

*Original Paper*

Research on the Spatial Planning and Comprehensive  
Development of Modern Railway Station Based on the  
Development of Station-City Collaboration

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Received: October 23, 2023    Accepted: December 06, 2023    Online Published: December 26, 2023

doi:10.22158/se.v9n1p1

URL: <http://dx.doi.org/10.22158/se.v9n1p1>

**Fund projects**

- [1] PhD Research Fund Project of Zhengzhou University of Light Industry (Grant No: 2020BSJJ020)
- [2] The 13th batch of teaching reform and research projects of Zhengzhou University of Light Industry
- [3] Henan Province philosophy and social science planning project (Grant No: 2022CYS059)

**Abstract**

*With the increasing urbanization characteristics of railway station buildings, the comprehensive development of station space has become an opportunity for the coordinated development of transportation and city. Under the guidance of station and city coordination, on the one hand, through the rational planning of station space, introducing urban functions, can effectively revitalize the land resources, increase the sustainable development of the railway industry; on the other hand, the development of station space can help the organic combination of railway traffic advantages and regional resources, promote the station and underground space planning, and play its social effect and economic benefits, and urban group development. This is not only the connotation of the coordinated development of the city, but also a positive response to the sustainable development of the city.*

**Keywords**

*station-city collaboration, railway station, spatial planning, function integration, comprehensive development*

## 1. Preface

With the rapid development of high-speed rail transportation in China, the large-scale station construction and land development have driven the development of cities along the line, and the synergistic relationship between stations and cities has become increasingly close. Therefore, through the open design of railway station space, connecting urban planning and traffic layout, traffic, commercial, office, entertainment, residential and other urban functions and the station building construction, the station and cover function, surrounding property integration development, make all kinds of space together, realize mutual benefit, the efficient use of land, and realize the railway station architectural design concept of promotion and innovation, guide the station and the coordinated development of the city.

At present, the 14th Five-year Plan period has become an important stage for the improvement of China's railway network, and railway stations, as the network node of railway network planning, are playing an important role in China's railway operation system. In the development planning of the new period, in order to better solve the problem of railway construction funds, but also to improve the travel experience of passengers, the new railway station has inevitable requirements for the comprehensive development of the site.

## 2. The Constituent Elements and Planning Layout of the Station Space

### 2.1 *The Constituent Elements*

System division according to the components of the railway station space, It mainly includes the internal space of the station (Station function core space—traffic service, taking into account part of the commercial services, mainly for traffic passengers), the external space of the station (the function outside the section of the station—the combination of traffic, landscape, business, business and other functions, Service to traffic passengers and urban people) and underground space (station function expansion space—transportation, business and other comprehensive services, Services for passengers and the public) and other three parts, According to the composition structure, It can be divided into the ground part (inside and outside the station and the upper space) and the underground part (station underground space and station city underground connection space).With the integrated development of station and city and the promotion of TOD mode, the boundary and estrangement of railway station space have also been weakened, and the correlation and integration degree between them have been improved. (Figure 1)



**Figure 1. Railway Station Space Structure**

2.1.1 Station Interior Space

The internal space of the station mainly refers to the internal space of the station building. As the core space, the internal space is the core space of the railway station. It takes the waiting hall (or comprehensive hall) as the center, and various functional Spaces are arranged around its combination, becoming an activity space for the collection of waiting, ticketing, catering, retail, cultural display and other functions. With the development of social economy, the perfection of railway traffic, the progress of construction technology and update station design concept, combined with the diversification of people travel demand, the station internal space is gradually changing and expansion, become a transportation, business, catering, entertainment, leisure, finance, municipal services, and other functions in an integrated space, its function and service category has gone beyond the previous station traffic function. The station layout changes from simple to compound, from scattered to unified, from closed to open, from plane to three-dimensional, from management to close to the people, which improves the integration of the station space and the urban space. (Figure 2)



**Figure 2. Railway Station Interior Space**

2.1.2 Space outside the Station

The station space is the connection space between the station and the city, centered on the square in front of the station, including passenger entry and exit station system, traffic system, commercial

system, landscape system, etc. With the development of urbanization and the improvement of the urban transportation system, the shaping of the spatial form and functional system outside the station is turning to the open and humanized. For the high-speed era of railway station space shape and utilization way, this change is more obvious, early in the external space of the railway station (such as station square) design around the station and urban traffic function demand, development concept is relatively single, use way is relatively simple, to “plane development + horizontal diffusion” mode, the form of much stronger than functional, and urban synergy is weak. (Figure 3)



**Figure 3. Early Railway Station Exterior Space Design**

Since the beginning of the 21st century, influenced by urbanization factors, the design positioning and functional system of the station space have changed, which are mainly reflected in the integration of spatial functions, the combination of development levels and the diversification of spatial organization, and the flexibility and foresight of the station space design have been improved. at the same time, The functional layout and format development of the station space should be based on the planning of the site environment, Railway departments, design units and construction companies should fully investigate the environmental composition and development trend around the station, In keeping with the urban construction, Rational development and utilization of the station space: for example, Osaka-Namba station in Osaka, Japan is located in the core area of the city, The densely populated and small space around the station, The space outside the station is relatively compact, Not suitable for large-scale development of the square in front of the station, Then the design department put the station building directly to the city street, Fully docking with the urban transportation, To ease the passenger flow at the station, And make full use of the top space of the station laying green plants, the construction of aerial landscape garden. In the planning of Hefei South Railway Station, China, the station project has relatively sufficient land resources, and then provides a guarantee for the development of three-dimensional and multi-functional station front landscape square and comprehensive transportation transfer center, so that the diversified development of the space outside the station has more direction. (Figure 4)



**Figure 4. Osaka-Namba Station and Hefei South Station**

### 2.1.3 Underground Space

The development of urbanization makes the railway station built in the early years gradually surrounded by the city, and the unique traffic advantages of the station also make the station area in the city. Even with the development of regional economy, the strong agglomeration effect of the station will bring great popularity and vitality, and rapidly enhance the land value and development intensity around the station. Meanwhile, the problems of urbanization development and population growth make the traffic, life and environment increasingly serious, and the railway station as the urban transportation center also becomes the key point to solve such problems. (Figure 5)



**Figure 5. Concept of Underground Space Development of Beijing Urban Sub-Central Station**

Therefore, how to improve the effective utilization rate of station land is an important issue that should be considered at the beginning of the planning of contemporary railway stations. Especially, some stations are located in the urban built-up areas, which need to respond to the urban building environment, and there are certain restrictions on the development of high altitude. In this case, increasing the development and utilization of underground space is a very effective means of space. Station underground space is an urban underground space system composed of underground traffic space and underground public space, Through the development of traffic functions, commercial functions and landscape functions, To achieve efficient connection with the urban transportation system, good undertaking with the urban commercial blocks, and effective continuation of the urban landscape axis, In order to form a three-dimensional, composite, dynamic station underground space function system and personnel activity place, Transfer of the active population and urban functions of the ground layer to the underground layer, To meet the comprehensive development needs of the railway station land, Thus to alleviate the station ground space shortage, personnel congestion, environmental deterioration and other problems, And to respond to the development needs of the station space composite under the trend of station and city integration, It has become the core content of the coordinated development of land use and transportation in railway stations. For example, by transferring Shenzhen Futian Station fully to the underground, it not only builds a three-dimensional and compound underground comprehensive transportation hub, but also reserves abundant ground space and green space resources for urban construction, which provides an important reference for the comprehensive development of railway station space in the future. (Figure 6)

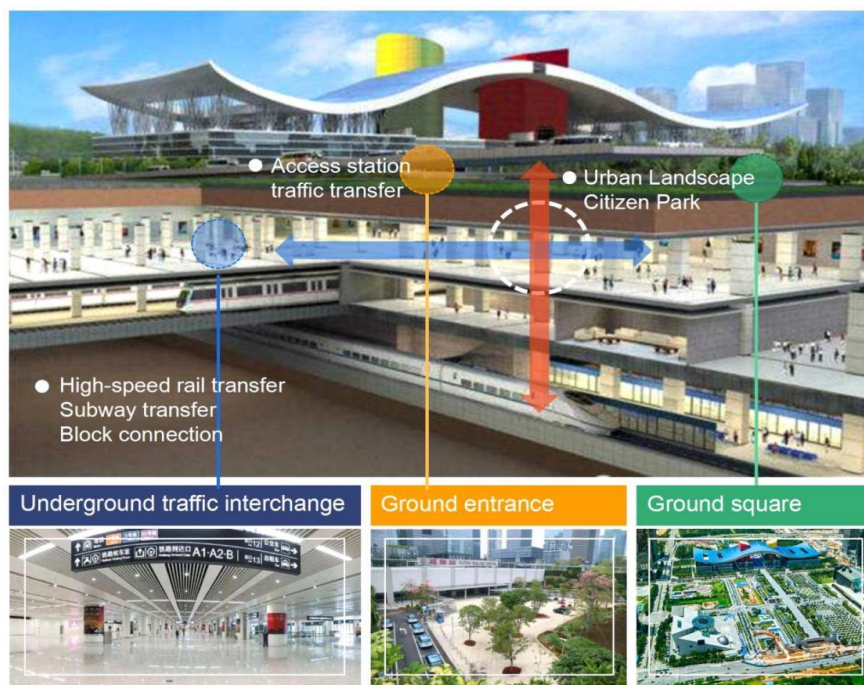
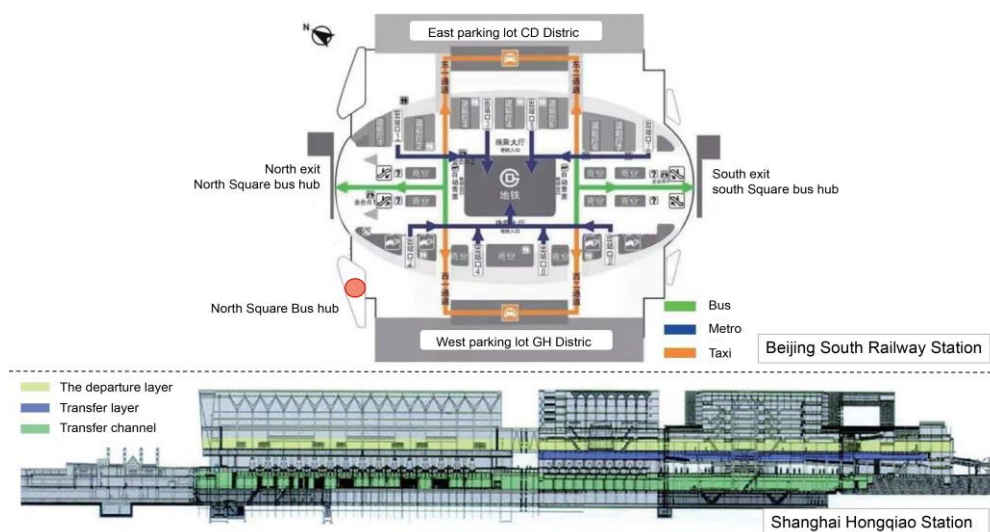


Figure 6. Space Design of Futian Station

### 2.2 Station Space Planning and Layout

Since the reform and opening up, with the construction and development of national railway transportation, the spatial planning of China’s railway stations has experienced the development process of “waiting ride type- -passing type- -elevated waiting ride- -three-dimensional passing, transfer and waiting ride”. Among them, the above built in the late eighties of Shanghai station, Tianjin station, the two station in the domestic pioneered the “two-way in and out, elevated waiting” station layout mode, maximize the bridge in the city center of the large railway station of urban space and split, for the optimization of the station area of urban environment is of great significance.

After entering the 21st century, with the rapid development of high-speed traffic, the construction of Shanghai hongqiao station, Guangzhou south station, Beijing south station, Wuhan, Shenzhen futian station, Chongqing shapingba station station, through the three-dimensional development, the introduction of all kinds of service facilities, make the new station has a more comprehensive service ability. For example, each boundary of the internal and external space of Beijing South Railway Station can accept traffic flow and people in different directions and levels, making the surrounding area a traffic corridor and smoothly connect with the urban traffic network. The composite spatial structure of Shanghai Hongqiao Station improves the capacity of various transportation systems and service facilities, enriches and improves the business content and service capacity of the station space, and guides the optimization and transformation of the industrial structure in the surrounding area, which well follows the development and functional layout of the urban area. (Figure 7) In addition, such changes also expand the space volume of the station, promote the integration of the internal and external space, form more interface changes, and provide a new choice for the innovative design of the station buildings.



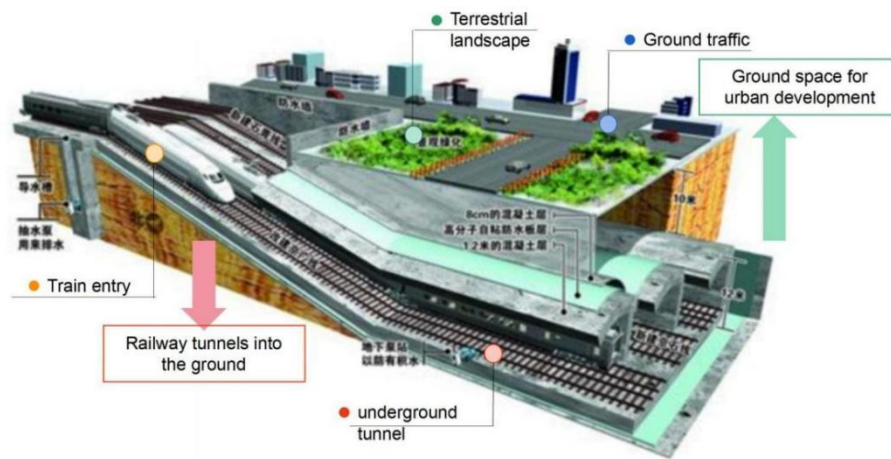
**Figure 7. Space Structure of Beijing South Railway Station and Shanghai Hongqiao Railway Station**

### 3. The Development and Transformation of the Contemporary Railway Station Space

#### 3.1 Station Outside Space

##### 3.1.1 Transformation of Land Development Mode

Railway station space of land use mode and the current land development and utilization strategy closely linked, the traditional railway station traffic organization and the function layout in the station as the center for the overall arrangement, the characteristics of land use is: around the station cluster buildings, make the city presents a nuclear—axis development pattern, usually in the front station street and activity square. With the development of social economy and the expansion of urbanization, the building density in big cities is gradually increasing, the traffic population is growing rapidly, and the land is increasingly short, and the functional development of urban buildings tends to be combined and integrated. then, A single railway station is being replaced by a complex of transport hubs, More and more urban functions and service facilities are incorporated into the station function system, Change the layout principle and utilization pattern of the land spatial form in this area, Reflected in the combination of land use, the multidimension of the spatial level and the integration of development functions, The overall utilization rate of land resources has been effectively improved; If the newly built Shijiazhuang Station also makes full use of its traffic and location advantages, Combined with the planning scheme of the railway under the city, Implement the deep development of the station land, The development mode of three-dimensional comprehensive transportation hub forms a good connection with the business district and living area around the station. (Figure 8)



**Figure 8. Shijiazhuang Station Railway Runs under the Urban Design**

##### 3.1.2 Transformation of Land-Use Properties

The nature of the land in the contemporary railway station area is changing from the past railway station traffic land to the combination of transportation and urban function, and there are many reasons for the transformation of the land nature from single to diversified. first, With the rapid development of the Chinese economy, There is a large number of floating population in all major cities, The railway



station, as an important transportation hub and activity center of the city, The development strategies and service facilities in many station areas are mainly aimed by the migrant population, Such as transportation, commerce, catering, entertainment, tourism, finance, office work, medical care, etc., Such functional collection and transformation can help to improve the overall image of the station, Attract many active population and industrial resources, Drive the renewal construction and prosperous development of the station and surrounding areas; next, Urban development requires the construction of a large number of export-oriented functional facilities, To coordinate the urban functional layout and the industrial structure balance, therefore, Part of the export-oriented urban functional facilities are located in the railway stations and the surrounding areas, Help to improve the existing urban functional zoning and population distribution, Equalize the urban resource allocation, It is of great significance to the realization of urban sustainable development goals. (Figure 9)

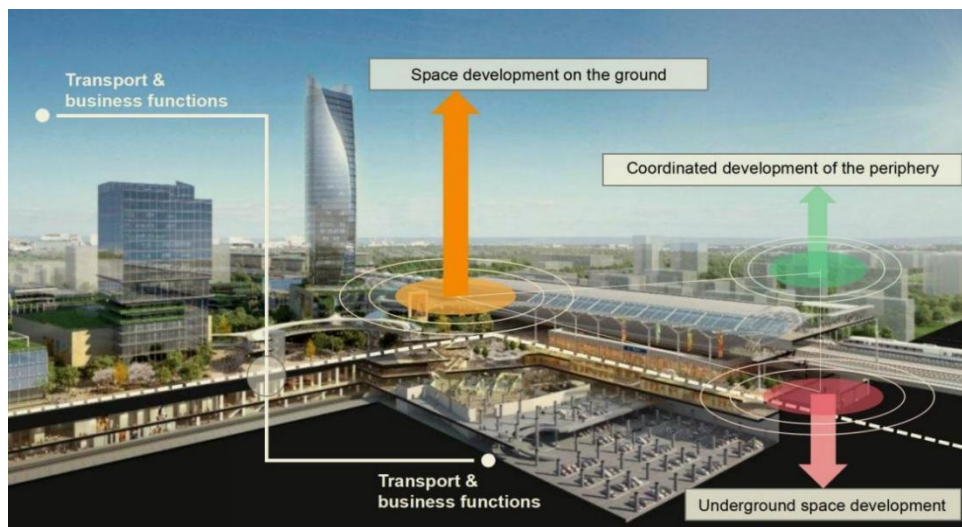


**Figure 9. Diversified Station Area Function Development**

### 3.1.3 Transformation of Land-Use Intensity

Land use intensity is regional population, construction scale and economic level, the greater the land use intensity, said the more dense the population per unit area and the building, the greater the density of travel, the higher the probability of residents use transportation travel, therefore, the railway station area traffic is proportional to the use of land intensity. With the development of social economy and the improvement of urban comprehensive transportation, the diversified integration and comprehensive layout of the station functions have been promoted. Contemporary many big cities railway transportation hub complex scale is often quite large, land use scale is increasingly nervous, which needs to increase the intensity of the optimization of land use, maximize the land use, to enhance the overall value of land resources, namely through scientific planning and foresight as a whole, guide the station land development from “horizontal expansion” to “vertical extension”, to improve the intensity of land use within the unit space, and accommodate more functional system, promote the rationalization of land resources station area, its main performance is the development of the station

complex construction and “ground-underground space” collaborative development, etc. In addition, the distribution of land use intensity in the railway station area is corresponding to the nature of land use, that is, the land use intensity is the highest in the railway station and its adjacent land, and gradually decreases to the periphery of the station. This is not only conducive to the rational use of the internal and external space of the station, realizing the efficient organization and reasonable distribution of passenger flow; but also provides a guarantee for the transformation of the horizontal connection before the railway station area into vertical connection, and provides more possibilities and choices for promoting the efficient use and reasonable development of land resources in the station area. (Figure 10)



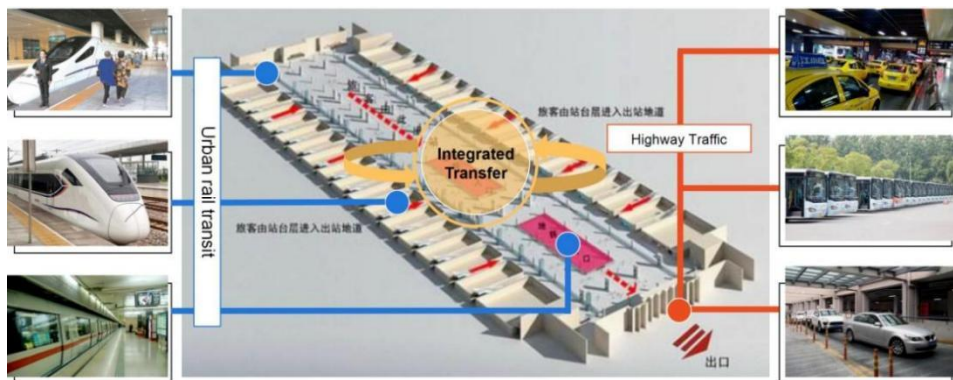
**Figure 10. Station Space for Vertical Development**

### 3.2 *Instation Space*

#### 3.2.1 The Station Streamline Mode Changes from “Waiting” to “Passing Type”

Affected by the objective conditions, Europe and the United States, Japan and other developed countries of railway traffic because started early, has the advantages of mature technology, complete facilities, the railway traffic as the main body of the comprehensive transportation system is more perfect, through reasonable control of the railway system, flexible adjustment of train marshalling, adjust to the departure density, to enhance the fluency of comprehensive traffic cohesion and transfer convenience, so the station streamline mode early realized through type, inside and outside traffic passengers in the railway station can go to go, convenient and quick. In contrast, the development of China’s railway transportation system lags behind, which is completely different from the foreign efficient station streamline mode, most of which are mainly waiting. In the past most people in the train travel to reserve more time to the waiting space waiting for ticket station, with the continuous development of economic level and traffic capacity, people to the idea of time has the very big change, at the same time, the development of economy drive high-speed railway, passenger dedicated line,

intercity trains, urban subway construction, contemporary railway station streamline mode is also changing, previously poor economy, low efficiency of “waiting” gradually to efficient “through” transformation. Due to the influence of national conditions, it must be noted that my country’s railway stations cannot completely transform from “waiting” to “passing” in a short period of time. There is still a long period of transition and coexistence. In the transformation process of this streamline model, in order to adapt to the “pass-through” functional layout and streamline design, the functional space is centered on the composite hall instead of the waiting area as the center, and the open waiting area is divided into The area is used as a temporary waiting area, and the “green channel” that directly enters the station is used to effectively realize the so-called “passing” space layout. At the same time, the increase of passing traffic space also enables the platform to assume a certain waiting space function. In the streamline organization It shortens the distance for boarding and alighting passengers, and also simplifies the related transfer steps to adapt to the change of streamline mode from “waiting type” to (Figure 11).



**Figure 11. “Pass-Through” Passenger Transfer Mode**

### 3.2.2 The Station Operation Mode Changes from “Management Type” to “Service Type”

With the rapid development of high-speed railway construction, the contemporary railway stations pay more and more attention to the efficiency and speed and people-oriented service consciousness. “Service” operation management mode emphasizes all passengers as the center, to meet the diversified needs of passengers as the focus, to create an excellent station environment and efficient service system for the purpose. The change of this operation mode helps to realize the development situation of “win-win, common benefit”, not only makes the passengers get more high-quality and comprehensive service, well display the construction of spiritual civilization of the railway traffic, but also improve the working environment of the station, improve the service awareness and dedication of the railway staff. Such as 2023 Henan ping yu along the railway station and urban culture service center cooperation, build “party + yuan universe” digital office, through the “one station multi-purpose, one room pluripotent” design concept, with “yuan universe Internet” and other emerging technologies, in the station office space, service places into the party construction culture, promote red ideological

propaganda and education, promote the station work and party building activities, guarantee passengers warm travel. (Figure 12)



Figure 12. Digital Design of the Cultural Space of Pingyu Railway Station

The biggest characteristic of the “service-oriented” operation mode is the open management and all-round service. Open management helps to reduce the constraints on station passengers, improve the autonomy and freedom; change the traditional impression of station management from material and spiritual aspects; the implementation of comprehensive service concept makes the station service facilities scattered in various parts of the station, restrict the station personnel, and attract the surrounding city people and improve the operating efficiency of the station service area. (Figure 13)

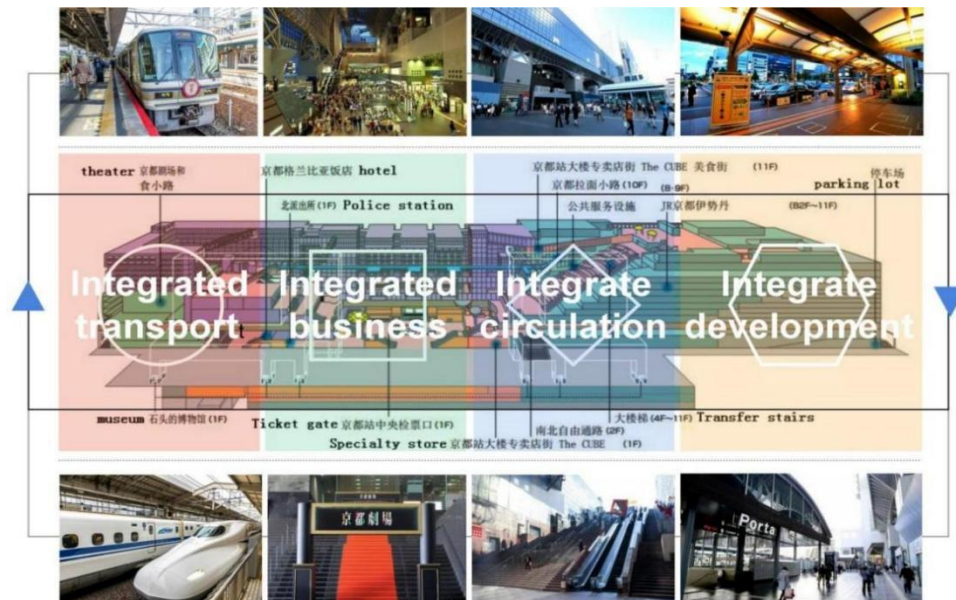


Figure 13. Diversified Station Service Functions

#### 4. Case Analysis—Hangzhou East Railway Station

Hangzhou East Railway Station is one of the largest railway hubs in China, with a scale of about 14 0,000 m<sup>2</sup>. A collection of railway, subway, bus, long-distance passenger transport, rental and other

modes of transportation, constitute a powerful drive of the flow of people. In terms of road traffic, the project approaches to Shangtang Road, Yulong Road in the south, Planning Road in the west, and Liuxian Avenue in the north. The north-south Xinxin Avenue directly passes through the tunnel under the East Railway Station. Rail transit includes Shanghai-Hangzhou, Hangzhou-Ning, Hangzhou-Ningbo, Hangzhou-Changjiang and Hangzhou-Huangshan passenger transport, as well as Hangzhou Metro Line 1 and 4. Traffic stations include passenger bus station, bus station, taxi station and underground garage. Hangzhou East Railway Station is divided into five floors, with two floors above ground and three floors underground. The first floor above the ground is the railway station platform; the second floor above the ground is the elevated departure layer, composed of three two-way 4-lane urban viaducts, which can realize the interchange of vehicles in the east and west squares; the first underground floor is the exit floor (exit hall), where passengers can directly take the taxi; the second and the third underground floors are the entry layer and platform layer of Metro Line 1 and Line 4, where passengers can take the subway. (Figure 14)



**Figure 14. Spatial Layout of Hangzhou East Railway Station**

#### *4.1 Station Interior Space*

**Elevated layer:** The commercial layout of the elevated floor of Hangzhou East Station is similar to the commercial layout of Hongqiao Station. The commercial layout of this layer mainly considers the area between the two groups of stations and the central channel area. The commercial business form mainly includes VIP waiting, convenience stores, featured product retail, and booths in the middle of the channel in the waiting area.

Customer service mezzanine: customer service mezzanine is not easy to reach, which belongs to the area to meeting the purposeful consumption demand. The commercial layout of this layer is mainly in four catering areas, supplemented by convenience stores, fashion clothing, product sales, leisure bars, etc.

#### *4.2 Underground Space of the Station*

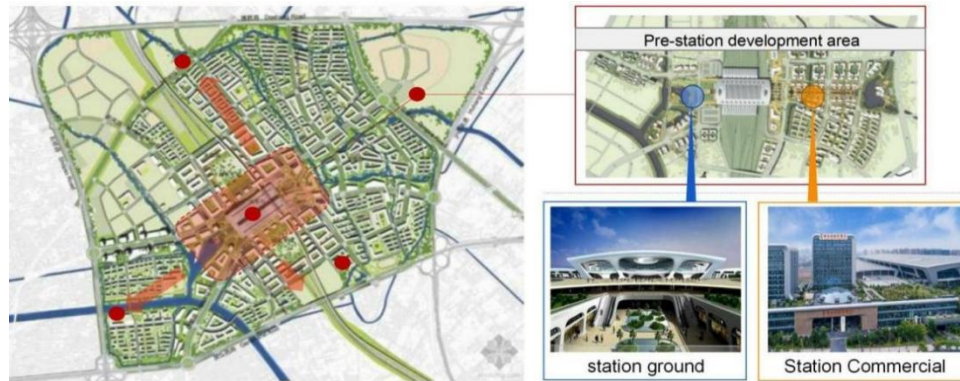
Outbound floor: There are two rail transit lines under the exit floor of Hangzhou East Railway Station, and there are entrance and exit in the middle of the city corridor. The commercial development countermeasure is to set up retail, supporting services, vending machines and other points in the middle of the city corridor without setting a large number of catering areas.

Platform floor: The commercial development strategy of this layer is to take the original waiting area as the reserved development rooms, such as the retail area, on the premise of canceling the basic platform waiting. Since the security check can be moved up to the elevated level after the cancellation of the basic platform waiting, the business of this floor can be open to the square, and the commercial value can be improved to a certain extent.

#### *4.3 External Space of the Station*

The space outside the site is mainly composed of residential areas, commercial and office complexes, hotels, auto parts market and undeveloped land, of which residential areas account for the majority. Hangzhou East New City is based on modern transportation complex, integrating modern production service industry, tourism distribution center and residential functions, carrying multiple roles such as business, leisure, new service industry and residence, which is reflected in Hangzhou East Railway Station. This area is the regional center driven by the transportation hub. It is a new city with concentrated business, living, leisure and commerce. It has absolute transportation advantages and seamlessly connects with the main urban area, and is in the stage of rapid development.

To sum up, the commercial forms of the external space of the station are mainly commercial businesses along the street and several commercial complexes. Through field research, it is found that the businesses along the street are mainly arranged in the peripheral space of the residential areas around the station, and the consumer groups are mostly local residents, which has nothing to do with the huge passenger flow brought by the East Railway Station. Several commercial complexes are closely integrated with nearby residential areas, and there are more projects under development that can meet the huge passenger flow and the living needs of a large number of local residents. There is a large auto parts market in an area near the railway station, which is not much related to the surrounding industrial facilities. In addition, the green land and undeveloped land are more, which provides sufficient space for the development of Hangzhou East Railway Station and Hangzhou East New Town. (Figure 15)



**Figure 15. The Comprehensive Development of Hangzhou East Railway Station and the Surrounding Urban Design**

#### 4.4 Summary

Since the operation of Hangzhou East Railway Station, the surrounding commercial operation has been generally good, especially the catering category is the most prominent, followed by retail, such as poor pharmacies. After analysis, it mainly lies in the layout difference between Hangzhou East Railway Station and the traditional U-shaped layout in the mezzanine catering and retail. Hangzhou east station catering set in the end of the “U” glyph, passengers dining by the elevated floor escalator arrived after retail area after catering area, after eating can also pass the retail area, the layout of the catering streamline at the same time, also drives the development of the retail formats, comprehensive development for the station and the surrounding city design laid sufficient traffic passenger flow and development opportunities.

#### 5. Conclusion

As a complex giant system, the coordination mechanism of station-city coordination has a guiding role in the comprehensive development of railway stations, which makes the internal and external space planning, functional layout and surrounding development of the stations interrelated. On this basis, the synergistic relationship of the station and the city should be considered comprehensively, and the development mode of the business form of the station area should be discussed, so as to further improve the planning, layout and comprehensive development of the railway station space.

**Figure source:** The author arranges and draws according to the Internet data

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