Development assessment of the Yangtze River Delta high-speed rail hub area based on accurate identification of customer groups:Threshold, differences and core space

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Summarize : Every station must become a citylt is a boom in the construction of high-speed rail hub areas in China, but the actual development situation is not ideal.From the perspective of the customer group, LBS full travel chain quantitative analysis was used to evaluate the customer group structure, behavior characteristics and functional layout of 50 major high-speed rail hubs in the Yangtze River Delta. The study found that there was a "double threshold" phenomenon in the development of the hub area, the size and structure of the customer group. The functions of the hub area are related to the characteristics of people such as business, commuting and leisure of "station activities", and are divided into three categories: regional function-led, urban function-oriented and characteristic function-oriented. The functional layout takes 1.5 km around the hub as the core space, and the refined design that is aimed at the customer group and different from station to station is the core grasp to enhance the space in the hub area. In addition, customer groups and functions have a two-way effect and should be objectively understoodHub fixed customer group,Group setting function, the technical logic of functional layout, while paying attention to the reaction of space on the customer group, and building a smart platform to dynamically monitor customer group changes.

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Keyword: Portrait of customers; Accurate identification; High-speed rail hub of Yangtze River Delta urban agglomeration; Development assessment

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At the end of 2023, the national high-speed rail business mileage reached 45,000 km, high-speed railStation Super1000 seats, an increase of nearly 3.5 times in the past 10 years, especially in the Yangtze River Delta region, with a high-speed rail operating mileage of 7100Km, accounting for nearly 1/6 of the country. The comprehensive development around the high-speed rail hub area has become a major initiative for the development of various cities, with the construction of a number of high-speed rail new cities and high-speed rail business districtsGrow vigorously[1],"Every station must be a city" has become a trend, but the actual development and construction conditions are not ideal.In this context, the state ministries and commissions jointly issued a document "Guiding Opinions on Promoting Rational Development and Construction in Areas around High-Speed Railway Stations", proposing that "adhere to the planning guidance, fully demonstrate the feasibility and necessity of development and construction around high-speed railway stations, prevent blind pursuit of scale and quick work, and promote the surrounding areas of high-speedReasonable and orderly development and construction." Therefore, it is crucial to study the feasibility and planning path of the comprehensive development of the high-speed rail hub area.

1 Research origin and research methods

1.1 Passengers in the hub areaGroup researchThe significance of

Regional integration development promotes closer links between cities[2], the scope of people's residence, employment and travel has changed from "city" to "regional" [3], and cross-regional travel has continued to grow with the encryption and strengthening of the high-speed rail network. Compared to the low-frequency, long-distance interregional customer groups in the past, there are more and more high-frequency, medium- and short-distance intercity guest groups, such groups for cross-city business, Tongle and leisureAnd medical treatment as the main purpose, is more sensitive to time, and travel more wants to "enter the station when you go out, and arrive at the station as the destination" [4]. As the high-speed rail passenger group structure evolves to "high frequency, short distance, high time value", it has spawned business exchanges, public services, hotel leisure, exhibition trade and other It can be seen that the hub passenger group is the driving force for the comprehensive development of the high-speed rail hub area, customer group changes are a key factor in promoting the renewal and iteration of the hub area. Comprehensive evaluation and science of the development of high-speed rail hubs based on the perspective of customersGrindJudgment, with academic and practical value.

1.2 Customers in the hub areaGroup researchSum up

FollowAt the beginning of the 21st century, scholars at home and abroad conducted a lot of research on high-speed rail hubs, mainly exploring the hubs themselves and the development model of hub areas, mostly from the perspective of supply, such as the functional distribution and spatial layout of hub areas. Schutz [5] and Boer[6] A spatial

structure model of "3 development zones" around high-speed rail stations is proposed. Zheng Degao[7]The "node-one-place" model [8]Applied to the space layout around the high-speed railway station, a circle-layer space layout model is proposed. Subsequently, some scholars expanded the "node-one-place" model to "node"OneArenaOneThe "Passer Flow" model [9] further expands the research of macro-level hub areas. In contrast, existing research has paid less attention to the hub customer group from the perspective of demand, mostly focusing on the study of passenger flow and customer group structure prediction methods, with a view to planning for the hub areaFor the foundation. Yan Weidong, etc.[10] Zhou Langya et al. has built a railway hub passenger flow forecasting method based on network analysis using the integrated transportation network as the medium [11]A short-term passenger flow prediction model of the high-speed rail hub is proposed based on factors such as surrounding land. Wang Jingyu and others[12] Establish a quantitative passenger flow assessment system through the analysis of the population distribution mode of railway hubs, and guide the design optimization of comprehensive railway hubs.

It can be seen that there are high-speed rail hubsGroup researchIt is mainly used to guide the design and construction of the hub's ontology architecture, etc.[13], the analysis of customer group structure and demand is mostly qualitative and fuzzy, making it difficult to accurately support research on the development of hub areas [14]. This paper establishes a precise technical method for the identification, analysis and evaluation of the hub group, focuses on the accurate portrait of the customer group, quantitatively analyzes the characteristics of the scale and structure of the hub group, the activity and distribution of the hub group, and realizes the scientific evaluation of the development of the hub area.

1.3 Research method for accurate identification of hub customer groups

Research data using the Yangtze River DeltaLBS whole process travel chain data. First, on the basis of multi-dimensional cleaning of the original data, the purpose of travel is judged according to the scene label information and the stay time of the passengers after arriving at the station, and accurately identify the structure of the passenger group.Secondly, quantitatively identify the spatial characteristics and functional requirements of the activities of the group according to the travel time and space trajectory of the group. Finally, the overlapping hub customer group structure and spatial distribution agglomeration characteristics, and evaluate and analyze the hub development types.

1.3.1 Based on destinationPrecise lake sourceGuest group portrait analysis

First of all, accurately identifying the destination of the group of passengers will be defined as the number of people who only take the train in the hub, and will be on the train and around the hubPeople who have carried out activities within 5km (except for the hub itself) are defined as "stop-to-station activities":

$$P_t = P_{All} \cap P_{rail} \text{、} \quad P_z = P_{rail} \cap P_{5\,km}$$

Among them,Parking lot_TIndicates the crowd on the bus, P_{ALL}Represents all guest groups,Parking lot_ZExpressing the "on-station activity" crowd,Parking lot_{Rail} ∩ Parking $lot_{5Kilometre}$Indicates the number of people taking a train at the hub and moving within 5 km around the hub.

Define the "station activity" crowd coefficient as the ratio of the "station activity"

population to the passenger population, reflectingThe number of "at-station activities" in the hub passenger group, the high "at-station activity" crowd coefficient is mainly based on activities around the hub after arriving at the station, and the low "at-station activity" crowd coefficient is mainly based on transit within the hub:

$$E=P_z / P_t$$

AmongE represents the crowd coefficient of "station activity". Secondly, accurately trace the activity chain and length of stay after the arrival of the group, and determine the portrait of the group by staying longer than 1 hour and being the most important travel destination in the travel chain. The first category, cross-city business travel group refers to travel by train, the travel track point is a business office building, the duration of stay is more than 1 h and more than the stay in the leisure areaThe second category, cross-city leisure crowd refers to traveling by train, and the travel track point is the sceneryTourist areas, shopping areas, entertainment venues, people who stay for more than 1 hour and stay more than in business areas; third category, cross-city commuters refer to long-term residence and work places (more than 3 months) located in different cities and regularly take high-speed railCarrying out Tongle'sCrowd; category 4, other customer groups, that is, customers other than the above 3 categories,Its cross-city travel purposes include transportation transfer, medical treatment in different places, visiting relatives and friends, etc..

$$P_X=P_{X1h}-Max(T_X)、\quad P_C=P_A-\Sigma(P_X)-P_B、$$

$$P_T=P_A-P_X-P_C$$

Among them,Parking lot$_{Unknown}$Represents business or leisure people, $P_{Centigrade}$Represents the commuter crowd, P_TRepresents other groups of customers. Parking lot$_{X1H}$People who stay in business or leisure areas for more than 1 hour, Max($T_{Unknown}$) indicates a person who has stayed longer in other types of functional areas than in that category. Parking lot$_A$It means all the people on the bus, P_BPeople who work and live in the same city.

1.3.2 Analysis of spatial activity agglomeration characteristics based on the precise identification of the space-time behavior chain of the guest group

First, establish a hub customer group residence duration algorithm, calculate the amount of activity of the circle population with "frequency superimposed duration of stay" [15]. Count the activity of the population in the circle, and in the inner circleProgressive occupation.The ratio growth rate is greater than the proportion of the outer circle, and the spatial distance in the growth stage is the criterion for determining the quantified identification of hub customersGroup coreRange of activity and radiation impact range:

$$Lr = \frac{\sum(R_S + R_X + R_T)}{\pi(2r - 1)}$$

Among them,Lr is the number of customers from the hub r m, $R_{Small\ size}$, $R_{Unknown}$, R_TFor the number of business groups, leisure groups and commuter groups within r to r+50 m from the hub, π(2r-1) is the ring area with an inner diameter r-50 m and an outer diameter of rm.

Secondly, accurate tracking4 types of customer group travel chain, coupled spatial information identification function types[16], evaluation and analysis of different types of customersGroup functionSpatial distribution of activity requirementsFeatures.

1.3.3 Analysis of hub development types based on the coupling of customer group structural characteristics and spatial activity distribution characteristics

Define the "stop activity" crowd structure index toBased on the 4 types of hub customer group portrait structure, combined with the sensitivity of the customer group hub activity assignment of differentiated weights, weighting constitutes the "at-station activity" crowd structure index, reflecting the differences in the overall structure portrait of the hub group:

$$F=P_{X1}\times R_{(Px1)} + P_{X2}\times R_{(Px2)} + P_c\times R_{(Pc)} + P_T\times R_{(Pt)}$$

Among them,FahrenheitRepresents the "station activity" crowd structure index,Parking $lot_{Unknown1}$Representing business people, $P_{Unknown2}$Leisure crowd, $P_{Centigrade}$Represents the commuter crowd, P_TRepresents other customer groups, $R_{(Px1)}$Represents the sensitivity coefficient of the hub activity of the business population, $R_{(Px2)}$Represents the sensitivity coefficient of the hub activity of leisure people, $R_{(Pc)}$Represents the sensitivity coefficient of the hub activity of the commuter population, $R_{(Pt)}$Indicates the sensitivity coefficient of the hub activity of other groups of people,

Define the guestGroup spaceThe activity range index is hub customersGroup coreThe sum of the range of activities and the range of radiation influence reflects the distribution of functional activities after the hub group arrives at the station:

$$X=D+K$$

Among them,X indicates the guestGroup spaceActivity range, D indicates the core activity range, and K indicates the radiation impact range.

Based on the "node-one-place" model proposed by Bertorin[7], using the "station activity" crowd structure index and customers respectivelyGroup spaceActivity range index, quantificationHigh evaluationThe value of nodes and sites in the railway hub area. Take the "at-station activity" crowd structure index F as the "node" dimension parameter, with

customersGroup spaceThe activity range index X, as a "place" dimension parameter, comprehensively analyzes the development type of the hub area based on the coupling relationship of each hub in the "node-place" model, combined with the customer group structure and activity demand characteristics.

1.4 Research objects

1.4.1 Object definition: 50 major high-speed rail hubs in the Yangtze River Delta

Within the Yangtze River DeltaBased on 119 railway passenger stations in 41 cities, focusing on high-speed rail hubs as the mainTo be studied, the main high-speed rail hub studied in this paper is defined by the standard of opening more than 2 lines and more than 1 of which must be a high-speed rail or intercity line and no less than 100 trains per day. There are 50 standard-based hubs in the Yangtze River Delta, including 4 hubs in Shanghai, 16 hubs in Zhejiang Province, 19 hubs in Jiangsu Province and 11 hubs in Anhui Province. See Table 1.

1.4.2 Building a platform: Yangtze River Delta high-speed rail hub information platform

Build a Yangtze River Delta high-speed rail hub information platform, integrate multi-dimensional big data such as customer groups, functions, maps, etc., as a data base for researching and evaluating the development of high-speed rail hub areas. Among them, the customer group trajectory data contains information about 72 million customers in the Yangtze River Delta high-speed rail hub area, mainly gender and ageLabel information such as income level, education level, stay scenario, etc. can achieve meter-level data accuracy,Minute levelThe continuous activity track tracking at intervals screens the activity data of about 7 million people per day and the activity track data of about 10 million people per day around the research hub. Functional data integrates vector data for commercial, commercial, public services, residential, leisure and other land use within the Yangtze River Delta, including A01, land transfer,LeaseInformation such as price and building profiles and building floors in the hub area

Surface1 List of 50 major high-speed rail hubs in the Yangtze River Delta urban agglomeration

省市	数量/个	枢纽名称
上海市	4	上海虹桥站、上海站、上海南站、松江南站
浙江省	16	杭州东站、杭州西站、杭州南站、杭州站、宁波站、温州南站、义乌站、金华站、嘉兴站、嘉兴南站、绍兴北站、台州西站、湖州站、衢州站、诸暨站、丽水站
江苏省	19	南京南站、南京站、苏州站、苏州北站、徐州东站、徐州站、无锡站、无锡东站、常州站、常州北站、昆山南站、连云港站、盐城站、镇江站、镇江南站、南通站、丹阳站、海安站、淮安东站
安徽省	11	合肥南站、合肥站、芜湖站、阜阳站、阜阳西站、蚌埠南站、六安站、黄山北站、宣城站、滁州站、宿州东站

The hub information platform integrates three functional modules: analysis, evaluation and monitoring. The analysis module provides a quantitative analysis tool for the spatial and temporal characteristics of various crowd activities in the hub area, and visually analyzes and identifies the number of passengers, "station activities" and passengersGroup spaceScope of activities; The evaluation module is used to evaluate the spatial development of the hub area, analyze the building development volume, the functional composition of land use and the

POI business distribution in the hub area; the monitoring module dynamically tracks and monitors the Yangtze River Delta railway network, the scale of the hub passenger flow, the structure of the passenger group, the land use of the hub area, etc.,

2 Yangtze River Delta based on accurate customer groups50Development assessment of major high-speed rail hub areas

Using the accurate identification method of the customer group, build a framework for quantitative evaluation of hub area development based on the structure of the customer group and the trajectory of space-time activities of the crowd. First, starting from the passenger group dimension, identify the number of passengers and the scale of the "at-station activity" population at the hub, and calculate the "at-station activity" population coefficient; Second, starting from the customer group activity dimension, identify the functional needs and functional layout characteristics of different customer groups; third, starting from the spatial activity dimension, identify the core set of space-time behavior activities of the hub customer group based on the collected full trajectory point data of customer group activitiesCluster range and radiation impact range. After 3 aspects of research, the following three main evaluation conclusions have been found.

2.1 The development of hub areas has a large number of customers andGuest groupStructural "double threshold" phenomenon

Evaluation chiefTriangleThe size of the 50 major high-speed rail hubs andGuest groupStructure. First, the size dimension of the customer group. In 2021, 2 high-speed rail hubs that sent more than 50 million passengers, accounting for 4% of Shanghai Hongqiao Station and Hangzhou East Station; 3 hubs that sent more than 20 million passengers in 2021, accounting for 66%: 8 hubs that sent more than 10 million passengers in 2021, accounting for 16%;In 2021, 9 hubs sent more than 5 million, accounting for 18%; in 2021, 16 hubs sent more than 3 million, accounting for 32%, and 12 hubs sent less than 300 people, accounting for 24% in 2021. See Table 2. Secondly, the dimension of the customer structure.Arrival activity" crowd coefficient3 hubs above 1.5 are Shanghai Hongqiao Station, Nanjing South Railway Station and Hangzhou East Railway Station, accounting for 6 percent; 16 hubs with coefficient 1 or above, accounting for 32%; 7 hubs above 0.5, accounting for 14%, and 24 hubs with coefficient below 0.5, accounting for 48%. See Table 3.

Further combine the customer group size, customer group structure and high-speed rail pivotA correlation analysis of the proportion of development and construction in the New Zealand region found that there was a "double threshold" phenomenon in the development of the hub area.

First, the Yangtze River DeltaAmong the 50 major high-speed rail hubs, except for some hub areas, especially the area where there was large-scale development and construction before the opening of the high-speed rail line, the development and construction of other hubs have a threshold of 5 million passengers, that is, after the annual number of passengers exceeds 5 million, the proportion of development and construction in hub areas has increased The study found that of the 22 hubs that send more than 5 million passengers a year in the Yangtze River Delta, 20 hubs have a development and construction proportion of more than 50%. Typical representatives are Hangzhou East Station, Shanghai Hongqiao Station, Nanjing South Station, and the annual passenger volume in 202152.74 million, 51.07 million, 36.67 million, respectively, with a development and construction ratio of more than 70%; on the

contrary, such as Huangshan North Station, Fuyang West Station, 2021The sending volume is235 million, 3.71 million, less than 20% of the development and construction.

Secondly, after the annual number of passengers sent to the hub reaches the threshold, the proportion of "at-station activities" has a great impact on the development of the hub area(Figure 2). The study found that for stations with a population coefficient of "at-station activity" below 0.5, even if the annual number of passengers is more than 5 million, the development and construction of their hub areas are still not ideal. For example, the annual number of passengers at Wenzhou South Station and Yiwu Station is 1096 million and 9.5 million respectively, and the population coefficient of "at32 and 0.25, the proportion of development and construction in the hub area is less than 30%. It can be seen that hub area development is directly related to the size of the customer base, but it can'tOnly scaleThe hierarchical theory of the proportion of "station activities" is crucial, which determines the size of the population active in the hub area in the hub group, which directly affects the development of the hub area.

2.2 The development function of the hub area is closely related to the "station activity" crowd structure portrait

Evaluation chiefTrianglePortrait of the population structure of the "station event" of 50 major high-speed railway hubs (Figure 3). First, 9 hubs with a proportion of more than 40% of the business population are Shanghai Hongqiao Station, Shanghai Station, Hangzhou East Railway Station, Nanjing South Railway Station, Suzhou North Railway Station, Wuxi Railway Station, Suzhou Railway Station, Ningbo Railway Station and Hangzhou Station, mainly located in central cities with large economies such as Shanghai, Hangzhou, Nanjing and Suzhou; 18 hubs with business people accounting for more than 25% and 23 hubs accounting for less than 25%. Second, 17 hubs with a higher proportion of leisure people accounting for more than 20%, of which are mainly Hangzhou Station, Suzhou Station, Shanghai Station, Huangshan North Station, Nanjing Station, Jiaxing Station and Wuxi Station, all of which are old railway stations in tourist cities. For example, Hangzhou Station accounts for 30% of the leisure population, which is significantly higher than 10% higher than Hangzhou West 24 people account for more than 10% and 9 people below 10%. Third, the proportion of commuters is relatively low (less than 5%), and the hub with a relatively high proportion is the topHaihongqiao Station, Kunshan South Station, Suzhou Station, Shanghai Station and Suzhou North Station account for more than 3% of commuters. For example, Kunshan South Station is the "first stop" on the Shanghai-Nanjing Line, which only takes 20 minutes to reach Shanghai Hongqiao Station, and the frequency of trains is high, and there are a large number of cross-city

Surface2 Yangtze River Delta high-speed rail hub passenger group size (transit)

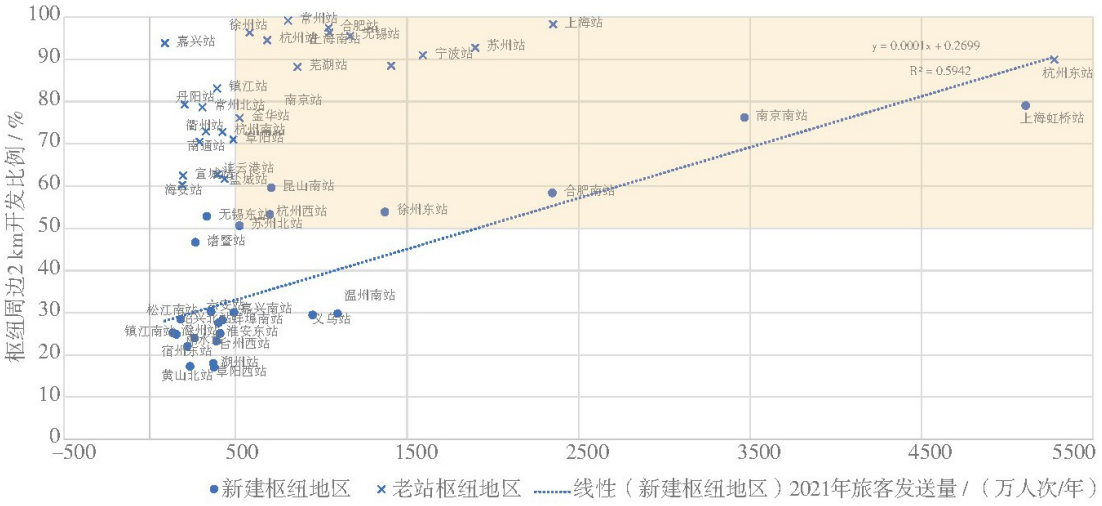
枢纽发送规模分级标准	枢纽名称	数量/个	占比/%
5000万人次以上	杭州东站、上海虹桥站	2	4
2000万人次以上	南京南站、上海站、合肥南站	3	6
1000万人次以上	苏州站、宁波站、南京站、徐州东站、无锡站、温州南站、上海南站、合肥站	8	16
500万人次以上	义乌站、芜湖站、常州站、昆山南站、杭州西站、杭州站、徐州站、金华站、苏州北站	9	18
300万人次以上	嘉兴南站、阜阳站、连云港站、杭州南站、蚌埠南站、淮安东站、绍兴北站、盐城站、镇江站、台州西站、湖州站、阜阳西站、六安站、无锡东站、衢州站、常州北站	16	32
300万人次以下	南通站、诸暨站、丽水站、黄山北站、宿州东站、丹阳站、宣城站、海安站、松江南站、滁州站、镇江南站、嘉兴站	12	24

Surface3 Yangtze River Delta high-speed rail hub passenger group structure ("at-station

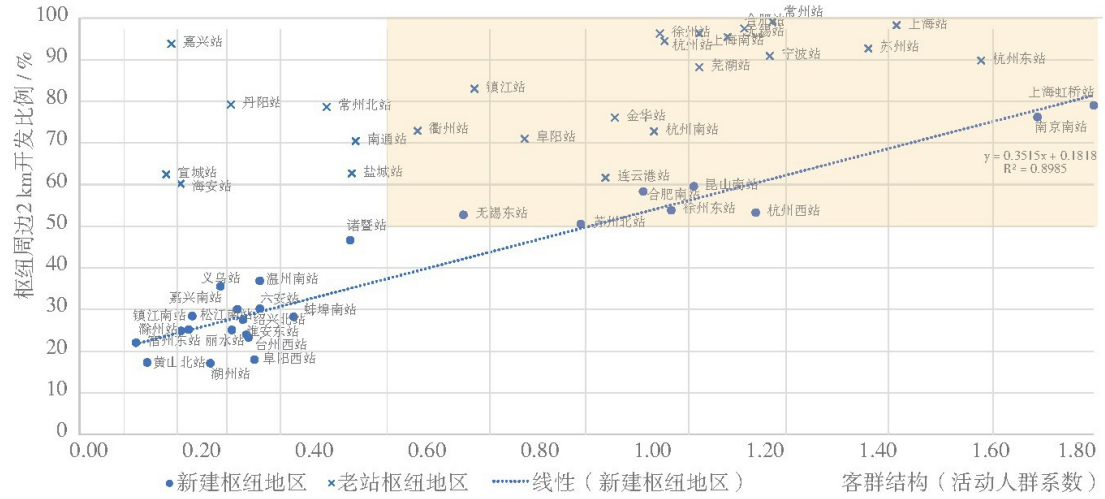
activity" crowd coefficient)

“到站活动”人群系数分级标准	枢纽名称	数量/个	占比/%
X≥1.5	上海虹桥站、南京南站、杭州东站	3	6
1≤X＜1.5	南京站、上海站、苏州站、常州站、宁波站、杭州西站、合肥站、无锡站、上海南站、芜湖站、昆山南站、徐州东站、杭州站、徐州站、杭州南站、合肥南站	16	32
0.5≤X＜1	金华站、连云港站、苏州北站、阜阳站、镇江站、无锡东站、衢州站	7	14
X＜0.5	南通站、盐城站、诸暨站、常州北站、蚌埠南站、淮安东站、绍兴北站、温州南站、六安站、阜阳西站、台州西站、丽水站、嘉兴南站、丹阳站、义乌站、湖州站、松江南站、镇江南站、滁州站、海安站、嘉兴站、宣城站、黄山北站、宿州东站	24	48

Picture1 Analysis of the correlation between the transmission volume of 50 hubs in the Yangtze River Delta and the proportion of development and construction in the hub area



Picture2 Analysis of the correlation between the passenger group structure of 50 hubs in the Yangtze River Delta and the proportion of development and construction in the hub area



Further coupling all kinds of customersGroup behaviorActivity chain and functional space layout, discovering the Yangtze River DeltaThe development function of 50 major hub areas

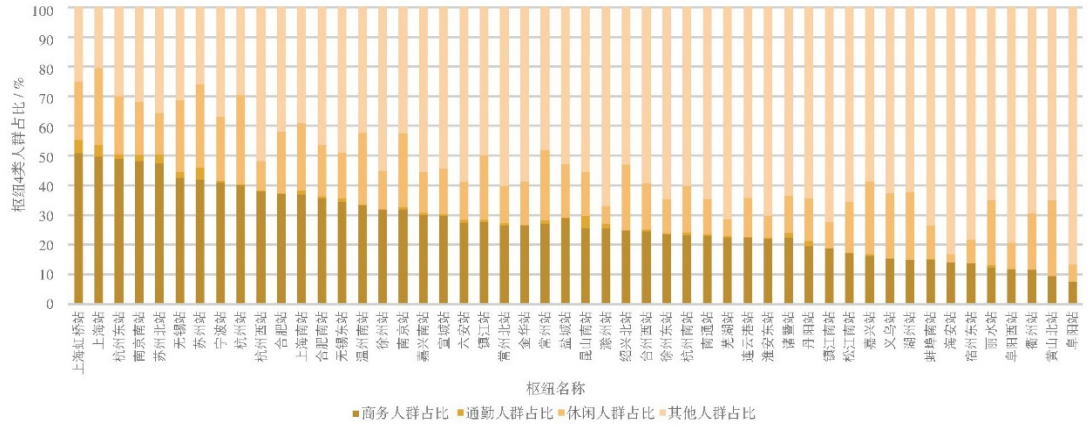
is closely related to the "on-site activity" population structure.

First of all, for stations with a high proportion of cross-city business and commuters, the hub area will form a business district of a certain size. Among the 50 major hubs, 1km will be formed around 5 hub areas such as Shanghai Hongqiao Station, Shanghai Station, Nanjing South Station, Suzhou North Station and Hangzhou East Station.[2]In the above business districts, commercial land accounts for more than 10% of development and construction land.Based on the analysis of travel LBS trajectory changes,The business district around the hub attracts a large number of cross-city business customers that originally flowed to the city's core CBD, satisfying the business crowdAnd Tongle crowdYes, travelHigh timeSensitivity needs. In addition, Suzhou Station, Hangzhou Station, Wuxi Station, Ningbo Station cross-city business andThe proportion of commuters is also higher than40%, but limited by the development of existing cities, the proportion of commercial land does not reach 10% (Figure 4). Commuters such as Shanghai Hongqiao Station, Shanghai Station, Suzhou Station and Kunshan South StationThe proportion of groups is highThe hub, which has a commercial and residential apartment function that serves a certain proportion of commuters in the business functions around the station.

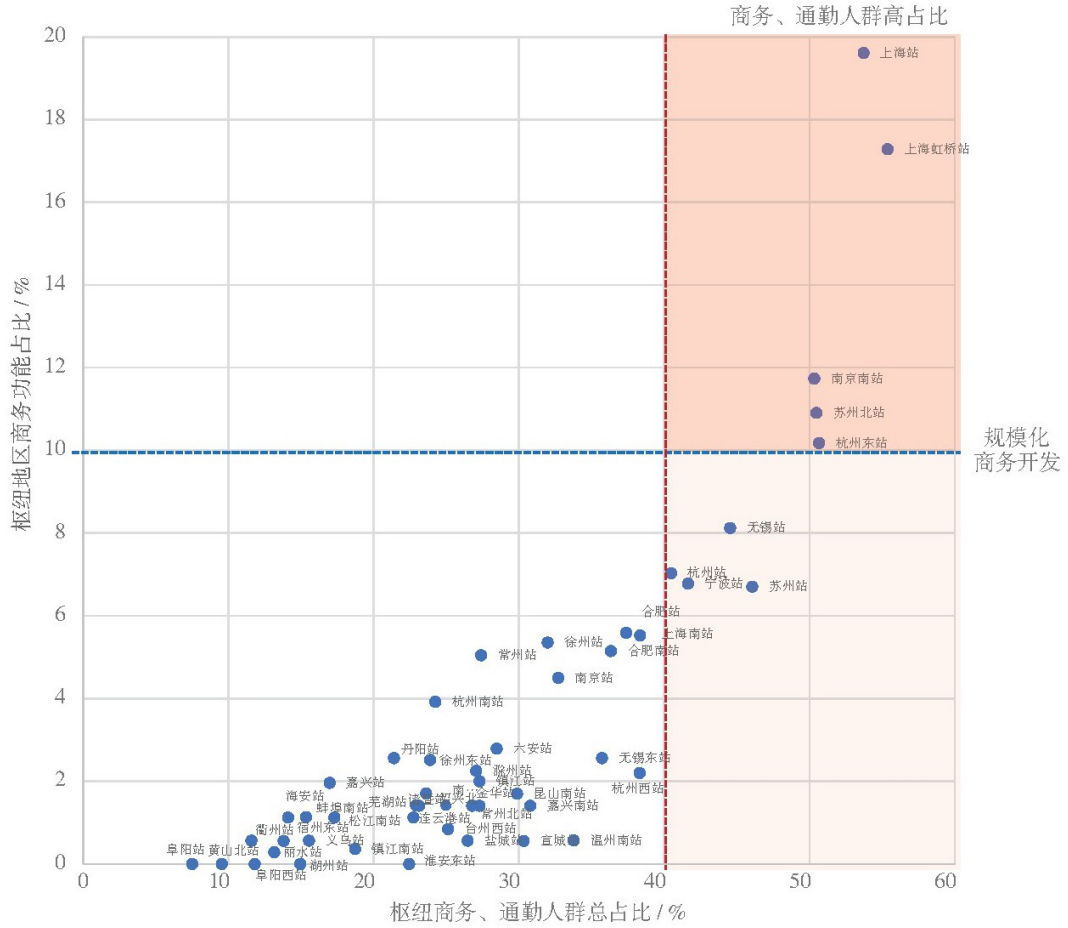
Secondly, the commercial and leisure functions in the hub area are closely related to the proportion of leisure people. Yangtze River Delta17 hubs with a proportion of leisure people accounting for more than 20%, most of which are located in cities with developed commerce or attractive tourists. The hub area is concentrated with a certain scale of commercial leisure functions. Seven hub areas, such as Shanghai Station, Hangzhou Station, Suzhou Station and Wuxi Station, have carried out commercial and trade development on a certain scale, with a proportion of related land use exceeding 10% (Figure 5). In addition, Huangshan North Station,Huzhou StationHubs with relatively small passenger flow, due to the proportion of leisure people accounting for more than 20%, the hub area has laid out a certain scale of homestay hotels for leisure and vacations and other functions.Looking at the activity trajectory of the group, the mature commercial development of the hub area and the surrounding characteristic landscape resources can "retain" the leisure population. 50% of the leisure population of the above 7 stations areStaying around the hub, such as Jiaxing Station is close to the South Lake Scenic Area, which is a leisure hub61% are active around the hub.

Third, hub areas with a high proportion of other populations are usually dominated by transportation and residential functions. 26 of the 50 major hubs in the Yangtze River Delta account for more than 50% of other people. These hubs are generally located in small and medium-sized cities with relatively weak levels of economic development. Cities are less attractive to high-grade commercial commerce, and the proportion of surrounding residential and transportation land is more than 40% (Figure 6). Further coupling other people's activitiesAccording to the trajectory and functional space layout, it is found that most of the activities of other people's activities are based on residential areas, which are weakly related to the hub area. On the way, they mostly stay in spaces such as catering, leisure and living services, etc., and are not characteristic people who are "at the station as the destination".

Picture3 Structure of 4 categories of population in 50 major hubs in the Yangtze River Delta



Picture4 Relationship between the proportion of business functions and the proportion of business and commuters in the Yangtze River Delta hub area



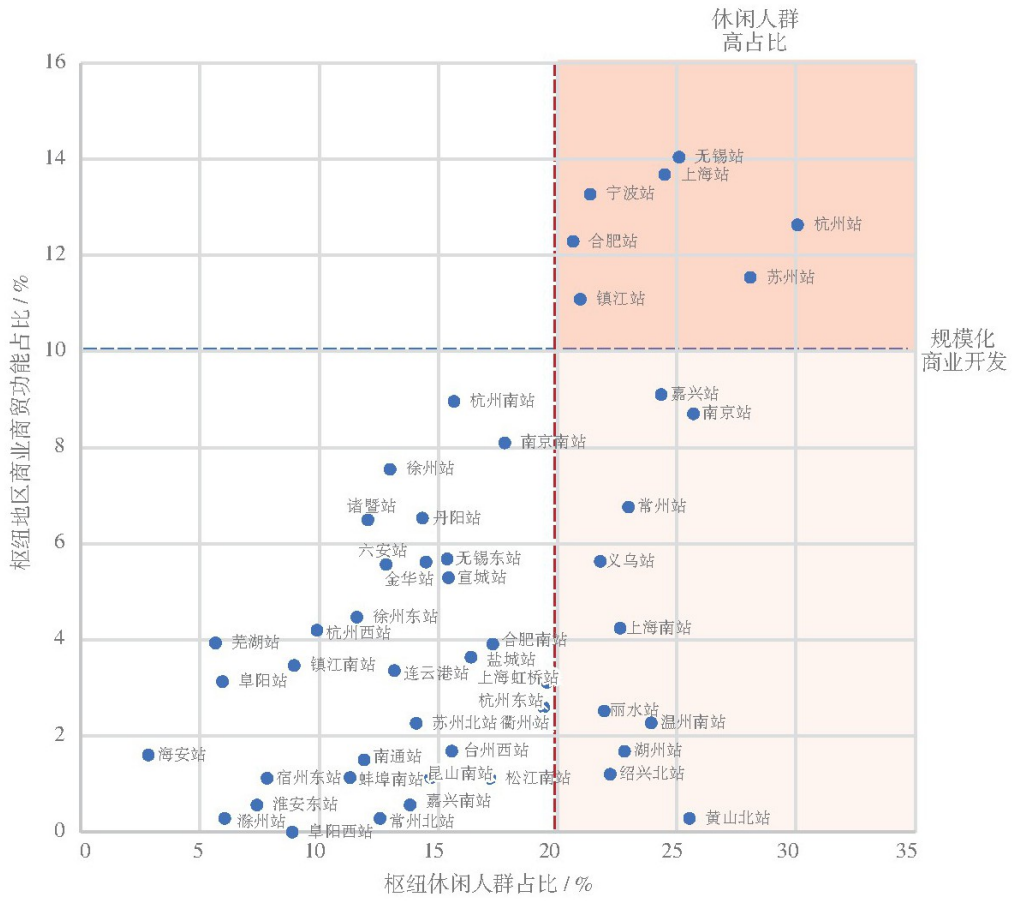
2.3 The functional layout of the hub area takes the surrounding 1.5 km as the core agglomeration space and moves along the crowdThe corridor is presentedRadiation characteristics

Based on the Yangtze River DeltaAccurate measurement of customer activity in 50 major hub areas found that 98% of population activity and core functions in hub areas gathered within 1.5km of space around the hub (Figure 7). Only the Hongqiao hub area gathers crowd activities and core functions within 2.7 km around the hub: on the one hand, the Hongqiao hub is the only one of the 50 hubsThe air-rail integrationHub, the east side of Hongqiao

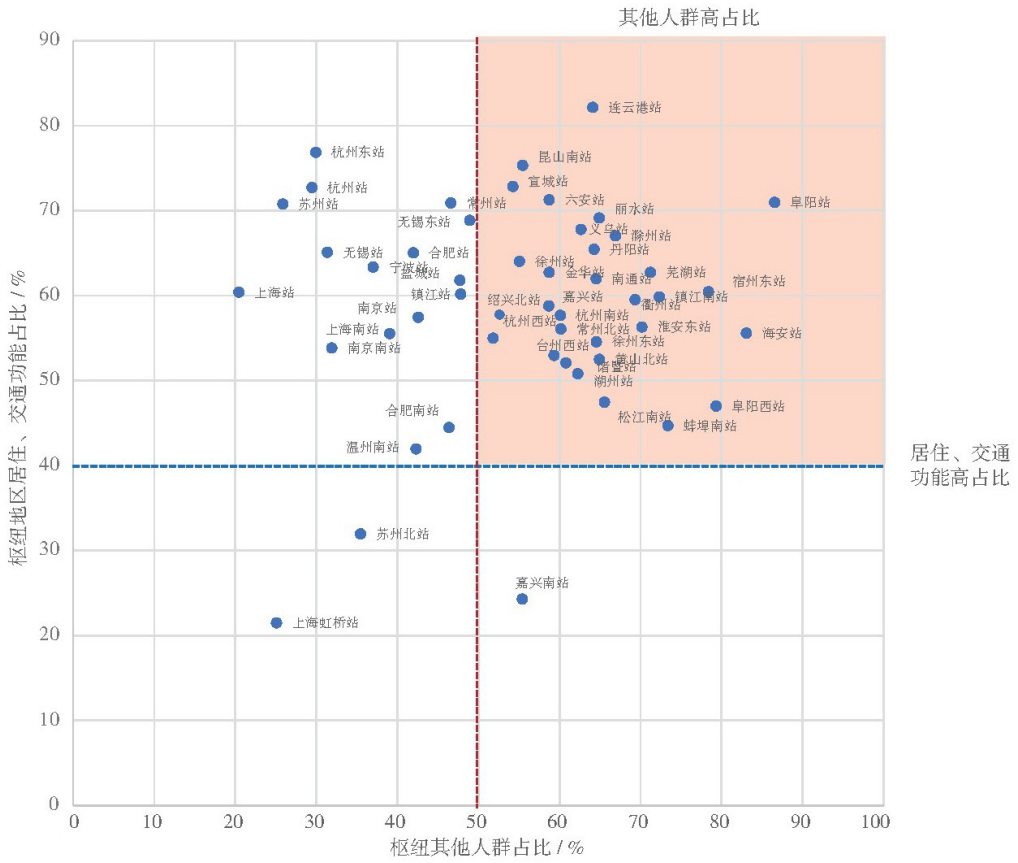
Station is the airport area, which limits the functional layout and crowd activities; on the other hand, the Hongqiao Hub ranked second in 2021, with 51.08 million passengers per year.If statisticsThe airport ranked first in passenger flow, and the crowd coefficient of "at-station activities" ranked first, with 1.8. Therefore, the scope of functional layout in the hub area is larger than that of other hubs. Among the remaining 49 hubs, those with low passenger flow scale,People's activities and functions gather around the hubWithin 500m, it is dominated by functions such as catering, accommodation and long-distance passenger stations; a hub with large passenger flow, the core of crowd activities and functional agglomeration is within 1.5km around the hub, focusing on functions such as business offices, large shopping malls, transportation and distribution facilities; 1.5km around the hub is dominated by urban functions such as residential and public services Further analysis shows that the annual transmission volume of the group is higher than 5 million, and the population coefficient of "station activity" is greater than 0.5. In the hub area that also meets the "double threshold", the core space area of crowd activity and functional agglomeration is more than 500 m, and more than 60% of more than 1 km per month. It can be seen that the size of the core agglomeration space is positively correlated with the size of the customer group and the proportion of "station activity" population.

In addition, the activity trajectory of people in the hub area is characterized by the distribution of corridors such as rail transit and urban main roads. The study found that the average number of people using the radiation corridor area adjacent to the hub as a travel destination is 1.5 times higher than that of non-channel areas. Taking Shanghai Hongqiao Hub as an example, in addition to the core area adjacent to the hub, the group travel destinations are mainly expanded along Rail Line 2, Rail 17 and main road corridors such as Bei Zhai Road, Wuzhong Road and Hongqiao Road. For example, the New Hongqiao Medical Center, located on the north side of Beiqing Highway, has increasingly become a cross-cityEmpt economyParks and Changfeng Business District have gradually become cross-city business destinations.

Picture5 Diagram of the relationship between the proportion of commercial and trade functions and the proportion of leisure people in the Yangtze River Delta hub area



Picture6 Relationship chart of the proportion of residential and transportation functions and other people in the Yangtze River Delta hub areas



3 Yangtze River Delta50Thoughts and suggestions on the development of major high-speed rail hub areas

3.1 Focus on the proportion of people in "station activities" and adopt differentiated planning strategies "variate by station"

There are often development misunderstandings in the planning and construction of hub areas. It is believed that once the station is completed and the government is willing, it will definitely promote large-scale development around the hub area. Based on the development assessment of 50 major hub areas in the Yangtze River Delta, the writer proposes that there is a customer group size andGuest groupStructural "double threshold" phenomenon: the size of the customer group is the basis for promoting the development of the hub area, and the flow alone does not necessarily promote the development of the hub area; the customer group structure is more critical. Even if some hub areas have sufficient passenger flow scale, if the hub "lives"The proportion of "movable" population is obviously low, and it is difficult to promote the high-quality development of the hub area.

Yangtze River Delta20 of the 50 major hubs reached the "double threshold", sorted by passenger flow scale: Hangzhou East Station, Shanghai Hongqiao Station, Nanjing South Station, Shanghai Station, Hefei South Station, Suzhou Station, Ningbo Station, Nanjing Station, Xuzhou East Station, Wuxi Station, Shanghai South Station, Hefei Station, Wuhu Station, Changzhou Station, Kunshan South Station, Hangzhou West The planning and construction of such hubs should strengthen services to the intercity customer groups, especially the "high-frequency, short-distance, high-distance, high-time value" "at-site activities" people. Their strong demand for "enter the station and arrive at the destination" is

strong, which has led to the hub area to become an agglomeration area for theSpatial planning and functional needs should also focus on the pluralistic balance of functional, transportation and urban development.

In addition, the rest30 hubs based on the size of the customer group andGuest groupStructural evaluation is divided into two categories. First, the annual transmission volume of the passenger group is more than 5 million, but there are two hubs with a population coefficient of less than 0.5, namely Wenzhou South Station and Yiwu Station. The planning and construction of such hubs should take into account the growth of potential "station activities" due to the growth of high-frequency sub-city travel with regional integration, so as to put forward new demands for functions around the station. Therefore, cities should be properly planned and guided to strengthen the functional cultivation and space creation of "at-station is the destination". In the recent stage of relatively small scale and functional demand for "station activities", it should be emptyInter-resource control and flexible reservation to avoid low-value utilization of high-value space resources under blind development. Second, there are 28 stations with a passenger group of less than 5 million passengers/year, namely Hangzhou South Railway Station and Wuxi EastStation, Zhenjiang Station, Lianyungang Station, Fuyang Station, Quzhou Station, Nantong Station, Yancheng Station, Zhuji Station, Changzhou North Station, Bengbu South Station, Huaian East Station, Shaoxing North Station, Liu'an Station, Fuyang West Station, Taizhou West Station, Lishui Station, Jiaxing South Station, Danyang Station, The planning and construction of such hubs should not deliberately pursue large-scale comprehensive development around the station, but should focus on the overall arrangement of transportation nodes and distribution functions, and the continuation of the old station in the cityBased on existing urban functions, the planning and construction of new stations should be kept objective and rational, and avoid inefficient or even ineffective urban construction investment.

Of course, the size of the hub's customer base andGuest groupThe structure will change with the change of the railway network and urban development, which is a dynamic evolutionary process. Planning and planning should also be objectively evaluated and reasonably predicted to strengthen scientific judgment.

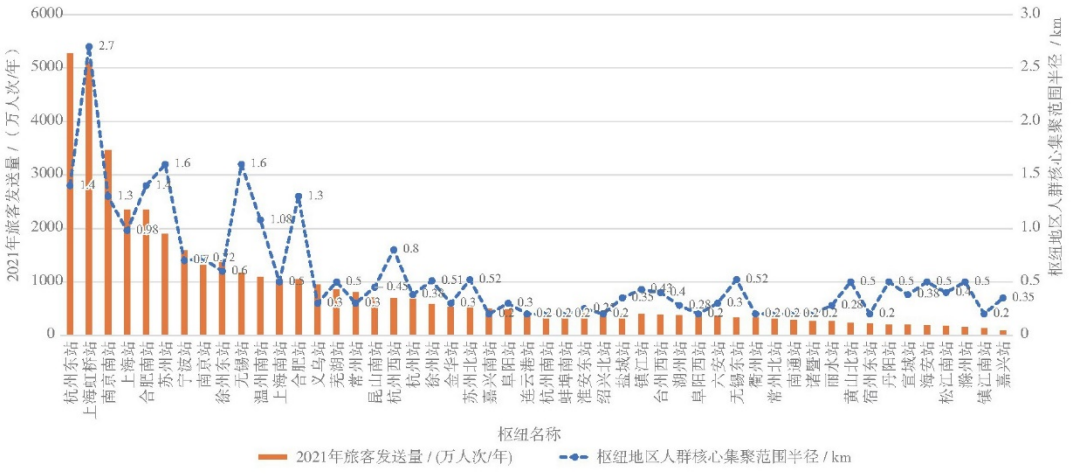
3.2 Functional development focuses on three types: regional function-led, urban function-led and featured functional-led

The Yangtze River Delta is currently meeting the "double threshold" with conditions for comprehensive development on a certain scale20 major hubsA coupling analysis of the structural characteristics of the guest group and the distribution characteristics of spatial activities found that the hub development in the coupling matrix shows three types of differences, as shown in Figure 8 and Table 4. First, the population structure index of "station activity" is higher than 2.3, and the spatial radiation impact range is greater than 8 km. It mainly includes 7 hubs such as Shanghai Hongqiao Station, Hangzhou East Station, Nanjing South Station, Suzhou North Station, Hangzhou West Station, Shanghai Station and Ningbo Station.The proportion of groups is highAt 40%, the hub value is mainly region-oriented strategic portals and functional nodes, and functional development is mainly regional-oriented business, conference, consumption and other functions. Second, the population structure index of "at-station activity" is 1.7-2.3, the impact of space radiationThe hub area covers 5-8km, mainly including 9 hubs such as Shanghai South Station, Hefei Station, Xuzhou

Station, Jinhua Station, Changzhou Station, Wuhu Station, Xuzhou East Station, Hefei South Station and Kunshan South Station. The proportion of other people in such hubs is more than 40%. The value of the hub is mainly the city-oriented transportation Third, the population structure index of "to-gu activities" is 2.2-2.7, and the spatial radiation affects 3-5km hub area, mainly including 4 hubs such as Suzhou Station, Hangzhou Station, Nanjing Station and Wuxi Station. The proportion of leisure people in such hubs is more than 25%. On the one hand, the value of the hub is a distribution portal for regional leisure people, functional development focuses on regional leisure, commercial consumption and urban services.

The writer believes that the functional development of the Yangtze River Delta hub area should follow the technical idea of "hub customer group, customer group setting function", focusing on the structural characteristics of the population of "on-station activities" and the difference in the range of radiation impactThree types of functional development directions, namely regional function-oriented, urban functional-oriented and characteristic functional-oriented [17], from customersGroup demandDepart from the station to implement policies to guide the functional development of the hub area. The regional function-leading hub represented by Hongqiao strengthens the bearing of space-to-area functions, and gathers regional-oriented business and commerce, scientific and technological innovation, production services, public services and other functions [18]. The above Hainan Station is represented by the urban function-oriented hub, on the one hand, improves traffic functions and improves the efficiency of transportation transfer.On the other hand, it focuses on planning the improvement of urban-oriented service functions. The characteristic function-leading hub represented by Suzhou Station, on the one hand, strengthens the space and features of the hub area itself, gathers special functions such as tourism services and displays, cultural experiences, commercial consumption, leisure and vacations, and on the other hand, strengthens the transportation link between the hub and the city's major leisure destinations.

Picture7 Statistics on the core concentration range of people in 50 hub areas of the Yangtze River Delta



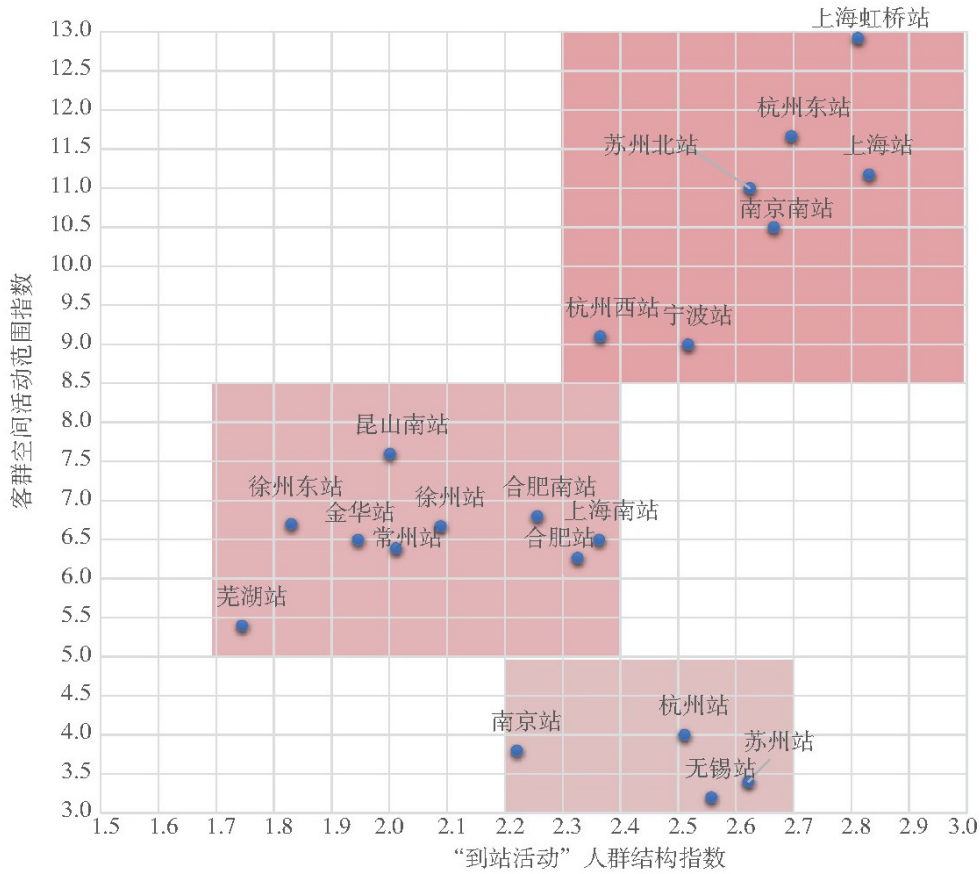
3.3 Space layout enhances the humanized design of the core area within the 1.5 km radius

Based on the functional layout characteristics of the hub area, further observe that the "double threshold" has been comprehensively developed on a certain scaleIn 20 major hubs, it can be found that in addition to the Hongqiao hub, the core space of crowd activity and

functional layout around the hub varies from 0.3 km to 1.5 km radius. There are relatively mature hub areas such as Hangzhou East Railway Station, Shanghai Railway Station, Nanjing South Railway Station, Nanjing Railway Station, Suzhou Railway Station, Wuxi Railway Station, Hefei South Railway Station, Hefei Railway Station, etc., with a core space range of more than 1km, as well as hub areas in the initial stages of construction such as Suzhou North Railway Station and Hangzhou West Railway Therefore, the 15 km radius around the hubIt is the comprehensive development of ZhanchengThe core space. On the one hand, the humanized design of the 15km core space is the development and construction of the hub areaThe key to the design of the space is to meet the hub activity crowd cloudSeeking talentEnsure the high-quality development of the hub area; On the other hand, close within 0.3 km around the hubStation City SpaceIt is the core area in the early stage of the construction of the hub[19]. Therefore, starting from the needs of diverse active groups and the gradual development of the hub area, we will grasp the characteristics of the customer group.Focus Station City BlockThe two spatial levels, taking "human scale, human experience" as the measurement standard, fully reflects the humanistic characteristics of the built environment.

First of all, create a walk-friendly and socialStation City Space.Station City SpaceIt is the core area with the largest flow of people, the most dense flow of people, and the most demand for people's functions. First, there should be a clear marking system and clear orientation to meet the needs of passengers entering and leaving the station quickly.[20], secondly, public spaces with appropriate scale and complex functions should be created for people to meet the diverse communication needs of people such as dining, shopping, leisure, entertainment, reading, office, experience, etc., and provide passengers with a diversified and comfortable experience when entering and leaving the station. Third, a pedestrian network should be built for people to adapt to the climate and use full-time, through wind and rain corridor bridges, building corridors, underground spaces, and ground publicCommon space and other ways to improve the contency of transportation transfer space and transportation walking space, improve the walking comfort of the crowd, and adapt to the shapeCreate a flexible and lively space atmosphere and create a functional link space[21] .

Picture8 Development classification of major hub areas in the Yangtze River Delta based on coupling analysis of customer group structure characteristics and spatial activity distribution characteristics



Surface4 Classification of 20 major high-speed rail hubs that reach the "double threshold" in the Yangtze River Delta

功能发展类型	枢纽名称	“到站活动”人群结构特征	数量/个
区域功能主导型	上海虹桥站、杭州东站、南京南站、苏州北站、杭州西站、上海站、宁波站	商务客群占比高于40%	7
城市功能主导型	上海南站、合肥站、徐州站、金华站、常州站、芜湖站、徐州东站、合肥南站、昆山南站	其他人群占比高于40%	9
特色功能主导型	苏州站、杭州站、南京站、无锡站	休闲客群占比高于25%	4

Secondly, create a breathing block space where you can stop and stay, heavyLook at the space design of the core blocks around the hub, create a comfortable travel experience for the crowd, meet the diverse functional needs of the crowd, and create an important urban functional node that is dynamic and attractive. First, create a small-scale block texture, classify and control the spatial scale, and control the block scale based on commercial commerce should be controlled in0.8-1.5 hm^2, should not exceed 2 hm^2, the residential block is 2-3 hm^2It is appropriate to create a dense network of small streets on a human scale, organize the layout, shape and volume of buildings with public space as the core, optimize walking, cycling and motor vehicle traffic flow, and create a safe, comfortable and pleasant green traffic environment.Second, create a comfortable and pleasant street interface,ReasonableControl the width of the street and the height of the interfaceIt enriches the functions of street facades and along the street, encourages the setting of diversified composite functions such as

commerce and exhibitions, strengthens the openness of the interface at the bottom of the street, establishes rich visual communication between buildings and pedestrians, and stimulates street vitality. Third, create a suitable public space to stop, improve the diversity of public spaces and systematically enrich the variety of public spaces, implant diversified functional experiences, provide a stop space that can "slow down" people, and provide a diverse leisure experience for travelers[22] .

In addition,Station City SpaceThe humanized design should strengthen the characteristics of the style andApproveIdentification, especially for the development of characteristic function-oriented hub areas, strengthening the design of places that highlight the context and the specializationStation city landmarkDesign to form a unityChangeStation City featuresAppearance. Appearance.

4 Conclusion and theLook ahead

With the continuous development of China's high-speed railway, the development and renewal of hub areas will become an important area for urban development[23], this article is cut from the perspective of accurate portraits of the customer group, systemEvaluation chiefThe passenger flow scale, passenger group structure and functional space layout characteristics of the 50 major hubs in the triangle believe that the development of the Yangtze River Delta hub area should focus on the structural characteristics of "station activities" crowds, "vary by station" and adopt differentiated planning strategies. In terms of functional direction, focus on three types: regional function-oriented, urban functional-oriented and characteristic functional-driven.DifferenceChemical guidanceThe spatial layout focuses on the humanized design of the core area within a radius of 1.5 km to promote the high-quality development of the hub area.

There are also some shortcomings in the research of this article.First of all, the development of the hub area is affected by multiple factors such as hub customer groups, passenger station location, urban structure, government will, etc. This paper only focuses on the study of guest group portraits, and does not conduct a comprehensive analysis of the correlation interaction of multiple factors. Secondly, the functions of hub customers and hub areas have a two-way effect. First, the size and structure of the customer group determine the functional planning of the hub area to a certain extent, and the customer group structure will alsoDue to the areaAssociation changes, line network layout adjustment changes. Second, the functional development of the hub area also affects the customer structure, especially in the stock hub area. The iterative upgrading of regional functions is bound to affect the changes in the customer structure of the hub. This paper focuses on the impact of the guest group on functions, and insufficient consideration is given to the effect of function expansion on the guest group. Looking forward to the future, in order to pushFor the high-quality development of the hub area, it is necessary to objectively and accurately understand the structure portrait of the customer group, follow the technical logic of "the function and functional space of the hub group, and on the other hand, further expand the research perspective, focusing on the linkage and interaction mechanism between multiple impact factors in the hub area, as well as the two-way effect

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