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Research on the Planning of Rail Transit in Shanghai Metropolitan Area Facing Shanghai 2035

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RESEARCH ON THE PLANNING OF RAIL TRANSIT IN SHANGHAI METROPOLITAN AREA FACING “SHANGHAI 2035”

ABSTRACT

As the first international metropolis in China, the rapid economic growth brings about a continuous influx of population, and the urban traffic operation is facing new challenges. Shanghai puts forward the goal of accelerating the integration of rail transit in metropolitan areas and gradually forming a Shanghai metropolitan area with Shanghai as the center and radiating suburban new cities and neighboring cities such as Suzhou and JiaXing. At present, there are some problems in rail transit in Shanghai metropolitan area, such as imperfect development, a mismatch between supply and demand, unclear functional level, and imperfect policies. Under the background of "Shanghai 2035" in the new period, this paper explores and studies the coordinated development of multi-level rail transit in the Shanghai metropolitan area, taking higher quality development and high-quality life as the fundamental foothold of planning and implementation, highlights the world, faces the future, and always adheres to the highest international standards and the best level with a broader vision.

Key words: "Shanghai 2035"; Metropolitan area; Rail transit; Multi-level; Coordinated development

1 INTRODUCTION

The "Shanghai City Master Plan (2017-2035)" (hereinafter referred to as "Shanghai 2035") puts forward the strategic focus of transportation based on the multi-objective vision of urban development, and determines the integrated development of regional transportation in a multi-dimensional space. Take high-quality development and high-quality life as the fundamental foothold for the implementation of urban planning. "Shanghai 2035" clearly focuses on building a science and technology innovation center, and proposes innovation, coordination, greenness, openness, sharing "five major development concepts", as the core city of the Yangtze River Delta world-class urban agglomeration[1], the future comprehensive transportation development will move towards green development and sustainable development, which will be incorporated into the formulation of strategies at all levels.

2 DEVELOPMENT STATUS OF RAIL TRANSIT IN SHANGHAI METROPOLITAIN AREA

2. 1 Composition of rail transit in metropolitan area

A Metropolitan area is an urbanization spatial form with super-large cities or big cities with powerful radiation driving function as the center and 1-hour commuter circle as the basic scope. At present, the development of China's metropolitan area is in its infancy, and rail transit also presents a polarized situation. One is urban rail transit, which usually has a small distance between stations and a slow driving speed and only meets the short-distance commuting and life of citizens in this city. The other is the national railway trunk line, which is mainly a variety of high-speed railways, intercity railways, and ordinary railways that provide services for medium and long-distance trips between regions and cities. The barriers between the national trunk railway and urban rail transit have not been broken, the two rail transit have not achieved complete connectivity and transfer between different levels of rail transit, and there is a lack of rail transit system that provides regional passenger transport services for urban clusters and metropolises that breakthrough administrative divisions.

2.2 Scope of Shanghai Metropolitan Area and Current Situation of Rail Transit

2.2.1 Planning Scope of Shanghai Metropolitan Area

Shanghai Metropolitan Area is the third inter-provincial metropolitan area after Nanjing and Chongqing, including three provincial administrative regions (Shanghai, Jiangsu, and Zhejiang), involving nine cities, including Shanghai,

Suzhou, Wuxi, Changzhou, Nantong, Ningbo, Jiaxing, Huzhou and Zhoushan (Figure 1). Intercity railway in metropolitan area lies between regional intercity railway and urban (suburban) railway, which constitutes the aorta of metropolitan area development. In order to consolidate and enhance Shanghai's radiation and leading role in the region, comprehensively utilize the existing railway channel resources, strengthen the composite channel function of "trunk railway + intercity railway in metropolitan area", and form the basic pattern of "three circles and four corridors" according to the regional and urban spatial structure and intercity travel characteristics The five new cities (Jiading, Qingpu, Songjiang, Fengxian and Nanhui) constitute the first circle of the metropolitan area, while Nantong, Suzhou and Jiaxing constitute the second circle, relying on the peripheral circles of Ningqi Railway, Xinchang Railway, Xuanhang Railway and Xiaoyong Railway, radiating four corridors of Changzhou, Jiaxing, Huzhou and Ningbo Integrate urban (suburban) railway passages, improve the "two verticals and seven links" system skeleton of intercity railways in metropolitan areas, realize decentralized and networked spatial balanced layout, and promote network interconnection and integrated operation[2].

Fig.1 Cities within the Shanghai metropolitan area
Source: Real Estate World

Fig.2 Overall spatial structure of Shanghai metropolitan area
Source: National Spatial Planning

The planning determines that the "one-hour" travel time is limited to a reasonable spatial scale of the metropolitan area, that is, the traffic reachable range determined by the travel speed dominated by the regional intercity rail multiplied by the travel time (1-hour limit). Forms three functional levels within the Shanghai metropolitan area (see Figure 3): First, the main city with an active radius of 30 thousand meters is a commuter circle formed around the central active area, that is, the global urban core area; The second is Shanghai commuter circle with an activity radius of about 60 kilometers, which forms close business ties in some adjacent areas and stably forms cross-city commuter traffic demand on some external development axes; Third, is a Shanghai metropolitan area with a comprehensive breakthrough in administrative boundaries and an activity radius of about 150 kilometers. Planning highlights the traffic skeleton, strengthens the construction of important regional traffic corridors and hubs, and guides and supports spatial nodes. Cultivate comprehensive node cities along Shanghai-Nanjing, Shanghai-Hangzhou and Shanghai-Lake corridors, and cultivate professional node cities along Hutong, Yangtze River, Bay and Shanghai-Ningbo corridors (Figure 3). With reference to the standard allocation of urban transportation in big cities, each city forms a city-level external transportation hub. To strengthen the construction of regional intercity rail network, high-speed railway, intercity railway, urban railway and rail express line serve different time and space ranges, different cities and functional nodes, and form different speeds and station setting standard[3].

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Fig.3 Functional system planning of Shanghai metropolitan area

Source: Land Spatial Planning of Shanghai Metropolitan Area

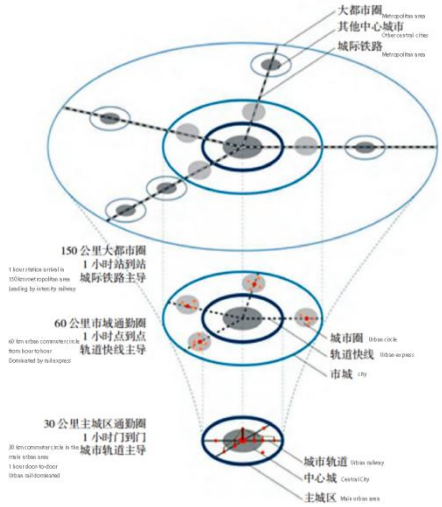

Fig.3 Functional layout schematic of three spatial scales of Shanghai metropolitan area

Source: Zhou Xiang. Comprehensive transportation coordination strategy of Shanghai metropolitan area based on high-quality development.Shanghai Urban Planning and Design Institute. 2018

2.2. 2 Current situation of rail transit in metropolitan area

There are four levels of rail transit in the metropolitan area: the first level is the trunk railway network serving the national strategic channel; The second level is the intercity railway network serving the urban agglomeration, which is the link between the central city and the secondary and tertiary cities of the urban agglomeration; The third level is the urban (suburban) railway network serving the metropolitan area, which mainly serves the development of "urbanization" in neighboring cities of the metropolitan area and the needs of "one-hour commuter circle" in metropolises; The fourth level is the urban rail network serving the inner city[4]. Although the above-mentioned different levels of networks have their own functional orientations, it is difficult to draw a clear line between the levels in the actual construction process, and the networks at all levels need to be compatible in function to a certain extent.

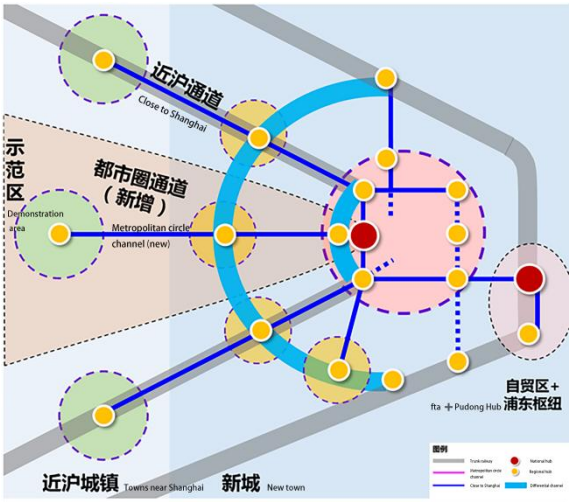

Fig. 4 Schematic diagram of urban (suburban) railway connection mode near Shanghai

Source: Shanghai Metropolitan Area Planning by building a multi-level and efficient transportation network with global access and global links. 2020

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2.3 Rail Transit Problems in Shanghai Metropolitan Area

Since the development of metropolitan areas in China is in its infancy, the lack of understanding of the travel characteristics of metropolitan areas has fundamentally restricted the development of urban rail transit, which is manifested in problems such as imperfect levels, unreasonable supply, unmatched demand, and unsmooth systems[5].

The metropolitan area is a spatial form between cities and urban agglomerations, because its concept is not clearly defined, the management system is not well established, and there is no clear allocation of facility construction and financial sharing. At the same time, urban rail transit is a public transportation system that integrates and develops multi-level rail transit. Its service scope and service population are not as small and short as urban rail transit, nor are they simple and direct from railway trunk lines. The functional positioning and service population of multi-level rail transit are not clear, and there is insufficient connection in planning layout, construction implementation, operation management and other links, which makes the service of intercity railway to the metropolitan area insufficient, and the operation organization mode of suburban railway is single and the service level is low. It is not high, the inner city track is excessively extended to the suburbs, the time is long, and the speed is slow. Intercity railways, suburban railways, and inner-city rails are all developing in the direction of integration, but without good integration measures, not only is it not convenient for people in the metropolitan area to travel, but it also causes a certain waste of resources. Due to the concentrated arrival and departure of long-distance trains during the morning and evening peak hours of main line railways, the current use of the remaining capacity of existing railways to run suburban trains is severely restricted, failing to meet the basic requirements of public transport and convenience. The development of new suburban railways is partly too advanced, and partly lags behind; the rail transit in the metropolitan area does not match the level of development along the lines. At present, the existing main railway lines in China present a barrier effect on urban development for a long time, the supporting facilities and related facilities along the railway lines. The industrial layout is lacking and the population distribution is small. This divides "city" and "railway" to a certain extent, so that people's "life" and "travel" have a clear sense of boundary. The two modes develop independently and the metropolitan area continues to develop, passenger flow is increasing day by day, and people's commuting distance is increasing. The system is not smooth, which is reflected in the fact that there are many constraints on the development of metropolitan rail transit. Due to the insufficient utilization of railway resources in the metropolitan area, the development along the line is backward, and the enthusiasm of railway enterprises is not high. It is difficult for local governments to communicate and negotiate with railway enterprises. At the same time, in the construction and operation implementation links such as the scale, standards, and renovation plans of existing railway facilities, the liquidation, negotiation and communication mechanisms between the road and the land need to be improved.

Facing the characteristics of multi-center, networked and diversified development, inter-city transportation interconnection has become the key direction of rail transit development. Different from the tight commuter circle in Tokyo with Tokyo as the single core, the Shanghai metropolitan area has formed multiple commuter circles of 30-50 kilometers in Shanghai, Nantong, Su-Xi, Xi-Chang and so on. There have been breakthroughs in cross-border transportation in core cities, but the lack of networking has resulted in low commuting rates. At the same time, due to the lack of intercity and urban (suburban) railway levels in the metropolitan area, the organization model of "high-speed rail + subway" leads to insufficient service depth and breadth.

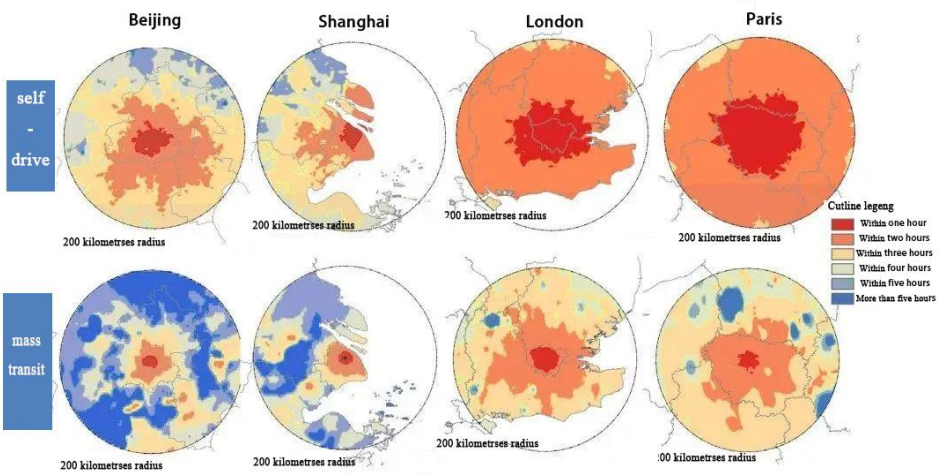

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Fig. 5 Accessibility analysis chart of urban centers in four metropolitan areas during peak hours
Source: Liu Miao, Zou Wei, etc. Research on Innovative Application of Operator Big Data in Planning Field [R].Shanghai Urban Planning and Design Institute. 2017.

However, the specific problems can go deep into the fact that the travel speed does not match the one-hour commuting and rail transit service in the metropolitan area, and the comfort level does not meet the development standards of the metropolitan area. According to the investigation and research, it takes 1 hour to more than 1 hour for the suburbs around Shanghai to reach the center of Shanghai, and the low speed of rail transit reduces the efficiency of daily commuting. Using the existing suburban rail extension service, the travel time will be longer, which cannot meet the requirements of long-distance and fast travel in Shanghai metropolis at all.

At present, the existing rail transit system in Shanghai metropolitan area-ordinary subway system, can not take into account the service system well when meeting a large passenger turnover during daily peak hours, and even the lines that do not cross the city center will be crowded during peak hours, with poor comfort. Especially for long-distance travel, without a comfort guarantee, the attractiveness of passenger flow will be greatly reduced. Moreover, changing routes for long-distance travel has become a major difficulty in daily travel. People can not realize the ideal state of travel as a service (MaaS). When changing different types of rail transit, they need to go through a series of in and out of the station security checks and other activities, which lengthens commuting time and reduces the commuting comfort experience. However, blindly expanding the length of the subway, extension the length of a single route makes the land resources wasted. Because the stretching along the track is too long, the service level cannot be guaranteed, and the flow of people along the suburbs is less, which also makes the industrial distribution uneven and makes urban development unbalanced. The center of gravity of the city is still in the prosperous areas such as the old city and Pudong New Area, which hinders the balanced development of the city to a certain extent.

3 "SHANGHAI 2035" TO THE DEVELOPMENT OF RAIL TRAISIT IN METROPOLITAN AREA

3.1 Development Orientation of Rail Transit in Shanghai Metropolitan Area

Shanghai is the core city of the world-class urban agglomeration in the Long Delta, and will build itself into an outstanding global city and a modern socialist international city with world influence. The urban spatial form of metropolitan area can be divided into three circles from inside to outside-the central area of the city, the peripheral area of metropolitan area and the expansion area of metropolitan area. The travel time in the center of the city should not exceed half an hour, the travel time in the peripheral area of the metropolis should be between half an hour and one hour, and the travel time in the expansion area of the metropolis should be between one and two hours[5]. Taking Shanghai metropolitan area as an example, the central area of the city is within the outer ring of Shanghai; the peripheral area of the metropolitan area covers all new cities and adjacent administrative with a radius of about 60km; the boundary of metropolitan expansion area is located in Changzhou, Huzhou and Ningbo, with a radius of 150km. Compared with the general metropolitan area, the rail transit at all levels in the metropolitan area should be positioned in a new function according to the actual situation, and any single rail transit level cannot fully serve the metropolitan area.

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Fig. 6 Railway Status Map of Shanghai Metropolitan Area

Source: Shanghai Metropolitan Area Planning by building a multi-level and efficient transportation network with global access and global links. 2020

To develop Shanghai metropolitan area into a world-class urban agglomeration, the development of rail transit needs the coordinated development of multi-level rail transit and it is necessary to optimize the layout of trunk lines and intercity railways for network integration through integrated connection and interconnection. Strengthen the integration and resource sharing of trunk railways, intercity railways, urban (suburban) railways and urban rail transit network facilities, link and coordinate system standards, technical standards, identification information, policies and regulations, promote the integration of operation organizations and transportation services, and give full play to the overall efficiency and benefits of the network. Closely link the planning of land and space, strengthen the management of "one map", highlight the core essence of "on track", coordinate the planning and layout of different track systems, accurately locate functions and divide labor, match supply and demand, reasonably determine service intervals, facility scale and construction timing, strengthen the support and guidance of rail transit for the green, smart, convenient and efficient development of regional integration. Adhere to the essence of service, give full play to the advantages of safe, reliable, intensive, efficient, green, low-carbon and backbone transportation of rail transit, strengthen the effective connection and convenient transfer between rail transit and other modes of transportation, strengthen the application of modern information technology, optimize the coordination of transportation organizations, and develop integrated, convenient, diversified and intelligent transportation services. Accelerate the establishment of an institutional mechanism to adapt to the integrated development of rail transit, fairly liberalize market access, encourage local governments to strengthen cooperation with market entities such as railway enterprises and urban rail transit construction and operation enterprises, promote reform and innovation in planning management, investment and construction, operation organization and comprehensive development. By 2035, build a Shanghai metropolitan area on the track of high-quality modernization, Realize the layout of trunk railway, intercity railway, urban (suburban) railway and urban rail transit facilities with one network, zero transfer between hubs and excellent operation service quality, so that Shanghai metropolitan area will become a model area for the networked, integrated, intelligent and green development of rail transit, and rail transit will comprehensively lead and promote the development of regional integration.

3.2 Concept and Thinking of Rail Transit Construction in Shanghai Metropolitan Area

3.2. 1 Shanghai metropolitan area based on the concept of urbanization

Urbanization means that when urbanization develops to a certain stage, neighboring cities in urban agglomeration or metropolitan areas realize rational allocation of resources and elements so that the flow of elements is not constrained by urban distance and system, and the access of elements between cities is realized in a short time, and the level of public services and infrastructure between cities is equalized. Being in a new development pattern in which the big domestic cycle is the main body and the domestic and international double cycles promote each other, facing the development requirements of globalization, integration, and urbanization of the Shanghai metropolitan area, we should actively carry out all-round and high-level opening at a deeper level and in a wider field. The comprehensive transportation system should closely follow the two key words of "integration" and "high quality", adhere to the basic ideas of "overall coordination, network docking, and mode transformation", and build systematic actions with sub-circle system layout, multi-hub system guidance, and composite corridor support, so as to realize the transformation from paying attention to central city activities to enhancing overall regional competitiveness.

3.2. 2 Multi-level rail transit coordinated development mode

The coordinated development of multi-level rail transit is to realize the "four networks integration"[6] of rail transit. The Metropolitan area is the key area to implement the "four networks integration" of rail transit, and urban express rail is an important carrier to promote the "four networks integration" of rail transit. The development of trunk lines, intercity railways, and urban rail transit in the Shanghai metropolitan area has been relatively mature and perfect, so it is difficult to seek the integration of trunk lines, intercity railways, and urban rail transit in the train control system,

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signal, and ticketing. In recent years, the development of urban railways has been an important opportunity to realize the integration of four urban networks [7].

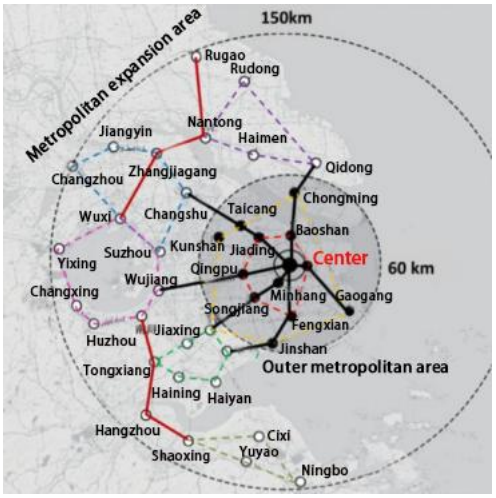

Fig.7 Construction of Shanghai Metropolitan Area in the same city
Source: Shanghai Metropolitan Area Urban Express Rail Network Planning Research

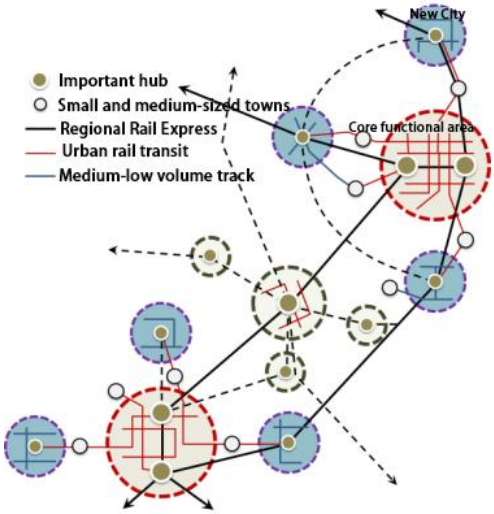

Fig. 8 Schematic diagram of the connection between multi-mode rail transit and hub
Source: Shanghai Metropolitan Area Planning by building a multi-level and efficient transportation network with global access and global links. 2020

Urban express rail refers to the passenger rail transit lines within the urban area of big cities, which serve between cities and suburbs, central cities and metropolitan cities and key towns, etc. The service scope is generally within 100 kilometers. The public transportation between the central city and metropolitan cities, suburban new towns, or airports has the characteristics of relatively small passenger flow and long travel distance, which should be undertaken by express vehicles with higher speed grades. The seat arrangement mostly adopts horizontal seat arrangement or mixed arrangement of the horizontal seat and vertical seat. An urban express rail is an important form of urban rail construction, and it is also a rapid development form of rail transit in China. Urban rail transit according to the regional characteristics of the lines, there are two types of central city lines and urban lines. Following this idea, the rail transit system is also divided into two levels: urban rail transit and urban rail transit. The former is used to connect the main traffic nodes in the central area of the city, while the latter is used to connect the edge of the city, suburban new towns, or airports.

Urban express rail is divided into upward integration and downward integration in the integration direction, upward integration of railway trunk lines and intercity railways, downward integration of urban rail transit, and a combination of the existing three rail transit modes. In the fusion form, it can be divided into transfer fusion mode and cross-line fusion mode. Transfer mode means that although it is necessary to transfer through the hub during transfer, the ticketing exchange and security check between networks are mutual trusts, and passengers do not need to re-purchase tickets and security check during transfer, which can achieve the goal of "non-inductive transfer"[5]. Cross-line integration is a more advanced and perfect integration system; The line can meet the requirements of dual-flow trains running under two different power supply systems: AC 27.5 kV and DC 1500V, which means that trains can run on a fast railway track or switch to slow urban track. It not only has the characteristics of the fast start and stop of subway vehicles and public transportation operations but also has the characteristics of the high speed and comfort of intercity trains.

Therefore, the integration of urban railway and rail transit should be promoted, and the coordination between urban railway and rail transit should be taken into account. Under the condition that the railway trunk line and the intercity railway have a cross-line transfer with the city railway at the same time, the intercity railway should be given priority. Intercity railway is a supplement to the railway trunk line and an extension of urban rail transit. Compared with the railway trunk line, the intercity railway is more flexible and different from the urban rail in cross-city passenger transportation. Intercity railway is built to enhance the transportation links between adjacent cities in the urban

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agglomeration, which is different from urban rail transit that serves the passenger flow within cities and suburbs, and other railways that mainly undertake cross-regional passenger and freight transportation; Cities connected by intercity railways have close economic ties with each other, high passenger flow intensity, and their passenger flow has the level of public transportation.

In the process of promoting the integration of the four networks, we should give priority to the top-level design, make overall plans for the integration modes between different levels of rail transit, make no difference in the supplement and connection modes between networks, and try our best to meet the needs of most travel modes in different time and space. Construct the institutional mechanism of multi-network integration and adaptation, build an efficient and smooth coordination mechanism of rail transit at all levels, and eliminate the institutional obstacles of rail transit network integration. Improve the network integration service level from the perspective of passengers' travel, focus on the interconnection of service interfaces between networks at all levels, strive to achieve one-ticket direct travel and mutual trust in security inspection, improve the connection of train operation between networks, and improve the transfer efficiency and service level of passengers traveling across networks within hubs. Deepen the exchange and sharing of operational information across networks, build a four-network operational information fusion platform for passengers, provide passengers with the best path planning for cross-network travel, display comprehensive information on the operational status of rail transit at all levels, and realize real-time information sharing of rail transit at all levels.

3.3 Effects and influences of metropolitan rail transit construction

The indicators of the development level of the metropolitan area include five indicators: economic strength, population agglomeration, innovation ability, public services, and transportation facilities. Among them, the construction of high-efficiency public transport facilities is building the spatial structure skeleton of the metropolitan area. The urbanized development of metropolitan traffic is a strategic choice for regional cooperation, strengthen the interconnection of cities in the metropolitan area, multi-network integration, and explore the coordinated development of cross-city traffic in the Shanghai metropolitan area. The improvement of rail transit will promote the transformation of a single facility network planning to a three-dimensional service network, promote the interconnection of key nodes, and realize the improvement of space quality under the guidance of rail transit through the efficient use of multi-level space; Collaborative sharing to enhance regional The level of urbanization of transportation services, and the process of urbanization of transportation will accelerate the spatial flow of various elements and promote the integration of resources within the circle.

The renewal of rail transit will bring new influences in terms of optimizing urban layout, influencing changes in industrial structure, and promoting economic growth. Rail transit is embedded in the city center and marginal areas, and through the guidance of population and capital, it changes the urban structure and makes the urban production factors and resources distributed in a reasonable and orderly manner. Perfecting the construction of rail transit in the metropolitan area of Shanghai will have a far-reaching impact on expanding the scale of the city and accelerating its development. Urban layout will also be affected by the layout of rail transit routes. The improvement of rail transit improves the living environment and investment environment of residents, makes travel more convenient for residents, and will certainly promote people's enthusiasm for travel and communication. Developed areas transmit technology, talents, information, and funds to underdeveloped areas through rail transit networks. At the same time, underdeveloped areas transfer labor resources to rapidly developing areas. This two-way complementarity makes the resources in the region rationalized and evenly distributed. It not only taps the industrial advantages of surrounding cities and improves the industrial structure. Formation and development play a vital role. A complete transportation system is the cornerstone of the development of the metropolitan area, and the rail transit system is an important factor affecting the radiation range of the metropolitan area[8]. Break through the administrative boundary restrictions through rail transit, and improve the overall functional level and core competitiveness of the area where it is located by guiding the surrounding cities to drive the economic development of the entire region.

Urban rail transit can not only provide favorable conditions for the development of various industries in central cities, but its own investment and construction are also one of the driving forces for regional growth. On the other hand, rail transit can also drive the development of related industries outside the city and the entire industrial chain. Generally speaking, it takes 8 years for an urban rail transit line from design to formal completion and opening to traffic. Long-term huge investment can stimulate the sustainable development of related industries. The equipment and

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technologies involved in the construction of rail transit are emerging industries with high technological content and human capital.

4 SHANGHAI-SUZHOU RAIL TRANSIT AND SPATIAL INTERACTIVE DEVELOPMENT

4.1 Shanghai-Suzhou Regional Coordinated Development Concept

Intercity railway and urban (suburban) railway network in metropolitan area should be integrated into a system, and share the needs of regional and urban business and commuting links. Through cross-line operation organization, the interconnection between the two networks is realized, and the business and commuting links in the metropolitan area are jointly served. Intercity railway and urban (suburban) railway stations in metropolitan areas should be set up in combination with major city centers and important hubs, it is laid along diversified demand corridors such as intercity and city business, commuting and leisure, so as to strengthen the direct connection between Suzhou and the main functional centers of surrounding cities, improve the convenience and directness of services, and promote the integrated development of regions and cities. At the same time, the city pays attention to the sharing of channel resources, gives full play to the city service functions of intercity railway and urban (suburban) railway in metropolitan area, intensively utilizes channel resources, and realizes the interconnection and unification of standards between intercity railway and urban (suburban) railway networks in metropolitan area, thus providing guarantee for the later network operation organization. In order to speed up the implementation of the integrated development strategy of Yangtze River Delta and integrate into Shanghai metropolitan area, Suzhou promotes Shanghai and Suzhou to be in the same city by strengthening regional coordination in ecological environment, industrial innovation, transportation system, facilities and services and cultural network, and jointly builds the core area of the world-class urban agglomeration in the Yangtze River Delta. Leading the construction of world-class lake areas and ancient towns in the south of the Yangtze River around tai Lake, and building a national ecological civilization construction demonstration zone and a new economic agglomeration zone. Promote the coordinated development of Suzhou, Wuxi, Changzhou, Suzhou and Zhejiang, and improve Suzhou's radiation driving ability in regional development. Suzhou can play a leading role in the development of surrounding cities in Shanghai metropolitan area. *4.2 Interaction between Shanghai and Suzhou Metropolitan Area*

Suzhou is located in the middle of the Yangtze River Delta and the southeast of Jiangsu Province. It is bordered by Shanghai in the east, Wuxi in the west, Jiaxing and Huzhou in the south and Nantong across the river in the north. The terrain of city is low and flat, with a slight inclination from northwest to southeast, dense rivers and lakes, broad plains and low hills dotted. It is a famous water town in the south of the Yangtze River. Shanghai metropolitan area and Nanjing, Hangzhou, Suzhou-Wuxi-Changzhou and Ningbo metropolitan areas will further form a relationship of "mutual hinterland and mutual promotion". The most noteworthy word of "Shanghai Metropolitan Area" is "Suzhou". The average distance between Shanghai and Shanghai metropolitan area in 2018 is 37.8 kilometer, and about 70% of the intercity travel distances are concentrated within 40 kilometer. The intercity transportation links show obvious short and medium distance characteristics. Among them, the first direction of Suzhou intercity contact is Shanghai, accounting for about 38% of Suzhou's total outbound travel; In addition, the inter-city business commuter passenger flow accounts for a large proportion, showing the characteristics of high frequency and regularity. Taking the travel between Shanghai and Soviet Union as an example, the survey data of railway passenger stations in 2013 showed that business, official business and commuting accounted for 40% of the travel volume of Shanghai-Soviet Railway, and 40% of people made more than four trips a month. Through the analysis of the starting and ending points of intercity railway passengers from Suzhou to Shanghai in 2018, it is found that 80% of intercity railway passengers are concentrated in the central areas of Shanghai and Suzhou, and the development trend of regional traffic urbanization is remarkable. The top three places of residence of cross-city commuters flowing into Shanghai are Kunshan City, Taicang City and Suzhou City, accounting for 72.4%, 14.2% and 5.3% of the total respectively, accounting for more than 90% in total. In addition to working in Shanghai from neighboring cities, people in Shanghai also work in neighboring cities. Kunshan, Taicang and Jiashan are the main working places of commuters in Shanghai, accounting for 64.0%, 15.6% and 6.6% respectively. The commuting between Shanghai and Suzhou makes it more necessary to speed up the connection of Shanghai-Suzhou rail transit, and the coordinated development of Shanghai-Suzhou rail transit will greatly improve the commuting efficiency of the two cities.

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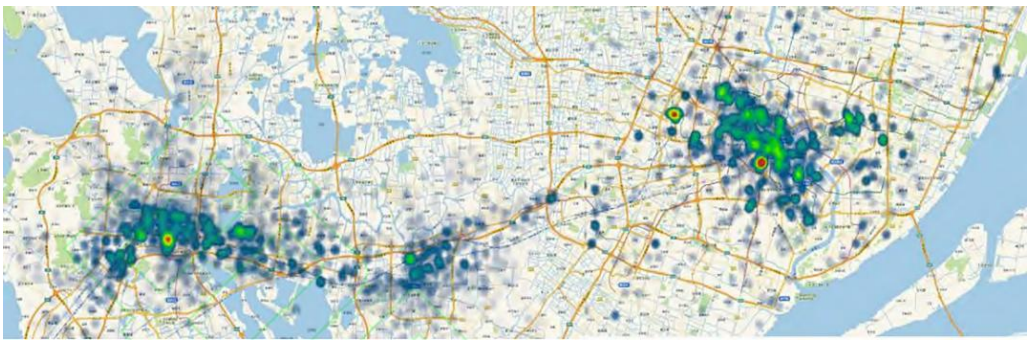

Figure 9 Distribution of passenger starting and ending points of Suzhou-Shanghai intercity railway in 2018
Source: China Urban Planning and Design Institute. Study on Intercity Traffic Passenger Flow Characteristics and Its Impact on Space Based on Multi-source Data [R]. Suzhou: Suzhou Natural Resources and Planning Bureau, 2018

Due to the serious lack of intercity railways and urban (suburban) railways, and the concentrated and continuous growth of intercity demand in Shanghai-Nanjing Passage, the capacity and timeliness of short-distance railway travel between Shanghai and Jiangsu are insufficient. According to the calculation, the saturation of Shanghai-Nanjing Corridor reaches 90%, and the transportation capacity of Shanghai-Suzhou-Wuxi section is the tensest. At the same time, although the existing urban rail transit mode of Huaqiao section of Shanghai Rail Transit Line 11 meets the cross-city travel demand of some Shanghai-Soviet border areas to a certain extent, which is of great significance to the demonstration of integrated development, the timeliness of this mode in serving the cross-city connection between Shanghai-Soviet city centers is still poor. Taking Suzhou Station to Shanghai People's Square as an example, the whole journey time of urban rail transit mode exceeds 3 hours, which obviously cannot meet the higher level of urban travel requirements of Shanghai and Suzhou in the future. Therefore, upgrading the level of transportation hub and improving the construction of rail transit are the primary tasks for Suzhou to fully integrate into Shanghai metropolitan area. By 2035, the whole city will build an integrated rail transit network with a total mileage of about 2,320 kilometers, including the national railway trunk line, intercity in metropolitan area, urban (suburban) railway and urban rail, with complementary functions, direct connection, services sharing and intensive resources. Fully integrate into the Yangtze River Delta integrated track network. Construct a multi-level docking system to strengthen the same city of Shanghai and Jiangsu, support cross-river integration and serve the integration of Suzhou, Wuxi and Changzhou.

4.3 Benefits of Rail Transit Construction in Shanghai-Suzhou Metropolitan Area

Since the second meeting of the Thirteenth National People's Congress in 2019, my country has proposed to upgrade the integrated development of the Yangtze River Delta region to a national strategy. At the Yangtze River Delta Integrated City Promotion Conference held in November 2020, Xu Kunlin, Secretary of the Suzhou Municipal Party Committee It is proposed that Suzhou should be deeply integrated into the construction of the Shanghai metropolitan area, and actively explore and promote the "integration of Shanghai and Suzhou"; during the "two sessions" in 2021, the Suzhou CPPCC organized a "suggestion for the integration of Shanghai and Suzhou in the Yangtze River Delta" Symposium. The "Shanghai-Soviet integration" has been reflected in all aspects of people's lives in the two places, such as the integration of the two places to benefit the people and the interconnection of various infrastructures. The development concept of "Shanghai and Jiangsu in the same city, transportation first" also reflects the importance attached by the country, the governments of the two places and the people's government to the connection between transportation. The smooth connection of rail transit between the two places has made the urbanization of Shanghai and Jiangsu no longer a mere theory. It can successfully solve important issues such as mutual exchange and circulation of talents between the two places, smooth economic and trade exchanges, and mutual linkage of policy support. The move to integrate into Shanghai has enabled Suzhou to have more development opportunities and a more stage for the world, and to a certain extent, Shanghai has given Suzhou certain economic support; at the same time, Suzhou has also brought more opportunities to Shanghai. The driving force for development will give Shanghai super-high-speed development technology, venue and other support.

Suzhou cooperates with Shanghai to create a number of high-tech industrial parks, which promotes a number of scientific research cooperation to connect with Shanghai and become the "back garden" of Shanghai's scientific and technological research and development. This is undoubtedly a kind of motivation and sense of security for Shanghai's technology and talents to come to Suzhou. "Shanghai and Suzhou integration" is both an opportunity and a challenge for Suzhou. Suzhou's economic growth in the future cannot be separated from the radiation of Shanghai's

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technology and talents, and it cannot be separated from the determination of the Suzhou government to implement the integration with Shanghai.

5 CONCLUSION

Transportation can support urban social and economic activities and can also shape a new pattern of urban and even regional development. When urban development and transportation development change from incremental development to excellent development, it is necessary to change the development mode from increasing transportation facilities to the coordinated development of organized and multi-organization modes, and more attention should be paid to developing a more efficient and comprehensive composite network structure. Moreover, it is necessary to optimize the information and management platform, build the overall facility network, operation organization network, and information guidance network, and realize the comprehensive operation and control of many parties. Under the background of the current integrated development of the Yangtze River Delta, Shanghai should focus on "30, 45, and 60" as the transportation goals (i.e., 30 min to realize internal commuting and contact with surrounding central towns, 45 min to reach cities near Shanghai, central cities and adjacent new cities, and 60 min to connect international hubs[8]), supporting the multi-level urban rail transit network with energy level improvement and external radiation enhancement of the main city and five new cities. Urban rail transit express line will play an important supporting role in improving the overall benefit and efficiency of the multi-level rail transit network. The planning and construction of the urban express line network should stand at the height of sustainable development of Shanghai city and transportation and be considered as a whole according to the functional positioning of each line. It is suggested that in the new round of construction planning projects, combined with the construction of five new cities and key areas such as the Yangtze River Delta Demonstration Zone, priority should be given to the planning and construction of the rail transit express line network. At the same time, in the development of the five new cities, the traffic rail transit system forms a supplement to the rail transit express network and rapidly promotes the optimization and improvement of the multi-functional hierarchical rail transit network in the Shanghai metropolitan area so as to better support the sustainable development of spatial layout and provide passengers with higher quality travel services. Make the rail transit in Shanghai metropolitan area truly meet the requirements of commuting within1-hour, non-inductive transfer between stations and lines, and comprehensive and thoughtful service system, and further promote the development of the Shanghai metropolitan area to an international metropolitan area with higher level and higher productivity.

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