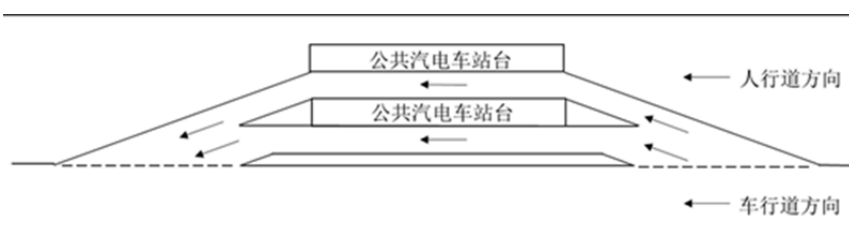


Figure 4-3 Deep harbor type bus stop

5 Station Setting

The site selection of bus stop is an important part of bus stop setting. Based on the optimization of the distance between stations at the macro level, the median level of site selection is to local adjustment based on the road and traffic conditions, and finally determines the bus stop site. Select the ideal stop site not only can make the passengers easier to catch the bus and transfer, but also minimize the influence of bus stop on other traffic flow. There are many factors that affects the bus stop site, mainly include distance between stops, convenience of get in bus, conditions of passengers collection and distribution, location of the intersection, road cross section form, and safety factors.

5.1 General requirements

- The setting of station shall meet the general requirements of the urban public transport plan. The planning and construction of the bus station shall synchronize with that of urban roads.

- When newly build, renovate, expand the large scale public places, business districts, and residential blocks, the planning and construction of the urban bus/trolley bus station shall be synchronized.

- The bus stop shall be convenient for the passengers to travel and the passenger flow collection and distribution, within 150 meters of the main entrance and exit of the metro lines, long distance bus stations, train stations, ports and residential areas, there shall be bus/trolley bus stations; within 200 meters of the main entrance and exit of the airport, there shall be bus/trolley bus stations. (the index values are based on related requirements in Passenger transport services for bus/trolley bus (GB/T 22484-2008))

- The average distance between stations shall meet the requirement of GB/T 22484, the setting of the station site shall meet the requirement of GB

50220.

- The setting of station shall not impact smooth and safe traffic of pedestrians, bicycles and other modes.

- The bus station shall not be set on the road with the gradient bigger than 5%.

5.2 Average distance between stations

- The distance between stations of normal bus/trolley bus shall be 300m to 500m in downtown, and 500m to 1,000m at the suburbs. (The index values are based on related requirements in Passenger transport services for bus/trolley bus (GB/T 22484-2008))

- The distance between express bus stations shall be 1Km~2Km.

5.3 Transfer

- On the roads, the same direction transfer distance shall be no more than 100m.

- On the plane intersection, the transfer distance shall be no more than 200m.

- On the overpass, the transfer distance shall be no more than 300m.

- Within 150 meters of the main entrance and exit of the metro lines, long distance bus stations, train stations, ports and residential areas, there shall be bus/trolley bus stations. Within 200 meters of the main entrance and exit of the airport, there shall be bus/trolley bus stations.

- There may be bus transfer services between high-density residential areas, CBD, industry parks and bus/trolley bus stations and rail transit stations.

- There shall be no taxi parking lot within 50 meters of the bus stop; the stop-and-go taxi stop may be set according to the situation.

(the index values are based on related requirements in Code for transport planning on urban road (GB 50220-1995) and Passenger transport services for bus/trolley bus (GB/T 22484-2008))

5.4 Relation with the intersection

- For newly built intersection, the bus stop shall be set at the outlet of the intersection.

- If the bus line is left turn or right turn, the bus stop shall be set at the extension section of the outlet lane.

- At the peak period, when the right turn traffic flow is large at the intersection inlet, the bus stop setting at the inlet is seriously affected; the bus stop shall be set at the outlet of the intersection in priority, to minimize the interference and conflict between bus and right turn traffic flow.

- If the bus flow is large, the bus stop shall be set near the inlet, in case when the bus stops at the outlet, the following traffic flow may queue and block the intersection. General requirement: the bus stop near the intersection shall be set more than 50 meters from the intersection; the newly built, and renovation intersection, the bus stop shall be set on flat or ramp with gradient no bigger than 1.5%, when the land is limited, the maximum gradient shall be below 2%.

- For harbor type bus stop, if the road and land conditions are met, shall be set at the outlet of the intersection.

- For linear type bus stop, if the difference between upstream and downstream traffic load is small, and both meet the setting conditions, shall be set at the outlet of the intersection.

- If the main passengers flow collection and distribution point at the intersection is focused in one area of the four corners of the intersection, to make it easier for passengers and minimize the passersby to cross the street at

the intersection, under the circumstances that road and traffic conditions are met for setting bus station, the bus station shall be set at the inlet/outlet adjacent to this area.

■ For intersection with many bus lines, if one bus station cannot meet the requirement of bus stop, or bus stop of one bus station poses huge influence on the traffic at the inlet/outlet, there shall be bus stations at both inlet and outlet lanes. Since the interference of left turn bus stop at the inlet station on the traffic flow, the left turn bus line shall not be set at the inlet station.

5.5 Reduce impacts from other traffic modes

■ When a bus station is set in a sidewalk of motor-NMT mixed road, a bicycle lane occupying excessive sidewalk width shall be designed between the station and sidewalk, separating bus and NMT.

■ Any taxi stop shall be set within 50m distance from a bus station, a taxi stop by sign may be set based on real situations.

5.6 Requirements of special lines and bus type on bus station setting

■ When setting charging facility at the station for super capacitor new energy bus, relevant signs and markings shall be set, fully considers the safety, prevent the safety threat to the passengers.

■ When setting at the bus/trolley bus station, the color, character font of the bus station board of the custom bus and Internet bus shall be compatible with other bus line bus station board, and if there is any change of the line, the information on the board shall be updated timely.

6 Platform setting

6.1 Type selection

- For the urban main roads, shall set the harbor type station.
- For the branch or below urban roads or auxiliary road of high-level road, the harbor type station shall be set if the principles in the following table are met; when the conditions are limited, the linear type station shall be set. (The index values are based on related requirements in Shenzhen Setting Rules for Public Transport Station (SZDB/Z 12-2008))

Table 6-1 Harbor type station setting conditions and setting type

Setting conditions	Setting type
Lines stop at the station are more than 3	Shallow Harbor type
In peak period, the passengers get in and off the bus is more than 500/h	Shallow Harbor type
In peak period, the bus flow is more the 60/h	Shallow Harbor type
Lines stop at the station are more than 6, or in peak period, the passengers boarding and alighting is more than 1000/h	Additional stops or deep harbor type

6.2 Size of the station

■ The number of boarding and alighting exceeds 1000 in peak hour, or lines of a station in mega cities, large cities, medium and small-sized cities shall not exceed 12, 8 and 6 respectively. When the number of boarding and alighting exceeds 1000 in peak hour or the number of lines exceeds the specified number, the station shall be divided into different stops, the gap between stations shall be no less than 25m, the total number shall be no more than 2, and the parking lot may not more than 3. (The index values are based on related requirements in Specifications for bus/trolleybus platform (DB11/T 650-2009))

■ The area of the platform shall meet the standing requirement of the passengers at peak period, the width of the platform shall be no less than 2.2m,

the effective width of the platform shall be no less than 1.5m, and the area per capita shall be no less than 0.25m². (the index values are based on related requirements in Code for design of urban road engineering (CJJ 37-2012))

- The floor of the platform shall be 0.2m above the ground.

- The length of the bus station shall be determined by the road conditions, lines of stop, numbers of the stop buses, length of the bus and passengers flow according to the urban public transportation planning.

7 Station service facilities Station service facilities

7.1 Bus shelter

■ Bus station shall set bus shelter, it should be safe, practical, economic, aesthetic, simple, and easy to identify.

■ There shall be integrated design of the bus shelter and its surrounding green belt and other facilities. The bus shelters may adopt attractive profile and color, forming the urban feature landscape.

■ The bus shelter shall have pillar, ceiling, and may set the chairs and backrest. The height shall be 40cm ~ 50cm. The facilities shall be solid and durable, and not affect the collection and distribution of the passengers and pass by of the pedestrians. The bus shelter may set barrier-free passage. (the index values are based on principles of Ergonomics)

■ The shelter should set the lines index information at the top for easy viewing of passengers from a certain distance.

■ The bus shelter can protect from the sun light, the rain and snow, and have good drainage.

■ The height between the lowest point of the edge of the bus shelter ceiling and the platform shall be no less than 2.5m; the width of the ceiling shall be no less than 1.5m, and the horizontal distance (backward) between the ceiling margin and edge of the curb shall be no less than 0.25m. (the index values are based on principles of Ergonomics)

■ The bus shelter shall be easy to clean, and meet the hygiene requirement of the urban environment.

■ The shelter load shall comply with the requirements of GB 50009. The shelters should be designed with modular structure and shall meet the requirements of GB 50017.

- The shelter with advertisement, which should not affect the operational safety of urban bus/trolley bus.

- The bus shelter shall adopt the materials that are wind resistance, rain and snow proof, heat-resistant, low temperature resistance, corrosion resistance and flame retarded according to the usage requirements.

- The quality of materials for the shelter shall be durable in normal maintenance, to ensure that the life cycle of the shelter is not less than 10 years.

- The bus shelter shall provide lighting for passengers to read station board at night. Brightness shall be accordance with specifications in GB 50034.

- The shelter lighting shall be safe, useful, energy-saving, attractive in appearance and harmonious with the shelter.

7.2 Bus station board

(1) Design principle of bus station board

- Enough guidance information: bus station board contains the name of the origin/terminal of the vehicle, the basic bound of line, passenger location, line number signs, whether card is acceptable, air conditioning, first and last departure time, this first and last time the vehicle reached the station, estimated get off stations other information.

- Concise guidance information: Passengers can quickly identify the kinds of information the bus station board, timely to obtain the required information.

(2) Requirement of the bus station board

- The content, character font, color, and signs shall comply with the regulation of GB/T 5845.3.

- Bus station board may contain a map for areas nearby, hub, transfer information, or set three-dimensional map if possible.

■ The bus station board may set in the front of the platform, the horizontal distance between it and the edge of the curb on the vehicle stop side shall be not less than 0.4m, does not affect the collection and distribution of the passengers, and is easy to look at.

■ For vertical arrangement of multiple boards, the height of the top edge of the uppermost board shall be no more than 2.2m; the distance from bottom edge of the lowest board and the floor shall be no less than 0.4m. (the index values are based on principles of Ergonomics)

■ When changes occur, it is timely to change or replace the bus station board; if the bus station board is covered or damaged, it shall be cleaned, repaired or replaced.

■ Manufacturing materials of station board shall be wear proof, non-discoloring and easy to be cleaned and maintained.

■ In the site where conditions are met and with requirements set up electronic stop sign, which should also meet the following requirements:

- Show distance of the buses nearest to the station, dynamic information from the station or arrival time, dynamic information update cycle should not exceed 15 seconds; (the index value is based on current situation of electronic station board technology and service requirements of users)
- Support extended information for displaying information to identify the operator, map of area near the platform, transfer information query;
- Having security and confidentiality measures, public information on the electronic stop sign should be displayed by encrypted transmission;
- Installation of automatic warning devices, monitors the internal electronic stop sign of each electronic device operating status,

- improve the electronic stop sign information facilities intact rate;
- Take measures to prevent the heat, dust and rain, when the electronic stop sign failure should be promptly repaired.

7.3 Barrier-free facilities

- Barrier-free ramps shall be set in two ends of side walk of deep harbor type bus stops, surface of the ramps shall be level, but not smooth.

- If possible, make special designs of platforms for level boarding and alighting. This is especially useful for the disabled.

- If a bus station occupies a sidewalk for the blind, the sidewalk for the blind shall bypass the bus station.

- In stations with board for the blind or voice prompts facilities, blind pass shall be set and can guide the blind to the board, area for the blind may be set according the real situations. The blind pass and setting of braille information shall comply with specifications of GB 50763

- The technical standard of the design of the barrier-free facility inside the bus station shall be in accordance with specifications of the national standard Codes for Design on Accessibility of Urban Roads and Buildings (JGJ 50-2001).

7.4 Other facilities

- For bus stations with many bus lines stop, may set bus lines stop electronic board. Based on the operation situation of the lines, the electronic board may assume the bus arrival time, display bus stop information, and the bus stops according to the electronic board.

- The guide signs, safety signs and comprehensive signs shall meet the requirements of GB/T 15566.4, GB 2894 and GB/T 5845.2.

- The signs and markings in the parking lot shall meet the requirements of GB 5768.2 and GB 5768.3.

- The platform may set outdoor environmental protection garbage can; the garbage can shall not be set on the passageway that passengers collect and distribute.

- The queuing signs and markings may set according to bus lines inside the platform, and shall comply with the requirements of GB 5768.2 and GB 5768.3. The queuing rail may be set if conditions are met.

7.5 Safety protection

- The surface of bus shelter facilities shall be smooth, without sharp corners and burrs.

- The electrical equipment shall install leakage protection device, its insulation grade shall be the same as the lamp. The insulation of the electric circuit and electrical equipment shall meet the requirements of GB 19517, GB 50054, and GB 7000.1.

- The metal structure frame, panel and pillar shall be well grounded. If necessary, install the lightning protection device shall meet the specification of GB 50057.

- The earthquake proof shall be determined by the earthquake intensity of the local area.

- The safety rail may be set at the edge of the platform if necessary, its height shall be no less than 1.1m, the horizontal load capacity shall be no less than 1kN/m. (the index values are based on related requirements in Specifications for bus/trolleybus platform (DB11/T 650-2009))

- The important station may be able to monitor the areas where passengers get in and off the bus and vehicles in and out the station.

7.6 Other requirements

- Parking pavement and transition pavement of bus inlet and outlet shall be solid, level and reinforced against bus-rutting.

- Gutter inlet shall be set in bus inlet side, and gutter inlet shall not be set in bus parking area.

8 Maintenance of the station

- The break of the platform floor shall be repaired timely.

- Bus shelter, bus station board and safety rail shall be checked monthly. If there are any rust, dropping of painting, and loosening and breakage of connection point, it shall be repaired timely, keeping the integrity of the station facility.

- The electrical equipment shall be maintained periodically, keeping the safety.

- The electronic bus station board and departing indication unit shall work properly, if there is any default, it shall be repaired within 48 hours.

- If the bus station board is covered or damaged, it shall be cleaned, repaired or replaced.

- Before the rainy season, the lightning protection facility shall be checked, guaranteeing the normal and safety usage.

9 Bus station building and maintenance management mechanism

9.1 Station planning and design mechanism

■ The authoritative department shall make an integrated bus station planning based on overall planning of the city and demand for urban public transport.

■ When urban roads are newly built, extended or rebuilt, bus station planning and design shall be conducted simultaneously with road planning and design.

■ Based on function demand, construction scheme of a bus station shall be designed by professionals organized by the authoritative departments, and determined after soliciting comments from the public.

■ Specifications, number and type of station facilities shall be fixed according to related standards, nature of a station, number of bus lines, passenger flow and road section traffic by the authoritative departments.

9.2 Station building mechanism

■ The building department shall comply with the station planning and apply required construction permits from related departments.

■ Auxiliary bus stations of projects shall be built by the main body project construction departments, and the auxiliary bus stations shall be checked and accepted, put into use simultaneously with the main body projects. Other bus stations shall be built by the authoritative departments, and not put into use until it has been checked and accepted.

9.3 Station adjusting mechanism

■ If information, such as line operation time, itinerary map, is changed, the bus company shall notice the authoritative departments in time. The authoritative departments shall adjust the information in time.

■ If station facilities will be adjusted for road reconstruction or station change, the authoritative departments shall take the charge of adjustment.

■ A written application shall be submitted to the authoritative departments for relocating, demolishing or rebuilding bus station facilities.

9.4 Station maintenance management mechanism

■ Operators or other building, operating, maintaining and management departments shall maintain bus station facilities in time and ensure the facilities meeting related standards.

■ The authoritative departments shall supervise, manage and assess the station facility operating departments according to related standards.

Section 3: Urban Bus Station Construction Standards and Design Guideline Study

1 Research contents

Research contents include Urban Bus Station Construction Standards and Design Guideline Study, among which:

- **Planning Standards:** focus on researching the planning Standards of Bus terminal/hub stations, parking lot and maintenance field, including planning site selection, the threshold value of starting the construction, construction contents and construction land scale, etc.
- **Design Guideline:** focus on researching the Design Guideline of supporting terminal station, hub station and parking lot, mainly including overall layout and facilities setup requirement, etc.

2 Research basis

- CJJ/T15-2011 Code for design of urban road public transportation stop, terminus and depot engineering
- GB/99—104 Construction Standard on City Buses, Trolley Buses
- GB/T22484—2008 Passenger Transport Service of City Buses and Trolley Buses
- JGJ50-88 Design Codes for the Disabled's Using Urban Roads and Buildings
- GB/T5845.3 Part 3: Station Boards and Guide Boards of Bus/Trolleybus of Urban Public Transport Signs
- JGJ50-2001 Codes for Design on Accessibility of Urban Roads and Buildings
- GB 50189-2005 Design Standard for Energy Efficiency of Public Buildings in Guangdong
- GB/T18487.3 Conductive Charging System of Electric Vehicle, Electric Vehicle and AC/DC charging machine (station)
- GB 50966-2014 Design Code on Charging Station of Electric Vehicle
- GB/T15566 Graphical Signs Principles and Requirements for the Application
- GB5768—2009 Road Traffic Signs and Markings
- GB/T5845.4-2008 Urban Public Transport Signs
- GB50016-2006 Code for the Fire Protection Design of Buildings
- GB50045-95 Code for the Fire Protection Design of High-Rise Civil Buildings

- GB50116-98 Code for Design of Automatic Fire Alarm System
- GB50011 Code for Seismic Design of Buildings
- GB50413 Urban Earthquake and Disaster Protection Planning Standard
- GB/T328.1~27 Test Methods for Waterproofing Sheets for Buildings
- GB50015-2003 Code for the Water Supply and Drainage Design of Buildings
- GB50067-97 Code for the Fire Protection Design of Garages, Repair Garages and Parking Areas
- JGJ16-2008 Code for the Electrical Design of Civil Buildings
- GB50034-2004 Standard for Lighting Design of Buildings
- CJ/T3010 Automatic Urban Public Transport Vehicle Monitoring System
- CJ/T2 Urban Public Transport Communication System

3 Concepts Definition

3.1 Bus terminal station

Bus terminal station includes the original and end of the bus line.

- Satisfy passengers' waiting, going on and off and other public transportation travelling demand;
- Starting stations should possess the operation, organization and scheduling functions of public buse;
- Possess passengers' supporting service facilities.

3.2 Bus hub station

Urban bus hub station could achieve connection and transfer of various transportation mode.

- Able to offer city public transporation, roads, railway, water transportation, aviation external transportation means, or passenger intermediate transferring service of public transportation means in different cities;
- Offer necessary space sites with certain construction, structure and facilities for passengers to transfer or the opeartion scheduling of public transportation vehicles.

3.3 Bus parking lot

Bus parking lots are the sites which can allow transportation operation public buses (trolley buses) to park together with necessary devices and carry out simple maintenance work.

- Possess service functions such as operation vehicle parking, simple maintenance;
- Possess facilities such as repair materials, fuel storage;

- Possess service functions such as fuel adding (fuel, gas, charging), vehicle cleaning, etc.

3.4 Bus maintenance field

Bus parking lots are the sites which can allow the maintenance of transportation operation vehicles like public bus (trolley bus) at all levels, relevant accessory processing, repairing, repair material storage, issuing.

- Possess service functions such as operation vehicle maintenance and repair;
- Possess service functions such as accessory processing, manufacturing;
- Possess facilities such as repair materials, fuel storage;
- Possess service functions such as fuel adding (fuel, gas, charging), vehicle cleaning, etc.

3.5 Supporting station

The bus supporting stations(terminus/hub/parking lot) refer to the supporting urban terminal/hub stations for bus or the parking lot for bus attached to civil buildings (residential, commercial, office, exhibition, etc.) and transportation hubs (urban railway connection hub and comprehensive passenger transfer hub) within the boundary line of the land.

4 Planning Standards for bus Stations

4.1 Planning Principles

(1) Supply and demand balance principle

Bus stations construction land scale shall meet the travel needs of residents in transportation construction projects and their radiation area.

(2) Stops and stations separation principle

The passenger distribution function of terminal and hub stations is relative separated with the parking function of parking lot. Abolish the restrictions on the traditional terminal stations of "must meet 60% of operating vehicles parking demand". The terminal and hub station mainly serve the passenger evacuation and transfer, the parking area of which only need to meet the arrival and departure of operational vehicles, the necessary parking and turnaround spaces for passengers up and down. Bus parking lot mainly service for bus parking, which has connection in space but not necessarily associated construction.

(3) People-oriented principle

Try to create standard, reasonable, safe, comfortable, convenient and seamless connected traffic environment and realize the separation of pedestrian and vehicles to ensure the security of passengers.

(4) Demands adapting principle

The technical features of new-energy vehicles, bus operation characteristics and passengers' transportation needs should be considered to ensure the stops and stations can meet the current needs and future development needs.

4.2 Site selection of bus station planning

- Bus stations should be connected with two or above city roads, making sure the bus can enter and leave the bus station successful when road congestion

or traffic accident happens.

- Bus terminal / hub station should be based on the direction of passenger flow. According to urban passenger flow OD survey analysis and prediction, bus stations should be close to the main passenger flow channel.
- Bus parking lot / maintenance field should be arranged in water, electricity supply, fire proof and municipal facilities available areas.
- When the construction of supporting terminal / hubs stations with the construction of new site project, the center distance from the built terminal / hubs stations should not less than 350m; when there are two or more new construction projects within a 350m radius at the same time, construction scale of terminal / hubs stations should consider the needs of all construction projects, the location should be close to the construction projects with a greater development intensity, more passenger demand.
- Bus park lot could be separated or joint with the construction of terminal stations / hubs; separated construction of parking lot should ensure the moderate distance from the terminao / hub stations, which should be controlled within the range of 1.5km, reducing empty traveled miles as far as possible. Joint construction should ensure the relative separation of both in function.
- Bus terminal / hubs stations and Parking lots should make sure intensive land use, the implementation of supporting construction should be within the boundaries of project lane use, should not be an independent construction land.

4.3 Start Threshold Value of Supporting Bus Stations

4.3.1 Threshold value of starting the construction of terminal station

Terminal stations generally are set up with the civil construction project. Civil construction projects reached to the construction area of opening a bus line, which could be taken the starting threshold of the planning and construction of terminal stations. Cities should combine with the city's own characteristics, according to urban traffic travel features, calculating the starting threshold of constructing terminal stations.

The calculating formula is as follows:

The building scale of supporting terminal stations = number of matched buses for unidirectional line * transport capacity of each standard bus* initial station sharing rate / (per capita mechanized trip rate * convention public traffic sharing arte * average transfer coefficient * initial station using proportion) * per capita building area

Notes: Initial station sharing rate is initial station accounting for transport capacity of all stations;the number of matched buses for unidirectional line = number of current standard buses / number of bus routes / 2.

4.3.2 The threshold value of starting the construction of hub stations

According to the feature and definition of hub station, hub station generally constructed with the construction of transportation hub. The threshold value of starting the construction of hub stations mainly consider the site passenger flow distribution scale.

Considering the traffic function features of comprehensive passenger transport hub, such construction projects should be matched with the bus hub stations. The

track connecting hub station should be confirmed in combination with the passenger flow scale of stops and stations. If the distributed passenger flow scale generally exceeds 2,000 person-time/peak hour, the bus stop and station needs to be built.

4.3.3 The threshold value of starting the construction of parking lot

If there is a construction project for the supporting terminal/hub station, the project-supporting parking lot should be built within the scope of construction project or 1.5km.

4.3.4 The threshold value of starting the construction of maintenance field

The threshold value of starting the construction of maintenance field should consider operating vehicle size of enterprise, which should be in accord with “Code for design of urban road public transportation stop, terminus and depot engineering”(CJJ/T15-2011).

4.4 Construction content

4.4.1 Terminal and hub stations

The construction content of terminal / hub stations with an independent land should be in accord with the relative regulations in “Code for design of urban road public transportation stop, terminus and depot engineering”(CJJ/T15-2011), such as “Table 2.1.7 Terminal Station Facilities” and “Table 2.3.11 Hub Station Facilities”.

Supporting terminal / hub station construction with non-independent land should appropriately adjust and optimize the relevant facilities in the national industry standards, increase the vehicle charging facilities, change the planting to the optional facilities at the same time.

Table 4-1 Supporting terminal and hub stations construction content

	Facilities	Deploy	Remarks
Information Facilities	Station board	√	——
	Public message board	√	When terminal stations has only one line, don't need to set
	Regionl map&Transit routes map	√	——
	Bus schedule	√	——
	Real-time dynamic information	√	——
Conference facilities	Barrier - free facilities	√	——
	Bus shelter	√	——
	Platform	√	——
	Seat	○	——
	Pedestrian passageway	√	——
	Non-motorized vehicle parking	√	——
	Motor vehicle park and ride	○	——
	Vehicle charging	○	——
Safety and environmental protection	Waiting corridor	○	——
	Lighting	√	——
	Monitoring	√	——
	Planting	○	——
Operation management	Station Management Office	√	——
	Line dispatching room	√	——
	Intelligent monitoring room	√	——
	Driver Lounge	√	——
	TOILET	√	——
	Dining room	√	——
	Cleaning utensils and appliances	√	——
	Parking apron	√	——
	Return path	√	——
	Repair and maintenance	√	——

Notes: “√” represent necessary facilities, “○” represent optional facilities

4.4.2 Parking lot

The parking lot should include parking facilities, operation management facilities, life service facilities, security and environmental protection facilities and other functions by reference to the Engineering design Codes on Urban Road Public Transport Station, Park and Factory (CJJ/T15-2011).

On the premise of ensuring security, intensive use of space and facilitating implementation, the related facilities in the national industry standards should be appropriately optimized and adjusted, the facilities like dispatching and oil and gas stations should be cancelled and the greening can be selected as the alterable facility.

Table 4-2 Supporting parking lot construction content table

Facility		Configuration
Parking facility	Stopping pad (garage)	√
	Service rack (room)	√
	Proving road	√
	Parking road	√
	Anti-freezing and skid resistant facilities	√
Operation management facility	Ticket business	√
	Bus fleet management	√
	Administrative office	√
	Low security garage and auxiliary workshop	√
	Garage	√
	Switching room	√
	Heat supply facility	○
Life service facility	Labor protection logistical base	√
	Bachelor dorm	○
	Recreation room	√
	Dispensary	○
	Dining hall	√
Security and environmental protection facility	Toilet	√
	Lighting	√
	Monitoring	√
	Fire fighting	√
	Greening	○

Note: √ denotes due facilities and ○ denotes optional facilities

4.4.3 Maintenance field

The construction form of maintenance field is mainly independent land, and the construction content should be in accord with the relative regulations in “Code for

design of urban road public transportation stop, terminus and depot engineering” (CJJ/T15-2011).

4.5 Construction scale

4.5.1 Overall construction scale of urban Bus stations

The overall size of urban bus station should match urban master plan and urban comprehensive transportation development policy, coordinating with the bus passenger demand and network scale at the same time.

The overall construction scale of urban bus station = Overall construction scale of “Station” + Overall construction scale of “Depot”. Here, “Station” denotes bus terminal stations and hub stations; “Depot” denotes bus parking lots and maintenance field.

The overall scale of "Station" and "Depot" did not particularly compute, but by using standard car average land area of "Station" and "Depot", estimate the overall construction scale of urban bus station, specific calculation formula as follows:

$$S_{AR} = Q \times S$$

Here: S_{AR} — The overall construction scale of urban bus station (m^2);

Q — Standard car scale in planning year;

S — Standard car average covering area (m^2);

(1) Standard car scale in planning year

$$Q = \frac{P \times r}{q}$$

P : Bus travel volume in planning year (person time / day), P = population size

* motorized travel rate * transportation sharing ratio;

r : Transfer coefficient, the city should base on the city's travel features, refer to "Urban road traffic planning and design specifications" (GB50220-95) determining transfer coefficient;

q : Standard bus approved transportation volume (passengers / day • standard car), acquired from statistical data in recent years. Standard bus approved transportation volume should include intercity bus and custom bus. Public bus vehicle conversion factor could refer to the provisions of "Public transit city assessment index system" issued by the Ministry of transportation in 2013.

② S_i : Standard car average covering area: According to the existing standard specification, comprehensive land use area of terminus (hub), maintenance field and parking lot are 255-310 square meters, this project take the intermediate value of 283 square meters.

4.5.2 Total construction scale of urban supporting bus stations

The urban bus stop and station supporting scale is the sum of the total scale of supporting “stations” and the scale of supporting parking lots. As a part of the urban bus station, the total scale of bus stations restricts the total scale calculation of the urban supporting station.

The urban bus stop and station supporting scale is the difference of regional total station supporting scale with the current “station” and “park” scale (excluding temporary stations and leased stations), the planned independent occupying “station”, the parking lot scale, and the total scale of the planned maintenance park.

$$S_{SC} = S_{AR} - S_{PR} - S_{IM} - S_{MU}$$

In the formula: S_{SC} — Urban supporting “station”/parking lot scale (m²);

S_{AR} — Urban total “station”/“park” supporting scale (m²);

S_{PR} — Current “station”/”park” scale (m²);

S_{IM} — Planned independent occupying “station”/parking lot scale (m²);

S_{MU} — The total scale of planned maintenance park (m²).

4.5.3 Land scale of project supporting station

4.5.3.1 Key indicators to determine the scale of land station

(1) Parking space scale confirmation

The parking space scale is the ratio of the station area and average occupied area of bus.

$$N = \frac{S_{PR}}{S_{AV}}$$

In the formula:

N — parking scale (parking space);

S_{PR} — Project supporting station scale (m²);

S_{AV} — Average occupied area of bus (m²)

Table 4-3 Land area of single public transport vehicle of various types

Type	Bus length range (m)	Standard bus conversion coefficient	Land area of single standard bus (m ²)	Land area of single bus
1	Below 5 meters (including)	0.50	120-150	60-75
2	5-7 meters (including)	0.70		84-105
3	7-10 meters (including)	1.00		120-150
4	10-13 meters (including)	1.30		156-195
5	13-16 meters (including)	1.70		204-255
6	16-18 meters (including)	2.00		240-300
7	Above 18 meters	2.50		300-375
8	Double-deck	1.90		228-285

(2) Confirmation of arrival and departure, turnover parking space scale

Arrival and departure, turnover parking space scale is only associated with terminal / hub station. Arrival and departure parking space scale is determined by average service time of line service vehicle and peak-hour departure volume. According to experience, each two lines can be set to a parking space, each line should be provided with at least one departure parking, each departure parking should preferably come with 2-6 turnover parking spaces. Including:

- Supporting station with the construction of the Housing, sports and exhibition, scenic spot and architecture, the number of each supporting turnover parking in departure parking space should appropriately be 3-6, not be less than 3.
- Supporting station with the construction of commercial Office buildings, the number of each supporting turnover parking in departure parking space should appropriately be 2.
- Supporting station with the construction of transport hub buildings, the number of each supporting turnover parking in departure parking space should appropriately be 3-6, not be less than 3.

(3) Confirmation of station housing area

- The land usable area of the houses of initial and terminal stations is 2-3 m² per standard bus and the office land of initial and terminal stations should not be less than 35 m²
- The office land of the junction station should be determined as follows: Small hub (2-4 lines) stations should not be less than 45 square meters , medium-sized hub (5-7 lines) should not be less than 90 square meters, large hub station (line 8 or more) and integrated hub station (with a variety of transportation transfer mode) of not less than 120 square meters
- Office and living building area in parking lot should be 10-15 square meters per standard car.

(4) Confirmation of non-functional area

By reference to the national standard Code for design of urban road public transportation stop, terminus and depot engineering, the greening land area should not be less than 20% of the total covered area of the station. For covered stations, the setting of greening area should not be considered.

(5) Electric bus charging parking demand

Parking service for terminus, hub station, parking lot of electric bus, according to the number of city electric buses and operations needs set charging parking. In principle, the fast charge facilities should be set in terminus and hub, slow charging facilities could be set in the parking lot.

4.5.3.2 Calculating methods of station land scale**(1) Terminal station**

The project supporting station scale is the sum of its own supporting scale and the supporting scale required by the project within 350 meters around. If there is an established station or independent station within 350 meters around, it should be deducted correspondingly.

$$S_{PR} = I + Y - S_{IN}$$

In the formula:

S_{PR} — Project supporting station land scale (m²)

I — The land scale of the project supporting station (m²)

Y — The project supporting land scale within 350 meters around (m²)

S_{IN} — The land scale of existing supporting station or independent station within 350 meters around (m²)

The calculation formula of I is as follows:

The land scale of the project supporting station = (Number of supporting bus routes * the standard bus scale of arrival and departure and turnover parking 1 line required * Standard car accounted for parking area + Configuration scale of Standard car * Standard cars accounted for land area of station room) / 0.8

Among them: the relevant indicators of the calculation formula is as follows:

- Number of supporting bus routes: Building area of single project / building area of supporting one bus route (start threshold value);
- The standard bus scale of arrival and departure and turnover parking 1 line required: no less than 3, 1 arrival parking, 1 departure parking and 1 turnover parking;
- Standard car accounted for parking area: Every standard bus accounted for 78 square metre, including (enter road, carriageway and shelters and other land area);
- Configuration scale of Standard car: Number of supporting bus routes * bus numbers 1 line required;
- Standard cars accounted for land area of station room: Calculating as 2-3 square meters per standard car;
- Planting area: according to 20% of the total land area.

(2) Hub station

Hub station land use scale = (Configuration scale of bus lines * the standard bus scale of arrival and departure and turnover parking 1 line required * Standard car accounted for parking area + Configuration scale of Standard car * Standard cars accounted for land area of station room) / 0.8

Among them: the relevant indicators of the calculation formula is as follows:

- Configuration scale of bus lines: Peak hour passenger flow distribution scale / single bus lines average peak hour capacity;

- The standard bus scale of arrival and departure and turnover parking 1 line required: no less than 5, 1 arrival parking, 1 departure parking and 3 turnover parking;
- Standard cars accounted for parking area: Every standard bus accounted for 78 square metre, including (enter road, carriageway and shelters and other land area);
- Configuration scale of Standard car: Number of supporting bus routes * bus numbers 1 line required;
- Standard cars accounted for land area of station room: Calculating as 2-3 square meters per standard car;
- Planting area: according to 20% of the total land area.

(3) Parking lot

The land scale of project supporting parking lot = the parking demand scale of standard buses within 1.5km around the project * the occupation area of standard bus of parking lot – the parking land scale of existing stations within 1.5km around

The parking demand scale of standard bus within 1.5km around the project = the parking demand of new supporting terminal/hub station within 1.5km around the project + the parking demand of existing terminal/hub station within 1.5km around the project. Standard bus parking area is 120-150m² / standard bus.

4.5.3.3 The land use scale control requirements of different station

To meet the station scale required for normal operation, when the calculated value of the supporting land scale is larger than the minimum area requirement, it should be established according to the supporting land scale calculation value, or it should be built based on the minimum scale. When the calculated value of the supporting land scale is greater than the requirement of the overall control area, it should be built by the overall control standard value, or it should be built by the

supporting land scale calculated value. In special land condition, the practical land environment should be combined to confirm the corresponding supporting scale.

- The minimum land scale of terminal stations should not be less than 1,000 square meters. If no planting space, the minimum land scale should not be less than 800 square meters; the maximum land scale should be determined by passenger demand, if take accessory construction form, which should cover an area of no more than 25% of the construction project land scale.
- The minimum land scale of hub stations should not be less than 2,000 square meters, if no planting space, the minimum land scale no less than 1600 square meters; the maximum land scale should be determined by passenger demand.
- The scale of parking lot should be determined by the bus parking demand of terminal and hub stations within the range of 1.5km. The calculating formula is “The land scale of the parking lot = the bus lines parking demand of terminal and hub stations within the range of 1.5km – numbers of parking spaces (the departure and turnover parking) in terminal and hub stations”. As to accessory parking lot, maximum land scale should not be more than 25% of land use of the construction project.

5 Urban bus station design guideline

5.1 Supporting stations overall layout

5.1.1 Plane layout

- Supporting stations should be close to supporting objects or placed within the inner to transfer or receive or send passengers through transportation transfer space transformation. If the lands of supporting objects are not sufficient, “route arrival and departure, passenger boarding and alighting function” and “operation organization dispatching function” can be set up separately. Passenger boarding and alighting areas should be close to supporting objects as much as possible to shorten the travel distance of passengers.
- The facility layout within supporting stations should be set up in the principle of separation of people and vehicles and smooth vehicle flow, and should comply with related national fire technology standards.
- Supporting terminal/hub/parking lots should consider the traffic condition of surrounding roads and should be placed where many buses can arrive and scatter rapidly to shorten the distance of buses to enter and depart.
- The location of supporting terminal/hub/parking lots should reduce the impact on the business value and business atmosphere of buildings.
- Layout form of the facilities within supporting stations includes wraparound type (passenger boarding and alighting areas are arranged around the inner of stations) and pathway type (passenger boarding and alighting areas are arranged in the pathway form within stations).

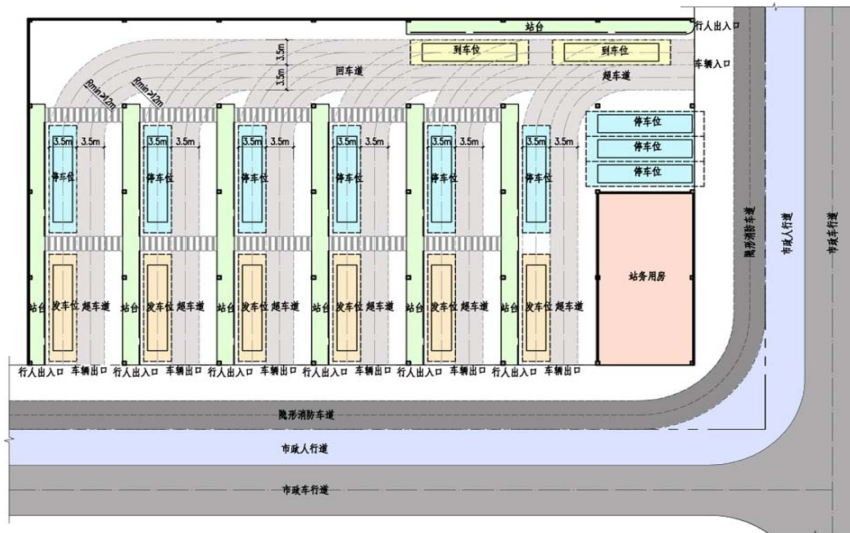


Figure 5-1 Pathway layout form

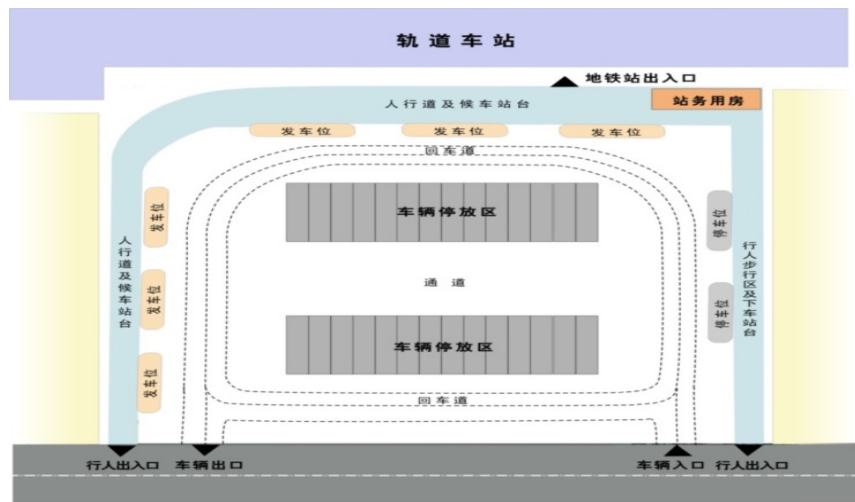


Figure 5-2 Wraparound layout form with hub

- Urban public transportation terminal/hub supporting stations should give priority to wraparound layout form; when the number of positions for departure exceeds the capacity of wraparound form in stations, the stations where it is inconvenient for vehicles to turn around due to column grids should use the pathway layout type. The specific layout types should be based on land conditions.
- Supporting terminal/hub/parking lots should have at least one pedestrian entrance and exit to connect with sidewalk.
- The entrance and exit of supporting terminal/hub/parking lots should not

connect with the crossing of main roads directly. If conditions are limited, side roads should be set up to pass in and out from the right; if the entrance and exit are set up in the by-pass, the turning radius of vehicle entrance and exit should not be less than 12m.

- The entrance and exit of supporting terminal/hub/parking lots should be separated and arranged at different road sections. If station lands are limited, one-way entrance and exit can be set up or the entrance and exit are set up at the same road section. The distance between the center line of entrance and exit at the same road section should not be less than 30m.
- The bus entrance and exit of supporting terminal/hub/parking lots should not share the entrance and exit with other social vehicles.
- The inner of supporting terminal/hub/parking lots and the roads to stations should not share with other motorized transportation modes, but can share with firefighting access.
- Station affair rooms of supporting terminal/hub/parking lots should be convenient for the access of drivers and conductors and dispatching management.

5.1.2 Space Layout

- The clearance height of bus running area should consider the heights of vehicle models and maintenance space. The minimum height is 0.6m.
- The clearance height of station affair rooms should not be below 2.6m. If the clearance conditions are allowed within stations, multi-floor setup can be considered for station affair rooms to save land resources.
- In the one-floor overhead or underground (semi-underground) supporting stations, the distance between column and parking space should not be less

than 0.6m, and the column grid distance of 8.2m or 11.7m is recommended.

- Stations with column grids should be set up in accordance with vehicle models, parking form of vehicles, safe interval of vehicle operation and arrangement form of roadways, and the building area of column grids should be reduced as much as possible.
- Column grids should use the same size. When the span size of parking position and roadway cannot be unified, the column grids can use two sizes, but should not use more than two sizes.
- The ramp of supporting stations should conform to Article 4.2.10 of Design Code for Garage JGJ100-2015.

5.1.3 Architectural Forms

- Supporting terminal/hub/parking lots should give priority to one-floor overhead type and plane formula rather than underground type. The underground type can be used when lands are limited.

5.2 Requirements on Facilities of Supporting Stations

5.2.1 Platform Facilities

- The station form should be chosen according to station condition, passenger flow demand, operation requirement and transfer setup. The station form includes straight-line type and diagonal type. The straight-line type platform should set up 1-2 overtaking lanes; the setup of diagonal type platform should meet the overtaking requirement.

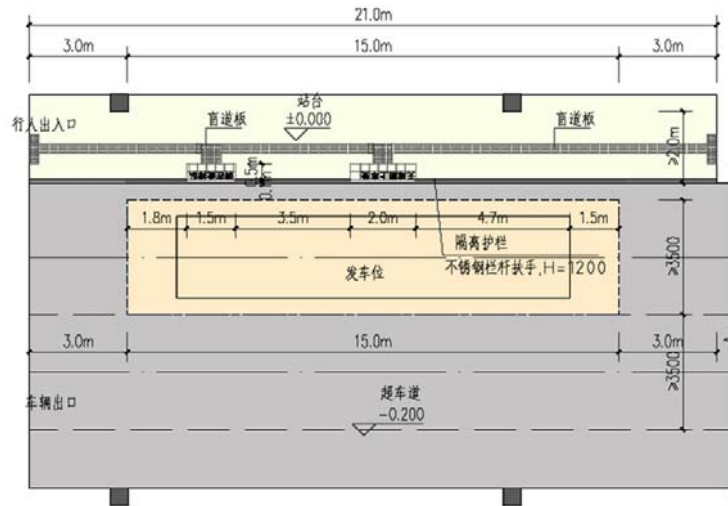


Figure 5-3 Linear platform schematic plan view

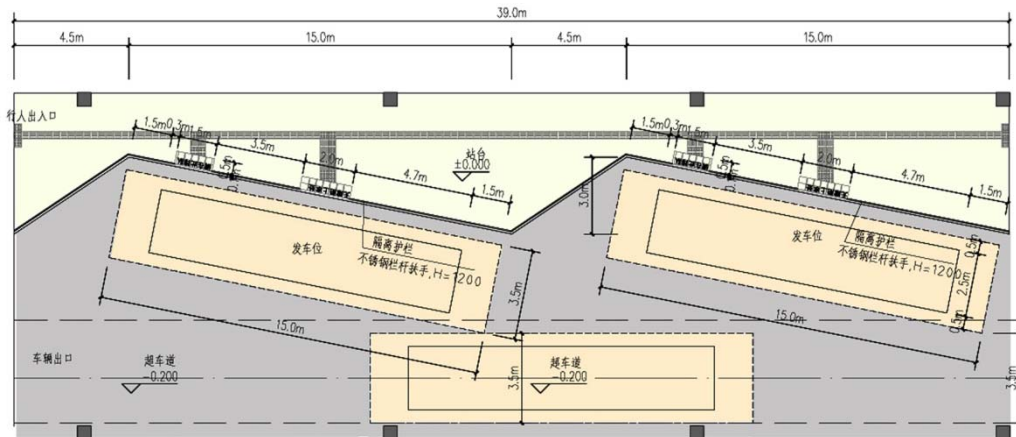


Figure 5-4 Diagonal platform schematic plan view

- The length of corresponding platform of a departure position should be the sum of one parking position and two safe distances. The safe distance between vehicles is generally 3m.
- The length, width and height of platforms should comply with related regulations of Code for Design of Urban Road Engineering CJJ37-2012.
- Waiting facilities and walkways should be set up properly on platforms.
- The boarding face of platforms should set up isolation guardrails to make passengers wait safely and queue up conveniently. The reserved boarding gate should be 1.5m wide and guardrails should not be less than 1.2m high.

- The design of platforms should conform to Design Codes for the Disabled's Using Urban Roads and Buildings (JGJ50).

5.2.2 Waiting Facility

- The platforms without covers should set up waiting corridors. The length of waiting corridors should comply with Engineering Design Code on Urban Road Public Transport Station, Park and Factory (CJJ/T15-2011).
- The architectural patterns, materials and colors of waiting corridors can be designed in accordance with local architectural characteristics and should be practical and beautiful. The facilities of waiting corridors should meet the requirements of preventing from rain, earthquake, wind, thunder and theft;
- The design of waiting corridors should comply with Design Codes for the Disabled's Using Urban Roads and Buildings (JGJ50) and Design Manual Accessible Architecture;
- The contents, forms and technical requirements of station boards should conform to Part 3: Station Boards and Guide Boards of Bus/Trolleybus of Urban Public Transport Signs GB/T5845.3 and Engineering Design Code on Urban Road Public Transport Station, Park and Factory CJJ/T15-2011.
- Waiting corridors should set up ceiling for rain and sunshine, night lighting, passenger resting chair, route-indicating board, bus route chart and so on.
- The ceiling of waiting corridors should cover the top of bus to avoid getting wet when passengers get on buses.
- As for the stations without covers, seats should be set up in combination with waiting corridors. As for the stations with covers, seats should be integrated with the platforms of stations.
- Waiting area should have lighting and ventilation equipment, and such

facilities as air-conditioning can be set up if conditions are allowed.

- Waiting seats should be set up for those passengers using wheel chairs, and the area of a single waiting seat covers 2m^2 ($1.4\text{m}\times 1.4\text{m}$) .

5.2.3 Pedestrian Facility

- Pedestrian entrance and exit should be set up independently. When pedestrian entrance and exit is set up with vehicle entrance and exit together, it should be separated by physical isolation facilities.
- Continuous pedestrian passageway should be connected with waiting area within stations, alighting area, pedestrian entrance and exit, outside connecting road, pedestrian facilities (overpass, underpass, sidewalk and so on) and top cover buildings.
- The net width of pedestrian passageway and zebra crossing should not be less than 3m. The net width of stairs, elevators and escalators can be decided according to related standards.
- As for stations with pathway model, zebra crossing of island platform should be set up at the rear end of platforms.
- Isolation guardrails should be set up between pedestrian passageway and roadway and the height of guardrails should not be less than 1.2m.
- Pedestrian passageway should set up accessibility facilities.

5.2.4 Barrier-free accessibility facility

- Supporting terminal/hub station barrier-free accessibility facility setup concern special needs to people with disabilities, the elderly.
- Barrier-free accessibility facility setup should conform to “Codes for Design on Accessibility of Urban Roads and Buildings (JGJ50)” and “Code for accessiblilty design(GB 50763-2012)”

- Accessibility design must be a necessary conditions on design review and acceptance for supporting terminal/hub station.

5.2.5 Vehicle operation facilities

- Boarding area and alighting area should be separated within supporting stations so that boarding people, alighting people and vehicles do not bother each other.
- In the supporting stations of pathway model layout, the alighting position should be set up in accordance with departure position; in the supporting stations of wraparound model layout, the alighting position should be set up in accordance with roads within stations, and the number should not be less than 1.
- Road reinforcement design should be done in vehicle arrival and departure positions of stations, acceleration and deceleration area, vehicle entrance and exit, etc.
- The turning lane should be decided in accordance with the turning track of operation vehicles. The width of straight sections should meet the lay-by requirement of buses and the one-way channel should not be less than 3.5m wide. The turning radius of centerline of roadways should not be less than 12m.
- Turning lanes should not set up 90°continuous turning. When stations are limited but 90°turning is needed, the one-way width of turning lanes should not be less than 4m.
- In the places where it is difficult to get public traffic lands, the near streets can be used as turning lanes to save lands;
- If station conditions are allowed, the entrance and exit should be set up in different roads; speed reducing facilities, signs and markings, indicators,

watch boxes and gates should be set up at vehicle entrance and exit.

- In order to reduce the impact of bus access on road traffic, the vehicle entrance and exit in stations should be more than 50m away from the crossing of approach roads like urban pedestrian overpass, underpass and bridge.

5.2.6 Station Affair Room Facility

- Station affair rooms should be arranged according to the land condition and plane layout of supporting stations, integrate with buildings and intensively use the space resources of stations.
- Station affair rooms should comply with the principle of safety, economy, environmental protection, application and proper advance, and conform to Design Standard for Energy Efficiency of Public Buildings GB 50189-2005.
- The design of station affair room buildings should be in accordance with related architectural design standards and regulations, and meet indoor environmental requirements on day lighting, lighting and ventilation.
- Supporting stations should include administration office, monitoring room, dispatching room, temporary resting room, tearoom, material room, bathroom, etc.
- Station affair rooms can be established according to the land area of supporting stations and actual demands. Monitoring room can be shared with dispatching room to save lands.
- If station affair rooms are built into two storeys, dispatching room, temporary resting room and bathroom should be set up on the first floor while other station affair rooms should be set up on the second floor.
- Bathrooms should be integrated with the public bathrooms of buildings, but

can be independently set up if conditions are limited.

5.2.7 Charging facility

- Itemed electric metering devices should be set up within supporting stations.
- In the supporting stations with electric new energy buses, the electrical load of charging facilities is grade one, and the maximum electrical load of a single charging unit is controlled in accordance with 100KVA.
- In the supporting stations with electric new energy buses, independent power distribution room, charging equipment room, monitoring system, safety protection system and other supporting facilities should be set up.
- Electrical high and low voltage power supply and distribution equipment and lighting should adopt energy-saving products within supporting stations.
- The charging facilities within supporting stations should conform to Conductive Charging System of Electric Vehicle, Electric Vehicle and AC/DC charging machine (station) GB/T18487.3 as well as Design Code on Charging Station of Electric Vehicle GB 50966-2014.

5.2.8 Sign System

- Passenger rules, a route map and other signs should be provided in a built-in station.
- A sign should be composed of text and graphs in a unified format and colour where the text should be unified and provided in Chinese and English and the graphs should be clear and concise.
- The dimensions of the signs should be standardized. Graphic signs should meet the requirements of GB/T15566 Guidelines and Requirements for Use

of Graphic Signs.

- A sign should be provided with a dynamic information guide symbol and connected with the information system.
- Markings should be used on roads to indicate parking positions and passage width.
- Speed limits, “No Parking” and “No Honking” signs, parking lines and other signs should be provided at the entrances and exits for vehicles.
- Signs and markings should meet the provisions of GB5768-2009 Urban Public Traffic Signs and GB/T5845.4-2008 Road Traffic Signs and Markings.

5.2.9 Safety and environmental protection

- Built-in stations should be provided with disaster protection facilities such as fire, earthquake and water protection facilities, which should be constructed according to the requirements of the current relevant national codes for the fire, earthquake and water protection design of buildings.
- For a built-in station, appropriate measures should be taken to reduce the influence of noise and emissions on the surrounding environment.
- Environmental protection facilities of a built-in station should include a drainage system, ventilation system and waste disposal and noise reduction systems, embodying the concepts of energy conservation and environmental protection.
- A built-in station should be divided into separate fire protection zones, which are separated with fire protection walls without doors and windows from other functional rooms.
- Built-in stations should meet the requirements of GB50016-2006 Code for the Fire Protection Design of Buildings and GB50045-95 Code for the Fire

Protection Design of High-Rise Civil Buildings.

- A built-in station should be provided with an automatic fire control and alarm system, which should be connected with the fire control centre and meet the requirements of GB50116-98 Code for Design of Automatic Fire Alarm System.
- Earthquake protection facilities provided in built-in stations should comply with the relevant provisions or requirements of the Code for Seismic Design of Buildings (GB50011) and the Urban Earthquake and Disaster Protection Planning Standard (GB50413).
- Water protection facilities provided in built-in stations can refer to the relevant provisions or requirements of Test Methods for Waterproofing Sheets for Buildings (GB/T328.1 ~ 27).
- A built-in station should be provided with water supply and drainage systems, which should meet the requirements of GB50015-2003 Code for the Water Supply and Drainage Design of Buildings.
- If possible, natural ventilation should be used in built-in stations. If mechanical ventilation is used, it should meet the requirements of GB50016-2006 Code for the Fire Protection Design of Buildings and GB50067-97 Code for the Fire Protection Design of Garages, Repair Garages and Parking Areas.
- Various vacant lands, isolation lands and corner lands within a built-in station, as well as building walls, and roofs should be greened as fully as possible to increase the greening coverage of the station.
- A built-in station should be provided with emergency lighting facilities, which should meet the requirements of JGJ16-2008 Code for the Electrical Design of Civil Buildings and should be in strict accordance with the provisions of GB50034-2004 Standard for Lighting Design of Buildings.

- Emergency exits should directly lead to outside and should be provided with conspicuous signs and emergency lighting facilities.
- The headroom and net width of fire exits should not be less than 4m. In the case of land shortage, a turning lane can be used as a fire lane, but the lane should keep available.
- Pillars inside a station with pillared nets should be L-shaped angle steel columns of 100mm × 100mm × 5mm and of an appropriate height of 1m and should be stuck with reflective plates for bump prevention outside.

5.2.10 Information system

- A built-in station should be provided with a centralized scheduling management system, an information collection and dissemination system, a video monitoring system, a broadcasting system, a security and emergency response system, a traffic information query service system, etc., which correspond with the scale of the station.
- The network wiring of the information system should adopt invisible wiring.
- The information system should meet the requirements of CJ/T3010 Automatic Urban Public Transport Vehicle Monitoring System and CJ/T2 Urban Public Transport Communication System.

5.3 Parking lot requirements for supporting stations

Since there is an existing national standard for facilities related to parking areas, facilities related to parking areas should comply with the provisions of the national standard Code for the Construction Design of Urban Road Public Transport Stations, Termini and Depots (CJJ/T15-2011). Meanwhile, safety and environmental protection facilities should comply with the following requirements besides the national and industry standards:

- Emergency exits should directly lead to outside and should be provided with conspicuous signs and emergency lighting facilities.
- Pillars inside a station with pillared nets should be L-shaped angle steel columns of 100mm × 100mm × 5mm and of an appropriate height of 1m and should be stuck with reflective plates for bump prevention outside.

6 The system to guarantee the implementation of stations

(1) Clear the responsibility for the bus station

Bus station has a certain public welfare as an important public infrastructure supporting urban transport development. It should be make clear that the dpartment of transportation as the responsibility for its plan and supervision.

- Plan: Dpartment of transportation is responsible for the city's bus station planning.
- Construction: Government supervision, the company who get the land use right responsible for construct.
- Operation: Bus Station company responsible for the operating and management.
- Supervision: Dpartment of transportation is responsible for supervision.

There is difficult of coordination between different bus operate companies and bus station operate company. Due to the shortage of land resources, the government should designate the price of station service and the station should service to all of the bus operate companies which have demand.

(2) Effect Implementation mechanism

Standards and guidelines are formulated for exerting their effects ultimately to effectively promote and guide the construction of built-in stations. Moreover, the key to achieve these objectives is to establish a sound system to guarantee the implementation, specify the processes, intervention processes and implementation method of the system and ensure the smooth implementation of the standards so that the standards can exert their effects in practical applications.

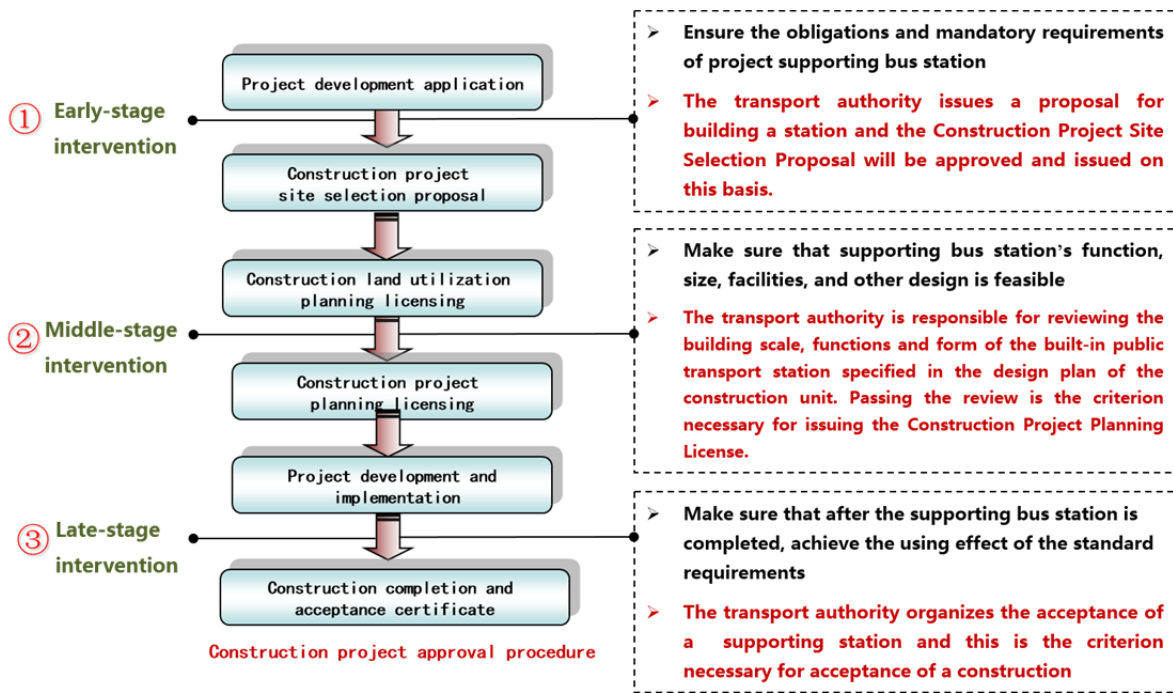


Figure 6-1 Insurance mechanism of supporting station

(3) Planning guarantee system

- It recommends that the city formulates the master plan of a public transport station: specifies the functions, types, overall scale and layout of the public transport station, incorporates the lands that are used for building public transport stations into the land utilization planning of the city.
- Focuses on the important aspects of land utilization planning control: Proposes the short and long-term construction goals, specifies the short-term public transport station construction plan and reserves lands for construction of public transport stations.
- Definitely control and guarantee the land used for the construction of the public transport station: Incorporate the public transport stations of the city into the yellow line range of the city and reflect this in the regulatory detailed planning, and guarantee the lands for construction of public transport stations.

7 Implementation countermeasures and suggestions of the comprehensive development of public transport stations

7.1 Enhance the overall planning

In the beginning of the implementation of a comprehensive development project, the concept of city management is introduced to enhance the preliminary planning of the comprehensive development of public transport stations. Through overall planning, achieve the following objectives:

- **By sorting the exiting station and city planning station land resources, determine the potential plots, help the government complete the reserve land in advance;**
- **Determine station function and comprehensive development scale, provide decision-making basis for the government to grasp the comprehensive development income and determine the distribution proportion of PPP cooperation model;**
- **Through conceptual design, clear comprehensive development and design conditions of station, provide the premise for designing the comprehensive development land with conditions, protect the implementation of station functions in the comprehensive development process.**

7.2 The introduction of strategic cooperation

Through strategic cooperation and introduction of funds and practice, the problem of insufficient funds for the early development stage of the project is solved. With the strategic cooperation partners with plenty experience in project development, the implementation of the comprehensive development of the project can be sped up. The abundant funds from the strategic investors, advanced management mode, market

operation experience and strategic resources ensure the success of the project. Close cooperation with strategic partners fosters the ability for the local company to implement the succeeding comprehensive development of the project easily.

7.3 Clear policy obstacles

(1) Promote the adjustment of land utilization planning

Change the nature of land utilization from “Transport Land” to “The Residential or Commercial Service Land with Transport Function”. Define this land as a public transport facility, which can be used jointly with other operating facilities. Affirm legitimacy of the comprehensive development of the public transport station area in the planning policy. Meanwhile, appropriately increase the planning volume rate of the lands used for public transport stations according to legal procedures, so that it is not less than the average volume rate of the commercial service land in the . This can ensure the feasibility of the comprehensive development of the public transport station area in terms of operation.

(2) Improve the land provision policy

Traditionally, a transport land is an allocated land, which can be used only for construction and operation of transport facilities rather than the development and construction of other nature. If we want to conduct the comprehensive development, we need to change the traditional views and establish operation mode appropriate for China’s circumstances:

- “Hierarchical land right”that is set up in the ground, on the ground or underground land to clear property rights by transport and property.
- Two ways of land transfer modes: one is the entire space transfer in one time by auction. And the second way is transfer different space in different type by the nature of land use.

The land sector can improve the relevant policies for hierarchical land provision according to the actual circumstances of hubs and the principle of encouraging intensive utilization, to clear the obstacles to the comprehensive utilization of public transport stations. Support the comprehensive development conducted by a single body. Enhance the ability of coordination between construction, planning and development to enable the construction of stations to be effectively integrated with the comprehensive development of the stations.

Second, establish the public transport station periphery land reserve system.

Refer to the case of Shanghai Hongqiao Hub. Ensure the provision of the operative lands around public transport stations by intervention of the Land Reserve Centre. Form an area that is integrally developed with public transport stations and has comprehensive functions according to the principle of “comprehensive planning and staged construction”.

7.4 Recommendations on the comprehensive development of public transport stations

(1) Development mode

Refer to the experience of rail comprehensive development, there are three modes of comprehensive development, “public-private joint venture and implement of integrated development”, “Public led and entruste private to implement of integrated development”, “Private led implement of integrated development”. As is shown in the following table:

Table 7-1 Bus station comprehensive development mode

Development mode	Land use owner (公开或定向招拍挂)	Construction	Operator	Profits distribution	Similar rail comprehensive development mode
Public-Private Partnerships mode	<ul style="list-style-type: none"> Joint venture to obtain land use rights Bus station operators and real estate development company joint ventrue 	Joint venture	Joint venture	<ul style="list-style-type: none"> Joint venture finance independent According to their investment distribute profits The public part's profits could subsidies station construction funds 	Shenzhen
Public led mode	<ul style="list-style-type: none"> The state-owned enterprise with station management experience obtain land use rights 	Public Sector commissioned a professional construction company to shoulder the responsibility of integrated development and	<ul style="list-style-type: none"> After the project is completed, transfer the station to public sector Public sector responsible for operation and management of station 	<ul style="list-style-type: none"> Distribute profits according to the agreement The public sector's profit to make up for the loss of the station transport operators 	Hongkong

		construction			
Private-sector led mode	Real estate development company which have comprehensive experience obtain land use rights	Private Sector	<ul style="list-style-type: none"> • After the project is completed, transfer the station to public sector • Government commissioned bus station operator responsible for operational management station 	<ul style="list-style-type: none"> • Government acquires profit in accordance with the land transfer contract • The government income could be taken as targeted subsidies to the bus station operator 	—

(2) Development Mode Select

Cities can select the appropriate development model according to their circumstances. Due to the government is weak control to make sure the bus station function meet the demand in the Private mode, it is recommended to choice Public-Privatd mode and Public led mode.

Table 7-2 Advantages and Disadvantages analysis for three modes

mode	Advantages	Disadvantages
Public-Privatd mode	<ul style="list-style-type: none"> • The joint venture company as a body, In favor of complementary advantages • Reduce negotiation costs and avoid unnecessary approval process • Reduce the governerment investment risk • Facilitate implementation of the station function 	<ul style="list-style-type: none"> • Multiple bus station operators is difficult to coordinate.
Public led mode	<ul style="list-style-type: none"> • Reduce the governerment investment risk • Facilitate implementation of the station function 	<ul style="list-style-type: none"> • The public (bus station operator) could have a high level of contract draft, legal matters. • The high cost of contract negotiations • Bus station comprehensive development profic is lower than subway, the privte part low interst in it.
Private led mode	<ul style="list-style-type: none"> • Development of high efficiency • Maximize the value of the land development 	<ul style="list-style-type: none"> • Bus station comprehensive development profic is lower than subway, the privte part low interst in it. • The government is weak control to make sure the bus station function meet the demand

(3) Development and implementation of procedures

■ The procedures of Public-Private mode

The Government commissioned a professional agencies for pre-planning, and land transfer by Tender, Auction and Listing to joint venture which combined by bus station operators and real estate development company. Joint venture responsible for the overall planning, “Traffic + Property” integration of comprehensive development and construction. Specific procedures are as follows:

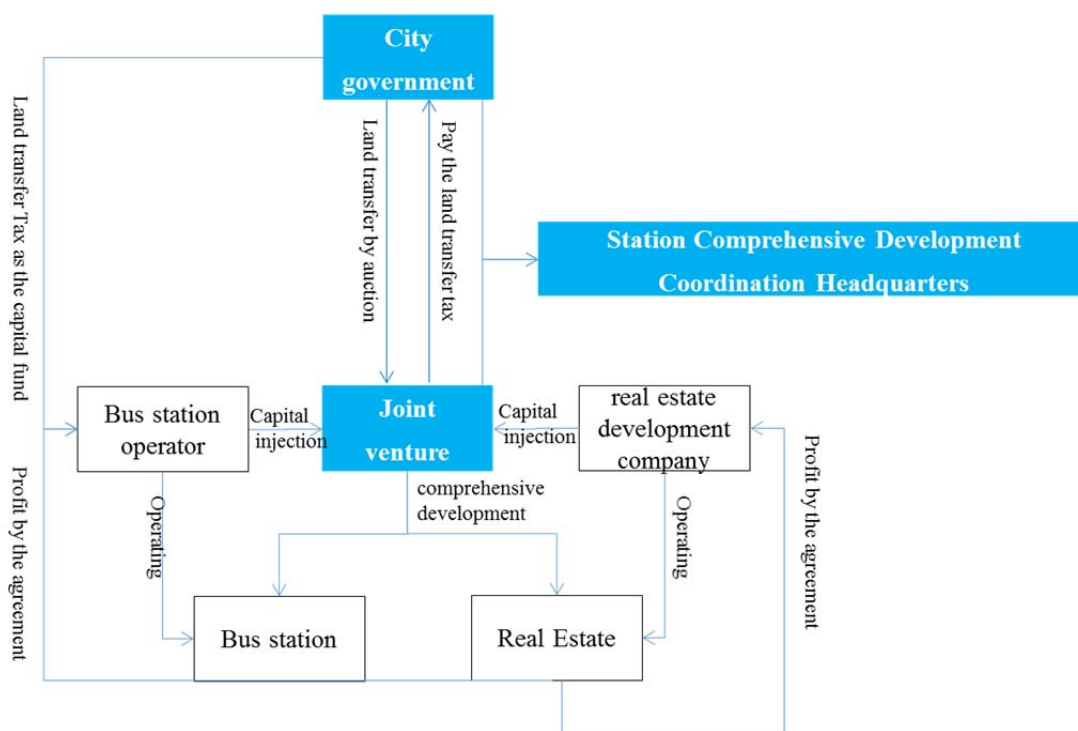


Figure7-1 Public-Private mode

■ Public led mode

The Government commissioned a professional agencies for pre-planning, then the land transfer by Tender, Auction and Listing to bus station operator. Bus station operator delegate a real estate developer to complete the comprehensive development. It will be transfer the bus station to the station operator and distribute the profit by the agreement when finish the construct.

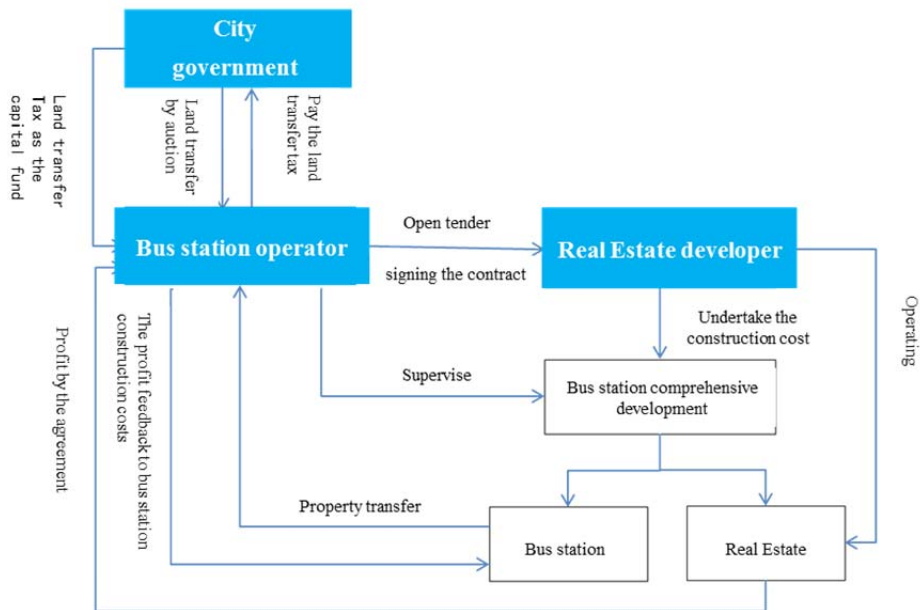


Figure 7-2 Public led mode

Summary

Through in-depth study of three topics, the project have the corresponding expression in advanced, guidance, operational and other aspects.

(1) **Advanced aspects**

Clearly bus positioning at different stages of city development (according to rail transit whether construction or not, the construction scale to distinguish different stages of development), proposed multi-level bus route network structure and put forward the concept of route layout , should be the bus route network as the rudder, the hub as the anchor, transfer to regional and hierarchical ideas.

About bus spot, emphasizes the people-oriented and pay attention to the passenger trip experience facility design ideas.

In the bus station planning and guidance design aspects, we put forward the principle of separation that based on the station functions, and the idea of develop urban on hub, encourage the comprehensive development of bus station.

(2) **Instructive aspects**

Summarizes the technical indicators of multi-level nets, propose specific methods of bus route network stratified layout, route regulation, route optimization techniques, cohesion optimization methods between regular bus and rail transit.

For bus spot facilities set, from planning, from construction, adjustment, maintenance, this four aspects propose the corresponding specific requirements.

This subject put forward planning and construction standards requirements for urban provided bus stations from several aspects, that is the station planning and site selection, station construction start threshold, the station construction content, station construction scale. At the same time, it proposes design requirement from the aspects of plane layout, space layout, buildings form and facility settings to provide planning and design guidelines for urban provided bus stations.

(3) Operational aspects

To guarantee the line adjustment can be implemented, the project proposed the institution in charge for urban bus line network research and adjustment, for metropolitan or urban agglomeration level, it makes a preliminary discussion on the possibility of establishing a metropolitan area / urban agglomeration Transportation Planning Commission or other institutions and proposes preliminary recommendations on institutional arrangements and responsibilities, the implementation of the program.

The study of bus spot, proposed station construction and maintenance management mechanism covering the whole process from four aspects, which is planning, construction, adjustment and maintenance, make the planning, construction, adjustment, supervision and management process clear, clear the responsibilities of relevant departments, it has an important role in ensuring the late standard guide for the implement.

To effectively promote and guide the development and construction of city bus station, ensure exercisable of this research results, with making a clear on the main bus station development, the project put forward corresponding implementation from implementation of provided stations and station land use planning, ensure that the research results can be implemented smoothly, and has application effectiveness in the practical.