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# From Test Site to Pilot Demonstration Area: Historical Development and Future Prospects of Comprehensive Transportation System in Shenzhen Special Economic Zone in the Past 40 Years

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**Abstract:** In the different development stage of industrialization, urbanization, and modernization in China, Shenzhen, as a pilot field of the reform and opening up, explores the transportation development mode that adapts to the characteristics of specific historical stages. This paper systematically summarizes the logic of Shenzhen's transportation mode: 1) to break the traditional mode of government supply paths and enrich choices of transportation supply path; 2) to identify the structural evolution and development of transportation system, and continuously adhere to the principles of intensive development as the only transportation mode to support the transformation from a specific economic zone to a megalopolis; 3) to balance the factors that relevant to transportation pattern, such as capital source, land space, management system, scientific and technological innovation, so as to promote the innovation of transportation structure. As Shenzhen enters the development period of a pilot demonstration area, it follows along with the core concept of the past 40 years' development. To lead a new paradigm of national transportation governance, we proposed three advanced demonstration directions of Shenzhen transportation development: to become the transportation engine for the Greater Bay Area and achieve global development strategy, to create a user-friendly space environment and build a rail-leading transit system, and to improve social governance and maintain green development. **DOI:** 10.13813/j.cn11-5141/u.2021.0104-en

**Keywords:** transportation pattern; development process; pilot demonstration area; transportation supply path; factor balance; future vision; Shenzhen

Over the 40 years of reform and opening-up, Shenzhen's comprehensive transportation system, as the epitome and model of the transportation development in China, has contributed to Shenzhen's evolvement from sketch to an international comprehensive transportation hub with multiple transportation modes and elements. Shenzhen's transportation infrastructure with seaports, airports, railways, highways, and land ports has reflected the "Shenzhen mode," "Shenzhen experience," and "Shenzhen standard" for world's transportation development. This paper analyzes the three phases of Shenzhen's transportation development (starting, accelerating, and booming) and assesses the strategic patterns, urban economic and social dilemma, and the rationale behind transportation strategies and actions in each development phase. This paper also explores the successful development of Shenzhen's transportation as a complex and giant social system integrating multiple elements and points out new strategic directions.

## 1 Starting phase: provide basic "port + highway" transportation services to support the "three-plus-one" exporting-oriented economy

The period of 1979–1992 was the starting phase of Shenzhen's transportation development. Shenzhen was the first city in China to explore a practical approach of rapidly building a "port + highway" transportation network with multiple funding resources, supporting a new mode of transportation development for the rapid initiation of industrialization.

### 1.1 Background: Reform and opening-up released the vitality of the market, while limited transportation functions restricted industrialization

How to efficiently serve the rapid industrialization became a historical problem in the early period of reform and opening-up. In 1979, China established the Shekou Industrial Zone, which opened the prelude to rapid industrialization in

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coastal areas. Taking advantages of being adjacent to Hong Kong, abundant land resources, and low labor cost, the industry entered a fast lane through the "three-plus-one" trading structure (processing imported materials, producing supplied samples, assembling supplied parts, and compensation trade) from Hong Kong. By 1983, 2,512 overseas-funded enterprises had been introduced and 82% of them are associated with the "three-plus-one" industries. A large number of the "three-plus-one" industries formed a special logistics pattern of "origin of raw materials–assembling and processing factories in Shenzhen–consumer market." It was necessary to build a convenient land and water transportation corridor between the origin and the consumer market, so as to meet the requirements of "large-volume importing and exporting" of production factors (as shown in Fig. 1). At the same time, Shenzhen's transportation was still in the stage of scarcity. There were only 721 km roads in the city, including 339 km local roads. Most roads were paved with gravel or sand bases and many bridges were wood-based or unsafe. The transportation infrastructure failed to enable convenient external goods transport for the "three-plus-one" industries, restricting the rapid industrialization in Shenzhen.

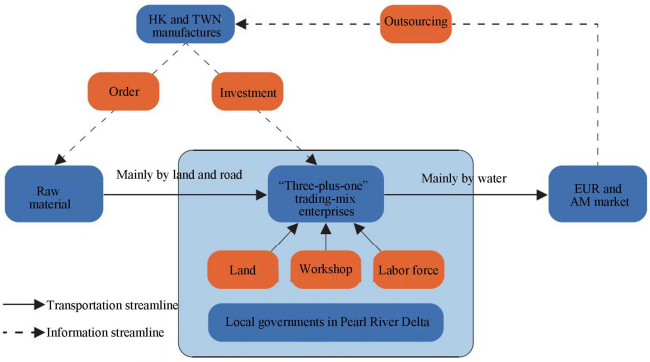



**Fig. 1** Labor-intensive processing industry and "large-volume import and export" circulation chain

## 1.2 Conflict: The government's single-source investment management mode failed to efficiently adapt to the rapid industrialization process

Under the background of reform and opening-up, the lack of decision in selecting transportation supply paths and modes became the fundamental reason for limiting the construction of transportation system and enlarging the gap between transportation supply and demand. In the early stage of reform and opening-up, the single-source government investment and government–enterprise management mode was the only theoretical basis and practical path of strategic transportation infrastructure and services. With industrialization and the rapid growth of market-oriented transportation demand, the government-led transportation supply mode barely met the needs of market-oriented development in terms of flexibility and adaptability. The financial resources required for infrastructure construction became the main issue challenging the government's transportation management ability. With highway construction as an example, in the early stage of reform and opening-up, China only invested CNY 200 million in the highway construction for national and border defense every year, without an additional budget planned for construction of other highways.

## 1.3 Solution: increase funding sources and test market-oriented mechanism of transportation investment and construction management

In response to the increasing contradiction between transportation supply and demand, Shenzhen first explored multiple funding sources in programs such as the "national investment, local financing, social financing, and overseas capital utilization," which contributed to the rapid development of exporting-oriented economy and provided a local model for the national system reform in the fields of ports and highways. In 1982, eight Chinese and overseas enterprises jointly established the China Nanshan Development (Group) Incorporation to develop and construct the Shenzhen Chiwan Port Area, which served as the foundation for the former Ministry of Transport to develop policies in 1984. The policies promoted "multiple businesses, healthy competition, and teaming up of all departments, industries and regions to perform transport development with state-owned, private enterprise-owned, and individual transport modes." [1] The administrative system has shifted from "centralized management by the central government with government–enterprise integration" to "dual-leadership by the central and local governments with local leadership being primary." [2] Since then, the Shenzhen section of Guangzhou–Shenzhen National Highway (G107) has been transformed to a toll-road system [3]. Shenzhen also accelerated the use of overseas capital and cooperated with the Hutchison Whampoa Limited to build and operate the Yantian International Port. To promote market-oriented operation of enterprises, Shenzhen Expressway Co., Ltd. was set up to raise funds, develop infrastructure, and operate expressways by itself, which represented a new path of transportation improvements based on a market-oriented approach to broaden funding sources and efficiently support the rapid economy and society development.

## 1.4 Achievement: establish the overall pattern of urban space and transportation development

The decentralization of Shenzhen's development driving forces resulted in a multi-center spatial pattern of the city. With the layout of ports in the East and West wings, the agglomeration of construction land and production functions along the National Highway 107 and other important transportation corridors have further strengthened the cluster of spatial structure. The master plan of Shenzhen Special Economic Zone (1985–2000) summarized the development experience of Shenzhen with a principle of being "favorable for production and convenient for life." It emphasized job-housing balance, focused on the construction of four

East–West corridors, and set two corridors as the main channels to serve for freight transportation; these approaches promoted the industry growth of the multi-center city. From 1979 to 1986, the construction land increased from 3 $km^2$ to 210 $km^2$, with Nigang Road, Sungang Road, Shennan Road, and Binhe Road as the main growth corridors. The "port + highway" transportation framework has established the unique "multi-center and multi-group" spatial pattern of Shenzhen (Fig. 2).

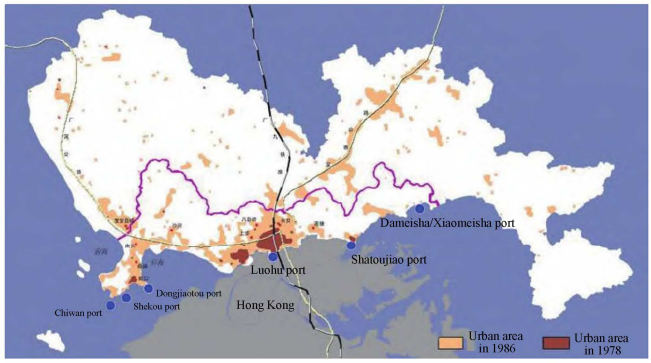



**Fig. 2** Layout of Shenzhen urbanized area along major road corridors and ports in 1986

Source: Reference [3].

## 2 Accelerating phase: rely on "regional hubs + people-oriented transportation" to support the rapid agglomeration of global industrial chain

The decade from 1992 to 2002 witnessed the acceleration of Shenzhen's transportation development. Shenzhen systematically promoted the construction of seaport, airport and urban transportation system, building a new mode of comprehensive transportation system adapted to the rapid urbanization process.

### 2.1 Background: highlight both industrialization and urbanization, with an unbalanced structure of the comprehensive transportation system

How to fill the gaps in the comprehensive transportation system and coordinate the transport functions for production and life service purposes is a practical problem in transportation development during rapid industrialization and urbanization. With regard to industrialization, global production organizations require extensive international connectivity of transportation. In addition to leveraging capital investment from Hong Kong, Guangdong Province actively attracted worldwide leading companies to establish their manufacture bases for processing and production, making the Pearl River Delta region a "world factory." Since 1992, Shenzhen has remained as the top exporting city among large and medium-sized cities in China [4]. The types of exporting products have changed from low-level raw products to mechanical and electrical products. The proportion of mechanical and electrical products increased from 30% in 1992 to 69% in 2002 [5]. The rapid urbanization in China, with a rate from 27% in 1992 to 39% in 2002 [6], took only 10 years to go through the process that took about 50 years in developed countries. Meanwhile, Chinese cities have been facing unique development characteristics of high population density. How to implement innovation and form an urban transportation system to support high-density and high-intensity development of megacities has become a challenge to transportation development, which is as important as the challenge of increasing international connectivity of manufacturing.

### 2.2 Conflict: require improved urban transportation development, given insufficient capacity of international resource allocation in seaports and airports

A key issue to be addressed in the construction period of a comprehensive transportation framework was to accurately understand the structural evolution trend, control the tempo and sequence of the construction of each component, and identify the common factor acceptable to all stakeholders instead of the ultimate optimal solution for transportation development. The two major functional demands for global connection and people's livelihood grow rapidly at the same time. Balancing the two transportation functions with limited resources became a primary conflict in the acceleration period of Shenzhen's transportation. In terms of global connection, with the upgraded industrial chain, Shenzhen's demand for global passenger and freight transportation surged and the port-dominated transport mode of bulky goods was difficult to support industrialization. The international air traffic hub represented the direction for upgrading Shenzhen's comprehensive transportation system. However, the approval authority of air traffic routes and airspace resources was controlled by the central government and the military. The development of Shenzhen Bao'an International Airport was limited given the existence of two adjacent international air hubs—Hong Kong International Airport and Guangzhou Baiyun International Airport. Therefore, the development of Shenzhen Bao'an International Airport had a late start (operation in 1991), with its expected role as an important airport instead of an international airport due to the shortage of airspace resources in the Pearl River Delta. It was urgent for Shenzhen to explore a breakthrough to meet the needs for upgraded economic and industrial development under international standards. In terms of urban transportation services, permanent residents of Shenzhen have increased from 2.68 million to 7.466 million [7] (increased by 179%) within the 10 years after 1992, and the main population changed from industrial workers to more diversely-employed urban citizens. The car ownership increased by 233% in the past 10 years [8]. To pay for the historical debt of inclusive transportation services for

people's livelihood, Shenzhen needed to make a choice between individual motorization and intensive public transportation.

### 2.3 Solution: share strategic hub and connect global network with the direction of transit-oriented metropolitan development

Shenzhen improved the connection channel with the regional air hubs and opened up the international path. As it is difficult to build an international air hub in a short time, Shenzhen focused on strengthening the construction of regional connection channels to connect with Hong Kong and Guangzhou air hubs (Table 1). In 1993, a shipping company was established to be responsible for the operation of the passenger transit line between Shekou, Shenzhen and Haitian passenger terminal of Hong Kong International Airport, enabling a 30-minute accessibility to Hong Kong International Airport. In 1994, the first high-speed railway in China, namely the Guangzhou–Shenzhen high-speed railway was officially opened, with a design speed of 160 km/hr (including the Xintang–Shilong section as a 200 km/hr high-speed trial section). In 1996, the 3rd line project of Hong Kong–Shenzhen railway started, which was the first enclosed and electrified parallel three-line railway in China and provided a railway system to connect Guangzhou Baiyun International Airport. At the same time, Shenzhen actively planned the upgrade of its own seaport and airport system to build a foundation for future internationalization. In 1993, the railway at the Yantian port was officially opened, representing the first attempt to optimize the structure of the collecting and dispatching system. At the end of 1991, Shenzhen airport officially started operation. In 1993, Shenzhen Airport passed the national acceptance and became the international airport with the fastest construction speed and throughput growth within the shortest period (only within one and a half years).

**Tab. 1** Main strategy and action taking advantage of regional hubs

| External transportation mode | Water | Railway | Highway | Air |
|---|---|---|---|---|
| Strategy and action | In 1993, a shipping company was established to reach Hong Kong airport directly for half an hour; in 1993, the railway at the Yantian port was officially opened, which was the first attempt to optimize the collection and distribution structure at the Shenzhen port; in 1996, the Shekou–Europe regular liner route was opened, which started the direct connection between the Shenzhen western port to European international liner route. | In 1994, Shenzhen West Railway Station started operation; in 1994, China's first high speed railway, Guangzhou–Shenzhen high speed railway, was opened; in 1996, the 3rd line project of Hong Kong–Shenzhen railway started; in 1996, Pingnan railway was opened, providing service for nationwide direct freight transportation. | In 1994, Huizhou–Shenzhen highway was opened; in 1994, Guangzhou–Shenzhen highway started trial operation, with the round-trip time between Shenzhen and Guangzhou shortened to an hour; in 1995, the Meilin–Guanlan highway was opened, becoming Shenzhen's first self-funded highway with self-organized construction and management. | In 1991, Shenzhen Airport was opened; in 1993, the terminals of Shenzhen Airport passed the national acceptance, becoming the fastest-growing airport in China and the only one upgraded to an international port within one and a half years; in 1993, Shenzhen Airport opened its first international airline. |

Source: Shenzhen Urban Transport Planning Center Co., Ltd.

With the existing road network as the urban transportation backbones, Shenzhen continued to promote intensive public transportation, rather than individual motorization, as the path for urban transportation development. For bus transit, Shenzhen cleared the obstacles for the development of metropolis transit through right of way protection and system improvement. In 1992, Shenzhen led the implementation of automatic ticket booking. In 1995, Shenzhen began to issue business operation permits and implemented the "four fixed measures of management" (fixed driving lanes, fixed parking locations, fixed price charging, and fixed time charging). In 1996, the contactless IC card system and electronic payment were launched. The first bus lane was opened in 1997. For railway transit, in the early 1990s, Shenzhen relied on the construction of mass transit to support urban development and started investigation and design research on Metro Line 1. In 1998, the first phase of Shenzhen Metro project was approved to start the transit development and serve as a port connector as well as a localized research platform.

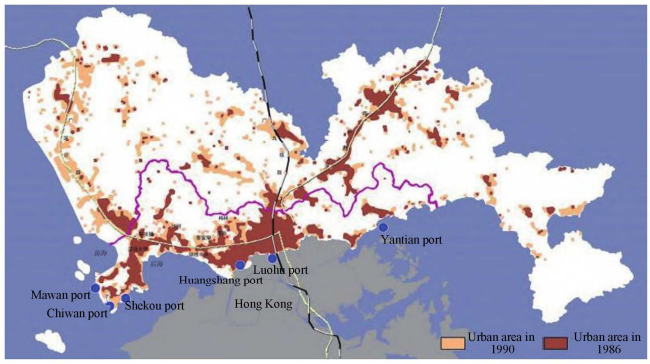
### 2.4 Achievement: anchor the strategic hub to the city center, with an initial formation of a comprehensive transportation system

During the 10 years when both extensive industrialization and rapid urbanization were highlighted, Shenzhen had basically addressed its structural weaknesses in global connection and regional circulation. With the emerging comprehensive transportation system, Shenzhen's path for urban transportation development with public transit as the focus was identified, which provided a solid transportation foundation for the transition from a special economic zone to a mega city. From 1992 to 2002, a series of land reform policies were issued, which allowed state-owned land to be leased to developers in the form of bidding and auction, with all revenues for funding reconstruction and expansion of infrastructure including transportation. The area of construction land increased rapidly from 210 $km^2$ to 800 $km^2$, which reflected Shenzhen's golden decade of growth in land and capital resources. Shenzhen Airport, Yantian Port, Pinghu container hub, and other strategic hubs achieved a leap development in function and scale, promoting the substantial construction of comprehensive transportation system in the city (Fig. 3).

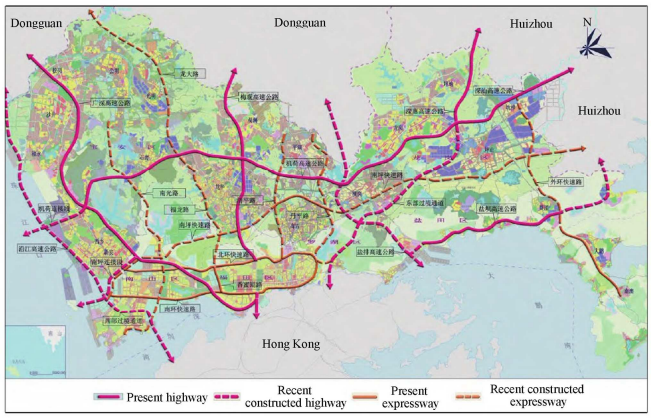
## 3 Booming phase: promote integrated governmental management of transportation and form a comprehensive transportation network to support international development

Since 2002, Shenzhen's transportation development has stepped into a booming phase. On the basis of a generally stable and comprehensive transportation system, it has become became challenges to Shenzhen's transportation development to continue to search for new driving force for the growth of transportation services and explore transportation

modes adapt to the post-industrialization and modernization development in China.




a Changes in Shenzhen's urban area




b Shenzhen's road network

**Fig. 3** Shenzhen urban area and "one-horizontal–eight-longitudinal" arterial roadway network system from 1986 to 1990

### 3.1 Background: with service economy and the middle class as focuses of new growth in the emerging post-industrialization era

Since 2000, Shenzhen has been ahead of most cities in China to enter the stage of post-industrialization and mature urbanization. Exploring a new path to achieve high-quality transportation became necessary to address travel demand growth in mega cities. At the beginning of 2002, substantial discussions were performed on the topic of "Shenzhen being abandoned." In fact, such topic reflected the adjustment of economic structure, the reorganization of industry, and the shift of social demand resulted from the transition from industrialization to post-industrialization. Compared with Shenzhen's average annual population growth rate of 21.8% in 1991–1995, the average annual growth rate of Shenzhen's permanent residents in 2001–2005 was only 3.4%, which is the lowest record. In terms of economic structure, service economy became an important growth point. In 2016, Shenzhen's service industry accounted for nearly 60% of its GDP, which is 14% higher than the 46% in 2005. For the human resource structure, by the end of 2018, Shenzhen had 143 high-level innovation or entrepreneurship groups and recruited about 110,000 overseas students with more than 40% annual growth rate for three consecutive years in recruitment [8].

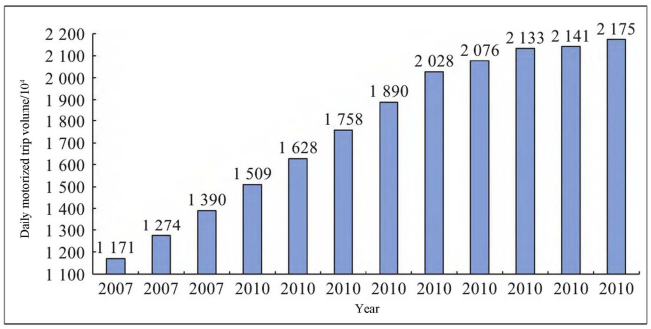



**Fig. 4** Changes of daily average motorized travel volume in Shenzhen

Source: Reference [7].

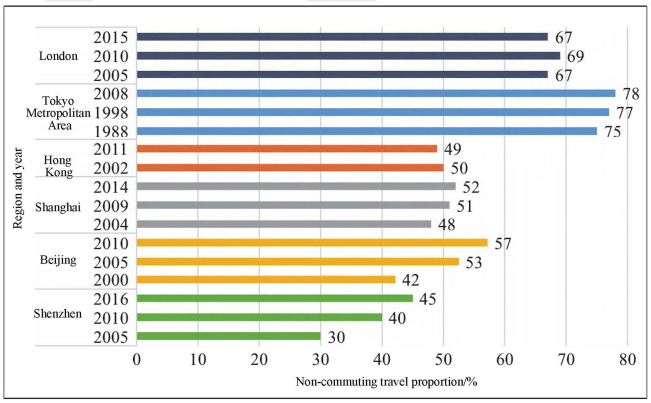



**Fig. 5** Comparison between non-commuting travel proportions of Shenzhen and other international megacities over years

Source: Reference [8].

### 3.2 Conflict: with limited transportation space resources, the hub capability and comprehensive benefits waiting for expansion

The challenge to Shenzhen's transportation during the booming period seemed to be the space, instead of capital, becoming a bottleneck that restricted the development of transportation; however, the actual challenge was the shift of the comprehensive transportation system from the past incremental development to current stock development. To change the factor of decreased marginal benefits of traditional resource investment, Shenzhen has to explore an independent transportation growth mode to solve the problem of insufficient growth in the new development stage. From 2002 to present, the construction land has increased by 180 $km^2$, which is only 30% of the total growth from 1992 to 2002. The proportion of transportation land in the construction land has reached 24.6%, which is higher than those in Singapore, Hong Kong, and other international cities. It is difficult to continue the traditional path of relying on space investment to support the construction of transportation system. At the same time, Shenzhen's travel demand has

experienced structural changes. From 2007 to 2018, the average daily motorized trip volume in Shenzhen increased from 11.71 million to 21.75 million personal trips per day [10] (Fig. 4). In terms of trip purposes, the proportion of commuting trips has decreased from 58% to 47% in the recent 10 years, while the proportion of business, shopping, entertainment, family trips and other non-commuting trips have increased by nearly 50% (Fig. 5).

### 3.3 Solution: use system innovation as driving force, save time by demand management, and obtain space through intensive public transportation

With the focus of refining transportation structure, Shenzhen is building a modern transportation system through the innovation of system and mechanism, composite utilization of space, and precise adjustment of policies.

1) For system and mechanism innovation, Shenzhen carried out the reform of transportation administration ministries and set up an integrated transportation management system. In 2009, the Transport Commission of Shenzhen Municipality was established based on the consolidation of Transport Bureau, Highway Bureau, Traffic Administration Office, Rail Transit Construction Headquarters Office, and the transportation departments and highway departments of Bao'an and Longgang Districts, as well as the integration of the Development and Reform Commission, Planning Bureau and Traffic Police Department. The reform of the transportation management system during the mature urbanization period conformed to the trend of transportation integration at inter-regional, regional, and urban levels; it also laid the foundation for a multi-network integration of transportation, such as highways, urban roads, external railways, and urban rail transit, which are traditionally under the management of different departments.

2) For spatial evolvement, the incremental space continued to be reserved for intensive rail transit development, and new high-speed railway stations such as Futian station and Xili station were located in the core area of the city. The city's system of "five main stations and four auxiliary stations" was created, anchoring the urban center system with transportation hubs. Shenzhen improved the network of high-speed railways, intercity railways, and urban rail transit within the city to strengthen the multi-level rail transit network for the Guangzhou–Shenzhen–Hong Kong science and technology innovation corridor and other coastal corridors. Four new high-speed railway routes and the intercity railway network of "three horizontal and four vertical routes" were planned, with the development space reserved for the construction of urban rail transit over 1,000 km [10] (Fig. 6). The use of incremental space was guided by the composite application of limited channel resources and making ground vitality space available. For instance, Shenzhen is promoting the construction of depressed roadways in ecologically sensitive areas such as the Binhai Avenue. The project can free nearly 40 $hm^2$ of ground public space resources and save the limited resources for building parks, green space and other city functions.

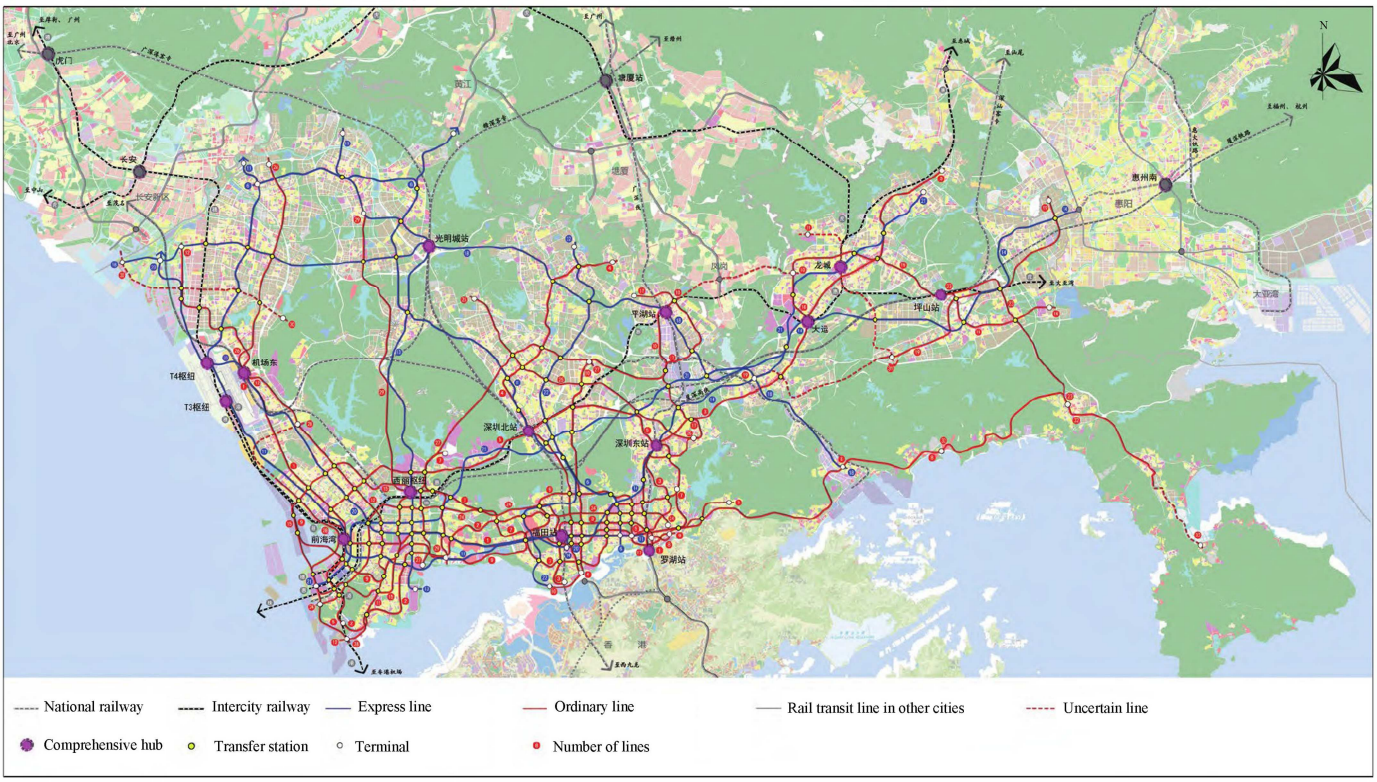



**Fig. 6** Shenzhen urban rail transit network planning (2016–2030)

3) For policy adjustment, Shenzhen established a transportation planning system with guidelines that are compatible with urban planning and lead to healthy development of a comprehensive planning-oriented transportation system. A "macro-meso-micro" TOD policy system was built. Macro-level zoning strategy of transportation was implemented to guide urban development. Management regulations were adopted for underground space development and utilization. Rail transit integration standards were formed to connect land use and transportation development around sub-district and rail transit stations. Shenzhen also used economic leverage to adjust transportation structure and explored new policies to address the complete life cycle of "ownership-usage-parking-scrappage" of passenger cars, which supported the transformation from limited road resources to intensive public transportation.

### 3.4 Achievement: complete initial development of a comprehensive multidimensional transportation network under international standards

Based on the reform of the transportation management system, the transit-oriented arrangement of spatial resources, and the policy adjustment in transportation structure, Shenzhen's multidimensional transportation network has been developed and started, serving as an international comprehensive hub. The airport has been upgraded from a regional airport to an international aviation hub at an average annual growth rate of 8.0%, the highest among the top ten airports in China, in passenger throughput over the past eight years. As a global container port, Shenzhen's port has become the preferred port in China for global super large container ships. Shenzhen's ability of transportation governance is taking the national lead with the improving comprehensive transportation planning, construction, operation, and management, and Shenzhen provides high-quality transportation services for the 20 million residents. With the car ownership increasing from 1.75 million in 2013 to 2.54 million in 2017 and the travel intensity increasing from 1.9 to 2.3 vehicle trips per day, Shenzhen relies on effective management approaches to maintain a traffic index in its central area at 4.0–5.0 during peak hours, reflecting a better performance than many major cities in China. The excellent transportation environment has provided a strong support for the circulation of resources and logistic elements.

## 4 Research on the changed and unchanged factors in Shenzhen's transportation development

This section summarizes the externally changing factors of Shenzhen's transportation development in the past 40 years and its inherent evolvement patterns, which highlight Shenzhen's experience in the transition of transportation system from a "test site" to a "pilot demonstration area."

### 4.1 The changed factors: create the comprehensive transportation system with unique characteristics through a special development process

A recollection of the 40 years of transportation development in Shenzhen has suggested a consistently evolving and improving transportation system in serving the social economic development, optimizing the transportation structure, and supporting the major city functions. In terms of supporting economic and social development, Shenzhen's transportation system has experienced an upgrading process: large-scale construction of roads and ports to cover the needs of industrial factors circulation, improvement in transportation services to adapt to the process of urbanization, and evolution and upgrade of economic and social development led by proactive transportation system. In terms of the characteristics of Shenzhen's transportation structure, the changes involved focusing on goods transport in the early stage of reform and opening-up to highlighting passengers travel as a function of people's livelihoods, and then to emphasizing the accurate coordination between passenger travel and freight transport. With regard to the transportation development mode, Shenzhen has transformed its system from the traditional demand-based supply in general to a combination of the demand-based supply for urban public transit and supply-determined demand for personal motorized travel; such a combination has set Shenzhen's transportation in a new stage of intelligent governance of space, policy, etc. The service concept of transportation system has changed from ensuring the basic production demand at the initial stage to promoting quality and efficiency of transportation functions for production and living, and further to enriching the supply options of transportation services for citizens' travel [15–16].

### 4.2 The unchanged factors: set the general development goal of "meeting people's needs, ensuring full services, and achieving front ranks in the world"

Effective support in the circulation of economic and social resources and consistent focus on people's travel satisfaction have been the core pursuit of Shenzhen's transportation development in the past 40 years. Shenzhen always pays attention to the integrated development between the transportation framework and the city, and controls the evolution and construction pace of transportation system during each development phase. For example, in the starting phase, Shenzhen relied on expressways or highways to form a multi-group spatial structure. In the accelerating phase, Shenzhen focused on its accessibility associated with the regional hub, rather than simply addressing mobility. In the booming phase, Shenzhen consistently concentrated on developing the urban temporal and spatial patterns through rail transit and anchoring the urban central system. Meanwhile, in terms of the multi-level factors affecting the construction of transportation system, such as capital, power, space, and time, Shenzhen also addressed the

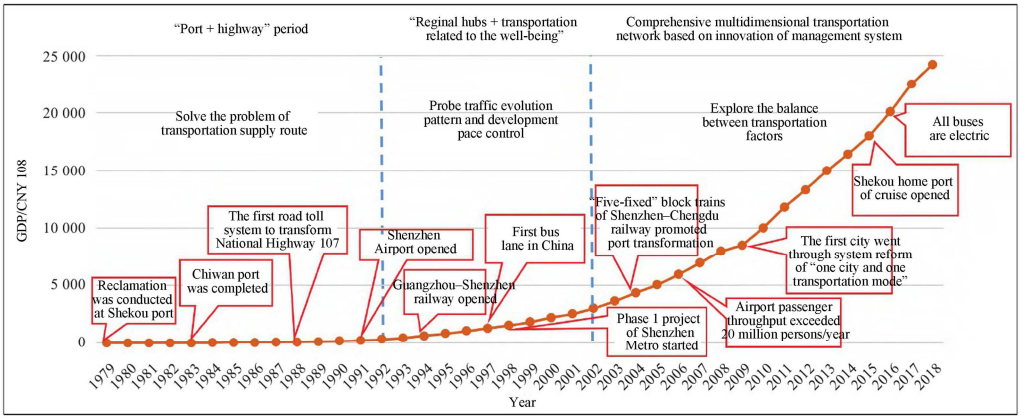



**Fig. 7** Shenzhen transportation development history

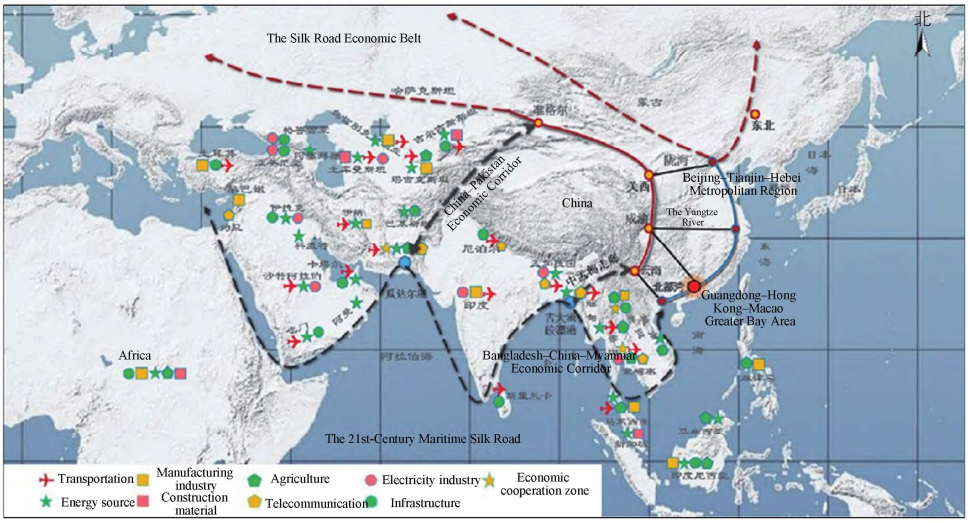



**Fig. 8** International capacity cooperation based on the "Belt and Road Initiative"

main contradiction, focus, and construction organization of the transportation system during each development phase, which enhanced the allocation capacity of the comprehensive transportation resources (Fig. 7).

## 5 Future direction of Shenzhen's pilot demonstration in transportation development

Innovation economy has replaced service economy to become a new global growth pole. China's urbanization has entered the second half of the development phase with the metropolitan area as the basic spatial unit. How to lead the global economic growth, how to support the construction of a world-class metropolitan area suitable for living, working, and traveling, and how to provide high-quality transportation support for the rapid aggregation and convenient circulation of innovative economy, innovative industry and innovative talents in the metropolitan area have become the primary tasks of Shenzhen's transportation demonstration.

### 5.1 Initiation from the Greater Bay Area and connection to the world

Shenzhen's main mission in the new period of globalization is to share its achievements from the innovative economy and actively participate in the global governance system. By the end of 2019, the number of international patent applications from Shenzhen has been the most in China for 16 consecutive years, accounting for about half of the total number of applications in China [17]. On the basis of the comprehensive transportation system structure, which is generally stable, Shenzhen should continue to explore new driving forces to grow transportation services by improving the system and mechanism, upgrade the functional positioning in the global supply chain system and value chain system through smart technology, and enhance its global influence in the scientific and technological innovation. Taking the Belt and Road Initiative as the development direction, Shenzhen can strengthen its leading role in serving the international cooperation via airports and seaports, promote the development mode and

experience, define international standards of transportation along the Belt and Road area, and support the core engine function for the Greater Bay Area to participate in global competition. (Fig. 8).

### 5.2 Space-friendly development and convenient urban mass transit

To address the typical issues in China's transportation development, such as working with local governments and coordinating unbalanced investment and financing mechanism, Shenzhen should demonstrate the new approach with "rail transit as the orientation, intelligent transportation as the lead, action planning as the guidance, compact and coordinated space, and integrated development of stations and the city" in the new phase of constructing the metropolitan transportation system. Relying on a multi-layer rail transit network to expand the spatial scope of the metropolitan area has become the consensus in the transportation development. However, further investigation remains active to deconstruct the traditional urban economic development and clarify investment return model of transportation infrastructure construction and a range of potential positive and negative external effects [18]. A group of innovative enterprises, with Huawei Technologies Corporation as a representative, has been working on the functional rebalancing in the metropolitan area. In 2018, 72 innovative enterprises with an average annual industrial output of 2% have relocated to the outer layer of the metropolitan area. Economic and social development has outpaced transportation development at the metropolitan scale. Therefore, the transportation development path from "rail city" to "rail metropolis" should be demonstrated. Through function differentiation and operation activity organization in the multi-level rail transit network, traffic information sharing between different cities and different ways can be enhanced to achieve integration and cooperation at different spatial scales, with door-to-door travel time instead of spatial distance as the constraint and intelligent technologies as the basis (Fig. 9). With respect to the development of intercity transportation, such as intercity railways, Shenzhen should introduce a market-oriented mechanism, establish an enterprise-oriented investment and financing platform and operation companies, and prioritize the development of rail transit that can be promoted and coordinated in the Shenzhen–Shanwei Special Cooperation Zone.

### 5.3 Social governance and intensive green development

Governance modernization has become the primary goal of the new round of Shenzhen's transportation development. The most successful paradigm of Shenzhen's transportation in the past 40 years has been its incremental development, which solved the structural problems of the transportation supply-demand system through consistently increased facility supply. In light of the limited stock development pattern of land use, space, ecology and other constraints, the key components of Shenzhen's traffic development involved refining the structure of transportation services, balancing the supply and demand for the sustainable development of ecological environment, and establishing a modern traffic management system [19]. Shenzhen's transportation development should first demonstrate the paradigm of collaborative governance from multiple perspectives and replace the traditional administrative management with social co-governance. By integrating the four elements, namely policy governance, space governance, service governance, and intelligent governance, Shenzhen will achieve an upgrade from simply focusing on traffic benefits to highlighting multiple economic and social benefits. Shenzhen will also achieve the goal of increasing its green traffic structure from 78% in 2019 to 85% in the planning horizon and demonstrate its modern traffic development without heavily relying on individual motorized travel.

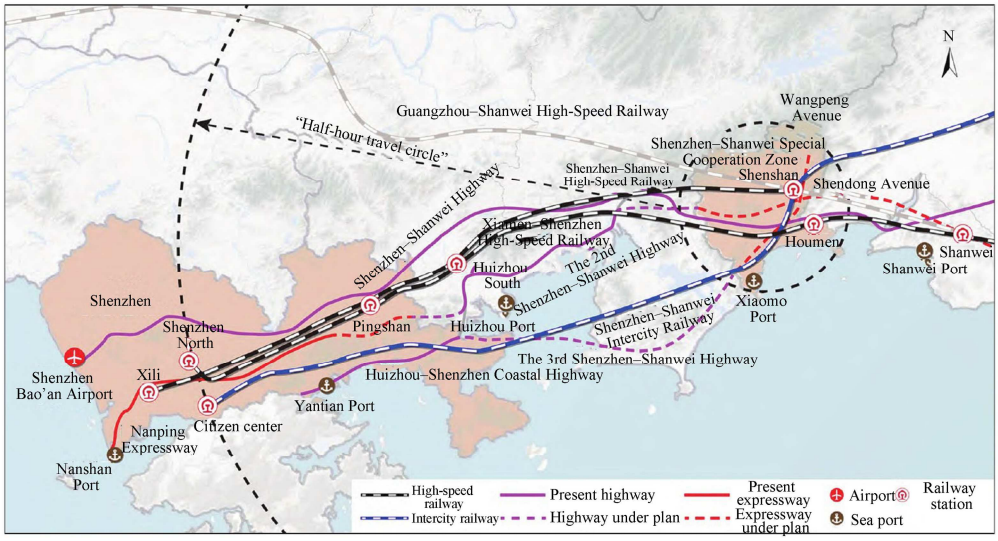



**Fig. 9** Shenzhen–Shanwei Special Cooperation Zone and Shenzhen half-hour railway service circle

## 6 Conclusion

As a strategic infrastructure influencing the flow of key factors and people' travel satisfaction, the comprehensive transportation system plays a critical role in the national economic and social development. Shenzhen has taken 40 years to accomplish a high-quality transportation system and played a leading role in demonstrating the development direction. With regard to more complicated uncertainties in the future, Shenzhen should continue to follow the development concept of "transportation for people to enjoy, goods with optimized movement, and world with global connection" and proactively demonstrate its modern transportation governance system for a future city.

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