Geography

Learning and Teaching Resources on Guangdong-Hong Kong-Macao Greater Bay Area (Greater Bay Area)

Transportation system in the Greater Bay Area

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1 Introduction

As a crucial part of urban and regional public systems, transportation is an important driver for regional development and an important indicator for promoting regional economic development. The building of the Guangdong-Hong Kong-Macao Greater Bay Area (Greater Bay Area)[1] has become development strategy at national level. The goal is to develop the Greater Bay Area into a world-class metropolis and drive the development of the Zhujiang Delta region. Transport infrastructure is the foundation for development of the entire Greater Bay Area. Geographically, the Greater Bay Area has numerous ports and cities. With proper planning and development of basic transport infrastructure, an efficient transport network can be established in the Greater Bay Area which will help drive socio-economic development.

2 Overview of transport infrastructure

A well-developed transport network sets the foundation for the economic development of the Greater Bay Area. Up till 2017, there are 20 railway lines, 38 highways, 6 major airports[2], 16 ports, 26 large bridges and 16 urban rail transit built or under construction in the Greater Bay Area (Guangzhou Daily Data & Digit Institute, 2018). According to the "13th Five-Year Plan Report" of the Central Government, building a "one center, three networks" transport system will be the future focus of transport construction. The "One Center" refers to a world-class international shipping logistics center while the "Three Networks" refers to a multi-directional channel network, a sea-air network and a rapid transit network. The goal is to form an integrated transport system that extends internally within the country and externally towards the world.

[1] Zhujiang is the largest river in South China. It consists of three main tributaries and other tributaries of the Xijiang, Beijiang, and Dongjiang. The transport materials of these tributaries are carried by the river water to the estuary (Zhujiang Estuary) and deposited at the estuary to form a fertile delta called the "Zhujiang Delta". After the reform and opening up, the Guangdong Provincial Government designated Guangzhou, Shenzhen, Dongguan, Foshan, Jiangmen, Zhongshan, Zhuhai, and the urban areas of Huizhou and Zhaoqing in the Zhujiang Delta as the Zhujiang Delta Economic Zone, which became the prior regions of the country's reform and opening up. On this basis, Hong Kong and Macao Special Administrative Regions were added to extend the concept of the "Greater Zhujiang Delta Region". In 2017, the state proposed to deepen the cooperation between Guangdong, Hong Kong and Macao and promote the construction of the "Guangdong-Hong Kong-Macao Greater Bay Area (GBA)". At present, the GBA includes the nine cities of Guangzhou, Shenzhen, Zhuhai, Foshan, Huizhou, Dongguan, Zhongshan, Jiangmen and Zhaoqing, and two special administrative regions of Hong Kong and Macao.

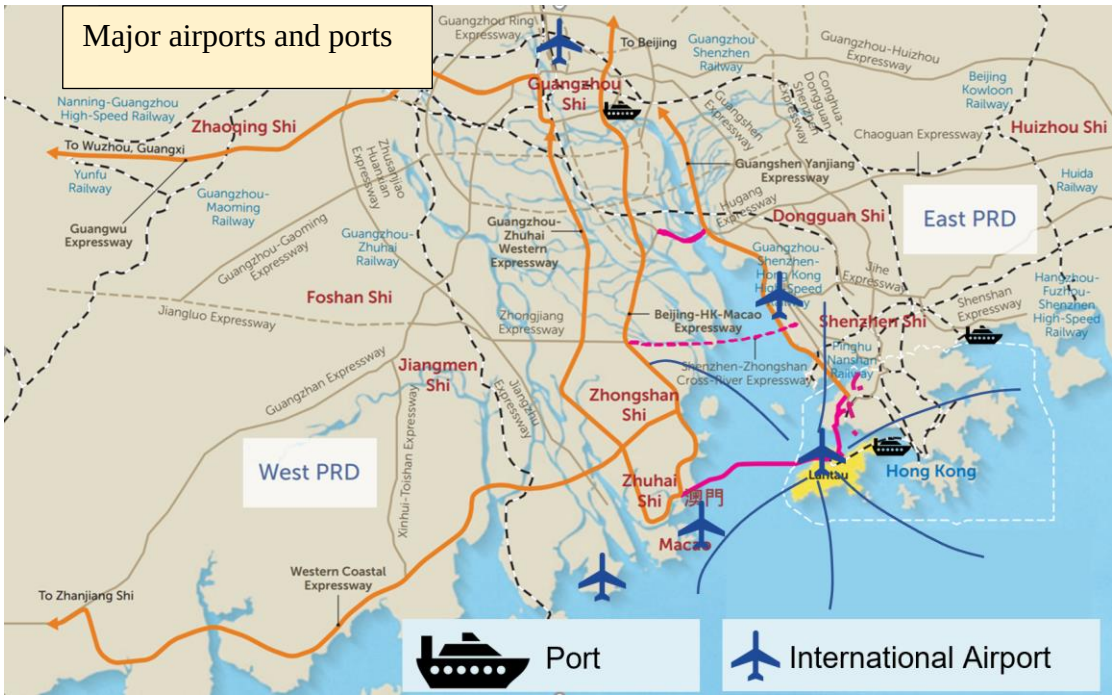
[2] There are six major airports in the Greater Bay Area, including the Hong Kong International Airport, Shenzhen Bao'an International Airport, Guangzhou Baiyun International Airport, Macao International Airport, Huizhou Airport and Zhuhai Airport. The other two small-scale airports include Zhongshan Airport and Foshan Shadi Airport.

The transport infrastructure in the Greater Bay Area can be divided into three categories: sea, land and air. Sea refers to ports; land refers to roads and railways; air refers to airports. The three forms a tightly connected transport and logistics network which not only contributes to regional integration and builds a one-hour living circle but also drives the development of the surrounding areas.

2.1 Airport and port

As the centre of the economy, the major airports and port groups in the Greater Zhujiang Delta region are concentrated in the Greater Bay Area. There are 23 important ports such as Guangzhou Port, Shenzhen Port and Hong Kong Port in the Greater Bay Area. The airport groups of the Greater Bay Area include Hong Kong International Airport, Shenzhen Bao'an International Airport and Guangzhou Baiyun International Airport as the major airports, the Macao International Airport, Huizhou Airport and Zhuhai Airport as the auxiliary airports.

Figure 1: The spatial distribution of major airports and ports in the Greater Bay Area



Source: Civil Engineering and Development Department (2017) Sustainable Lantau Blueprint

Compared with the other bay areas in the world, the Greater Bay Area has become the largest airport group among bay areas in the world with 6 major airports (Table 1). This meets not only the logistic demand of South China, but also fulfills the needs for logistics around the world. In 2015, the Hong Kong International Airport in the Greater Bay Area ranked second in terms of passenger volume in our country, and its cargo volume ranked first in our country and in the world. Guangzhou Baiyun International Airport ranks fourth in our country in terms of passenger volume and freight volume, while Shenzhen Bao'an International Airport ranks seventh and fifth respectively in our country (Legislative Council of the Hong Kong Special Administrative Region of the People's Republic of China, 2018). In the same year, the Greater Bay Area had an annual passenger throughput of 175 million passengers (Academy of Greater Bay Area Studies, 2019) and a cargo throughput of more than 60 million tons (Table 2). It ranks first among bay areas, showing that the Greater Bay Area has great competitiveness.

Table 1：Number of airports and passenger throughput in the world's bay areas

Bay Area	**Number of airports**	**Major airports**	Airport passenger throughput in 2015 (100 million people)
Guangdong-Hong Kong-Macao Greater Bay Area	6	Hong Kong International Airport, Shenzhen Bao'an International Airport, Guangzhou Baiyun International Airport, Macao International Airport, Huizhou Airport, Zhuhai Airport	1.75
Tokyo Bay Area	2	Narita International Airport, Haneda Airport	1.12
San Francisco Bay Area	3	San Francisco International Airport, Oakland International Airport and Norman Y. Mineta San Jose International Airport	0.71
New York Bay Area	3	John F. Kennedy International Airport, Newark Liberty International Airport, LaGuardia Airport	1.3

Source: Academy of Greater Bay Area Studies (2019)

Table 2: Throughput of major ports in the world's bay areas in 2015

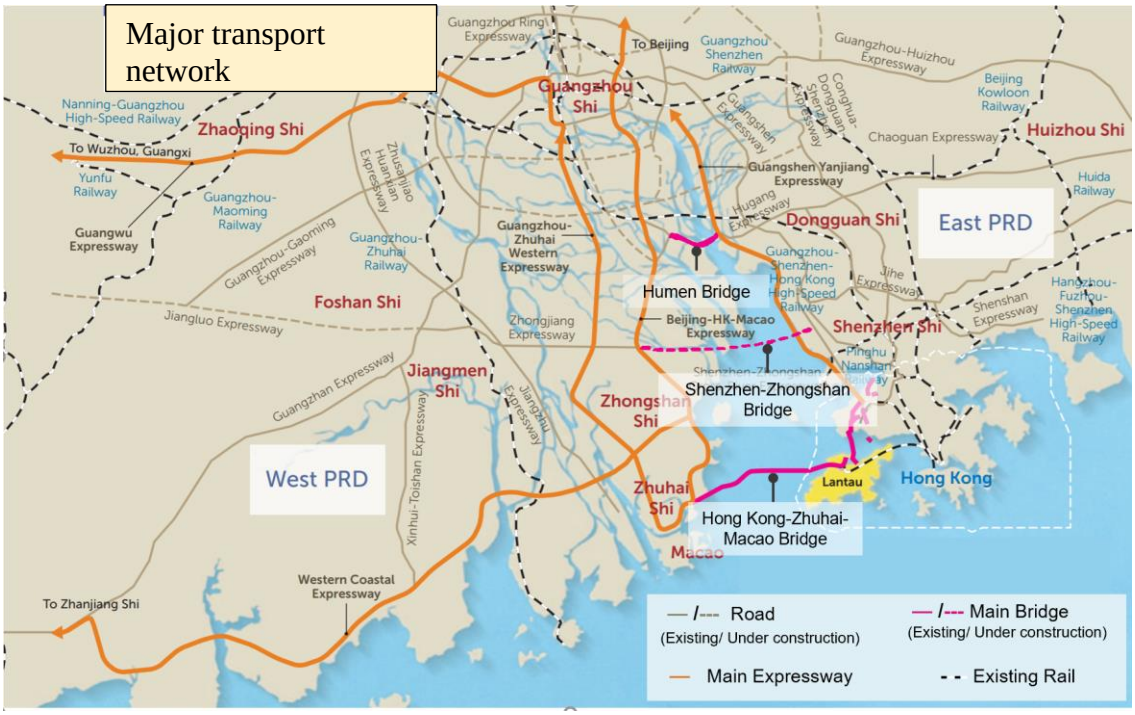
Bay area	Port	World ranking	Throughput (Twenty-feet equivalent units, TEU)
Guangdong-Hong Kong-Macao Greater Bay Area	Shenzhen Port	3	24,204,000
	Hong Kong Port	5	20,114,000
	Guangzhou Port	7	17,624,900
	Dongguan Port / Humen Port	43	362,657
San Francisco Bay Area	Los Angeles Port	19	8,160,457
	Long Beach Port	20	7,192,066
New York Bay Area	New York Port and New Jersey Port	22	637,200
	Virginia Port	63	2,549,270
Tokyo Bay Area	Tokyo Port	29	4,629,000
	Yokohama Port	54	2,787,296
	Kobe Port	57	2,706,967
	Nagoya Port	58	2,630,804

Source: Lloyd's List Martime intelligence Informa (2017) and Academy of Greater Bay Area Studies (2019)

2.2 High speed rail

The high speed rail is an important part of the transport network system in the Greater Bay Area. It is directly related to the effective mobilisation of personnel and resources as well as the vitality of the cities in the Greater Bay Area. In Hong Kong, the East Rail Line that connects to the Mainland has no longer been able to support huge passenger traffic and was fully loaded in 2014 (calculated on a per square metre basis). Even though the full load rate has dropped in 2015, it was still as high as 93%. It is difficult to meet the present condition and need.

Figure 2: The major transport network in the Greater Bay Area



Source: Website of the Guangzhou-Hong Kong-Macao Greater Bay Area – Map of Infrastructure

The Guangzhou-Shenzhen-Hong Kong high speed rail is the first high speed rail in Hong Kong. The Hong Kong section is 26 kilometers long and is connected to the national high speed rail network with a total length of 19,000 kilometers. Its terminal locates at West Kowloon in Hong Kong. It takes only 14 minutes from Futian Station in Shenzhen, or 48 minutes from Guangzhounan Station to Hong Kong West Kowloon Station by high speed rail, strengthening the ties between Hong Kong and the Mainland.

The Ganzhou–Shenzhen High-speed Railway, starting from Ganzhouxi Station in Ganzhou, Jiangxi, is connected to Shenzhenbei Station in Shenzhen. The railway connects to the Beijing-Shanghai High-speed Railway and can run at a speed of 350 km/h. It will become another land-based passage between Guangdong Province and other provinces, shortening the travel time between Hong Kong and the Zhujiang Delta and Changjiang Delta. Therefore, the construction of the high speed rail will help Hong Kong strengthen its connection to other cities of the Greater Bay Area, and even connect to the wider railway network of the Mainland.

2.3 Road transport

Unlike the main feature of other bay areas in the world, the transport network in the Greater Bay Area is well-developed where cities in the area can be reached within one hour (For example: Travelling from Zhuahi to Zhongshan, from Guangdong to Dongguan takes only one hour; travelling from Shenzhen to Zhongshan takes only two hours). This can effectively speed up the exchange and allocation of resources and factors of production. The logistics industry will become a direct beneficiary of road transport. Even though land transport is slightly more expensive than water transport, it is flexible in terms of time and choice of vehicle and is also more reliable.

3 Transport construction projects

3.1 Overview of the existing transport infrastructure and the projects under construction / planning

The infrastructure construction projects of the cities in the Greater Zhujiang Delta effectively shorten the transport time between cities, forming a one-hour living circle. More importantly, the convenient and efficient transport network can foster the exchange of the talents, goods and services in the area. Transport infrastructure in the Greater Bay Area has become even more comprehensive. A three-tiered and convenient rail transit-oriented transport system have covered the entire bay area, including level one: national high-speed railways; level two: inter-city rapid transits at regional level; and level three: metro networks in the cities. These will be crucial to help strengthen the cooperation between cities of the Greater Bay Area, expand economic activities and develop the Greater Bay Area into an internationally renowned bay area.

Table 3: Overview of the construction of the level one and level two transport infrastructure in the Greater Bay Area

	Construction project	Category	Status
1	Wuhan-Guangzhou High-speed Railway	Inter-city rail transit (high speed rail)	Commissioned in 2009
2	Xiamen-Shenzhen Railway		Commissioned in 2013
3	Nanning-Guangzhou Railway		Commissioned in 2014

4	Guiyang-Guangzhou High-speed Railway		Commissioned in 2014
5	Guangzhou-Shenzhen-Hong Kong Express Rail Link		Entire section commissioned in 2018
6	Ganzhou–Shenzhen High-speed Railway		Commissioned in 2021
7	Guangzhou-Shanwei High-speed Railway		Expected to be completed in 2024
8	Guangzhou-Zhanjiang High-speed Railway		Expected to be completed in 2024
9	Shenzhen-Zhanjiang Railway		Partially commissioned
10	Guangzhou-Zhuhai Intercity Railway	Inter-city rail transit	Commissioned in 2012
11	Guangzhou-Shenzhen Intercity Railway		Commissioned in 2019
12	Foshan-Dongguan Intercity Railway		Commissioned in 2020
13	Guangzhou-Foshan Circular Intercity Railway		Commissioned in 2021
14	Southern extension of Guangzhou-Shenzhen Intercity Railway		Under planning
15	Guangzhou-Foshan-Zhuhai Intercity Railway		Under planning
16	Shenzhen-Huizhou Intercity Railway		Under planning
17	Shenzhen-Zhuhai Intercity Railway		Under planning
18	Pearl River Delta Ring Expressway (Huadu – Zengcheng)	Highway / bridge	Commissioned in 2018
19	Hong Kong-Zhuhai-Macao Bridge, Hong Kong Port and Tuen Mun Chek Lap Kok Link		Hong Kong-Zhuhai-Macao Bridge and Hong Kong Port commissioned in 2018; Tuen Mun Chek Lap Kok Link commissioned in 2020
20	Nansha Bridge		Commissioned in 2019
21	Guangzhou-Foshan-Zhaoqing Expressway		Commissioned in 2019
22	Shenzhen-Zhongshan Link		Expected to be completed in 2024

Source: CBRE (2019) and Academy of Greater Bay Area Studies (2019)

3.2 Cross-border transport construction projects in progress

In the 13th Five-Year Plan of Guangdong Province, it was pointed out that the "12312 Traffic Circle" will be formed in the province, i.e. 1-hour connection between Guangzhou and the cities in Zhujiang Delta, 2-hour connection between the Zhujiang Delta and the cities in the eastern, western and northern Guangdong Province, 3-hour connection with neighbouring capitals, and 12-hour connection between Guangdong Province and the world's major cities. To achieve this, the Foshan Government is expected to invest RMB477.5 billion on infrastructure construction. The report of Zhongshan Government indicated that RMB140 billion will be invested in transport planning in the next six years.

Hong Kong and Macao are the important core cities in the Greater Bay Area. The Greater Bay Area has actively promoted the connection of transport infrastructure between Hong Kong, Macao and Zhujiang Delta in order to increase the speed and freedom in the exchange of personnel, goods, capital and services between Hong Kong, Macao and the Zhujiang Delta region, enhance economic integration and to make full use of the advantages of the three places. This includes several cross-border infrastructure projects (Table 4).

Table 4: Key cross-border projects in the Greater Bay Area

Key cross-border projects	Status
Hong Kong-Zhuhai-Macao Bridge	Commissioned in 2018
Guangzhou-Shenzhen-Hong Kong Express Rail Link	Entire section commissioned in 2018
Liantang / Heung Yuen Wai Boundary Control Point	Commissioned in 2020
Eastern Transit Expressway	Wutonglijiao to Liantang Port section commissioned in 2020
New Guangdong-Macao Channel (Qingmao Port)	Commissioned in 2021
Zhongshan-Zhuhai-Macao Riverside Expressway	Under planning

Source: Academy of Greater Bay Area Studies (2019)

3.3 Hong Kong-Zhuhai-Macao Bridge

The Hong Kong-Zhuhai-Macao Bridge is a massive sea-crossing bridge connecting Hong Kong with Zhuhai and Macao. The project consists of a main bridge situated in the Mainland waters together with the Eastern Artificial Island, the Western Artificial Island, tunnels linking the artificial islands, and the ports and link roads in Hong Kong, Zhuhai and Macao. The total length of the whole infrastructure is 49.94 kilometres. With the use of the Hong Kong-Zhuhai-Macao Bridge, travel time from Hong Kong to Zhuhai is shortened from 4 hours (land transport) / 1 hour (water transport) to 20-30 minutes, forming a "1 hour traffic circle" between Zhuhai, Hong Kong and Macao. This changed the uneven economic development between the eastern and the western parts of Zhujiang Delta caused by the difference in geographical locations in the past 20 years. Cities on the west bank of Zhujiang, such as Zhuhai and Zhongshan, will be able to develop as rapidly as the cities at the east bank of Zhujiang (e.g. Hong Kong and Shenzhen). It is estimated by the Central Government that the Hong Kong-Zhuhai-Macao Bridge will bring direct economic benefits of approximately HK$42.64 billion to Hong Kong, Zhuhai and Macao 20 years after its completion.

Figure 3: Location of main sea-crossing bridges in the Greater Bay Area

Source: Hong Kong Trade Development Council (2019)

Note: Before the completion of the Hong Kong-Zhuhai-Macao Bridge, the land route from Shenzhen to Zhuhai/Macau could only go through the original Humen Bridge and then go south through Zhongshan. After the completion of the Hong Kong-Zhuhai-Macao Bridge, the travel time between Hong Kong and Zhuhai / Macao has been shortened from the original 4 hours (land transport) to 20 to 30 minutes.

3.4 Shenzhen-Zhongshan Link

The Shenzhen-Zhongshan Link is a world-class project under construction since 2017, which consists of bridges, islands, tunnels and an underground interchange. Compared with the Hong Kong-Zhuhai-Macao Bridge, the scale of the Shenzhen-Zhongshan Link is even larger, especially for the 6.7-kilometer under-sea tunnels which is very difficult to build. The project is expected to be completed in December 2024. With the link, the travel time from Shenzhen to Zhongshan, Zhuhai and western Guangdong will be shortened from two hours to approximately 20 minutes, promoting the socio-economic development of the two banks of the Zhujiang.

3.5 Nansha Bridge

The Nansha Bridge (formerly known as Humen Second Bridge) is an important link connecting Guangzhou and Dongguan. The bridge starts from Dongchong in Nansha, Guangzhou and ends at Shatian in Dongguan, with a total length of 12.89 kilometers. The construction project of the bridge commenced in December 2013 and was completed in 2019. With this bridge, the transport connection between the east and west banks of the Zhujiang Delta becomes more convenient while the linkage of the entire area becomes closer.

Table 5: Introduction of the three major bridges in the Greater Bay Area

	Length	Areas connected	Status
Hong Kong-Zhuhai-Macao Bridge	Nearly 50 kilometres	connected to the artificial island of the Hong Kong International Airport in the east, then to Gongbei in Zhuhai, Guangdong and Perola Oriental in Zona Norte, Macao	Commissioned
Nansha Bridge (Humen Second Bridge)	Approximately 12.89 kilometers	Dongchong in Nansha, Guangzhou to Shatian, Dongguan	Commissioned
Shenzhen-Zhongshan Link	Approximately 24 kilometers	Shenzhen to Zhongshan	Expected to be completed in 2024

Source: Legislative Council of the Hong Kong Special Administrative Region of the People's Republic of China (2018)

4 Challenges of transport construction in the Greater Bay Area

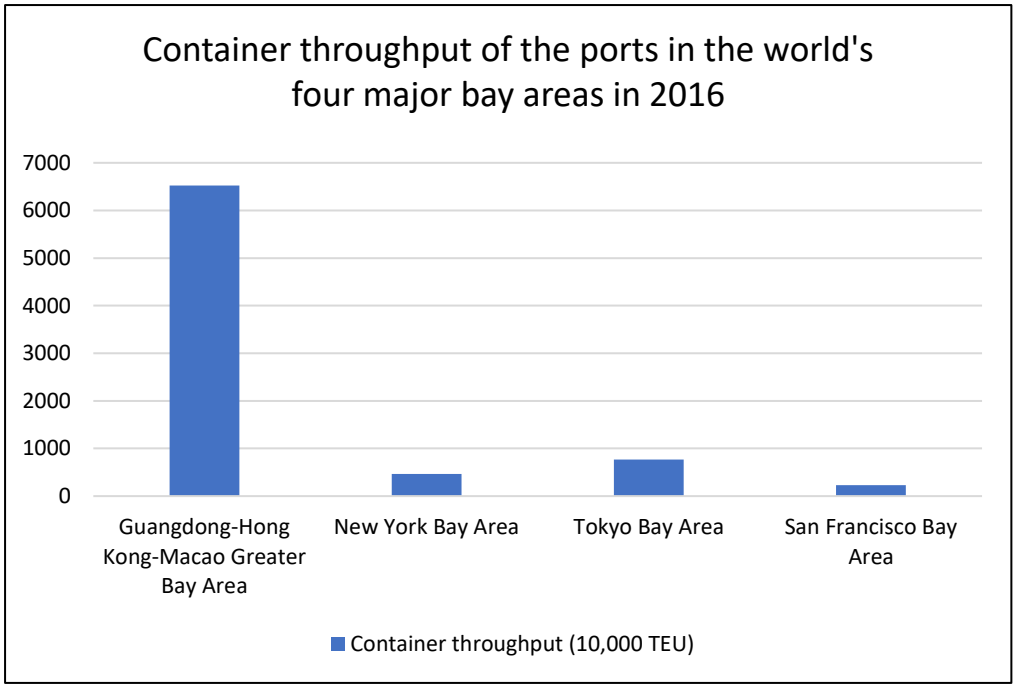
In recent years, local governments in the Greater Bay Area have been actively cooperating in transport constructions, therefore the road and railway networks are gradually improving. However, the Greater Bay Area still encounters challenges in the shipping and aviation industries. To build a world-class port group and airport group, the Greater Bay Area still needs to make greater effort to enhance its competitiveness.

4.1 Shipping industry

Compared with other bay areas in the world, the shipping industry has always been a mainstay of the Greater Bay Area while its scale has been ahead of the world. Among them, the three major hub ports of Hong Kong, Shenzhen and Guangzhou have developed rapidly. In 2016, the three major ports ranked first in the world, with a throughput of 62.47 million TEU (Twenty-feet equivalent units). The throughput of the

ports in the Greater Bay Area totaled 65.2 million TEU, which is 4.5 times the total throughput of the world's other three bay areas, namely the New York Bay Area, Tokyo Bay Area and San Francisco Bay Area. The logistics capacity of its huge port group is unquestionable (Figure 4).

Figure 4: Container throughput of the ports in the world's four major bay areas in 2016



Source: Goldman Sachs (2019)

However, the functions of the three major hub ports in the Greater Bay area have overlapped. For example, there is a clear competitive relationship between Hong Kong and Shenzhen as the port cargo throughput of the two cities both based mainly on foreign trade. To enhance the efficiency of various ports in the Greater Bay Area, vicious competition should be avoided between ports so as to reduce the overlap of resources and the wastage of capacity. Therefore, to ensure the sustainable development of the shipping industry in the Greater Bay Area, the primary task of the ports is to improve the service quality and to make use of their respective advantages and functions. Indeed, a single port would not be able to support the economic development of the Greater Bay Area. The ports in the Greater Bay Area can only achieve a multi-win situation with clear planning and division of labour.

4.2 Aviation industry

Among the bay areas in the world, the Greater Bay Area also maintains its leading position in the aviation market. In 2016, the Greater Bay Area has a passenger throughput of 175 million, surpassing the New York Bay Area, Tokyo Bay Area and the London metropolis. However, the number of trips per capita of air travel was only 3.28, only a quarter of that in the New York Bay Area (13.76 trips) and one-fifth (16.16 trips) of that in the London metropolis (Academy of Greater Bay Area Studies, 2019). Therefore there is still much room for improvement. In the future, if the Greater Bay Area can increase the number of trips per capita of air travel, it will bring huge passenger traffic, and this will further consolidate its position as a global aviation hub.

In addition, the Greater Bay Area is also facing the problems on the lack of connectivity between hub airports and global aviation networks, and limited number of destinations for international direct flights. Indeed, in terms of connectivity, the Hong Kong International Airport has the best connectivity in the Greater Bay Area, while the two major aviation hubs of Shenzhen and Guangzhou need significant improvements. According to the Megahubs International Index 2017 published by the OAG Aviation Worldwide Limited, the Hong Kong International Airport ranked 12th, with a connectivity index of 233, while the Guangzhou Baiyun International Airport ranked 32nd, with a connectivity index of 141. The Shenzhen Bao'an International Airport and the other airports in the Greater Bay Area were not shortlisted. It is not difficult to tell from the statistics that, in addition to Hong Kong and Guangzhou, other airports in the Greater Bay Area still need to enhance their connectivity, coordination and services so as to improve the competitiveness of the aviation industry in the Greater Bay Area.

4.3 Rail industry

Compared with the shipping and aviation industries, the challenges faced by the rail industry in the Greater Bay Area are relatively minor. Currently, the railway network in the Greater Bay Area has formed a comprehensive three-tiered national railway system: (1) national high-speed railway, (2) inter-city rapid transit and (3) metro networks in the city. With the completion of the Hong Kong-Zhuhai-Macao Bridge and the Hong Kong section of the Guangzhou-Shenzhen-Hong Kong Express Rail Link, the

"one-hour living circle" in the Greater Zhujiang Delta can be formed to help the integration of Hong Kong into the Greater Bay Area.

5 Conclusion

The airports and ports in the Greater Bay Area are densely distributed and there are comprehensive road and railway networks in the area. The Greater Bay Area has the basic conditions to become the world's top bay area in terms of transportation. However, improvements are still needed in terms of global logistics aviation, to make it a true world-class bay area. In the future, local governments in the Greater Bay Area still need to conduct in-depth research on the development of efficient and well-planned transport infrastructure so as to achieve sustainable socio-economic development and form a "one-hour living circle" of the Greater Bay Area.

The transport construction of the Greater Bay Area spans Guangdong, Hong Kong and Macao, while it involves several local governments and three different administrative systems. The development of shipping and aviation industries involve many complex technical issues on geographical locations, airspace and traffic. Therefore, it is not easy to properly handle the conflicts and obstacles arising from differences in regional development. It is necessary for the local governments to strengthen their coordination and cooperation to make the implementation of various projects more effective, and also to create synergies and ultimately win-win situations. This helps build the global hub position for the shipping and aviation industries in the Greater Bay Area.

List of Figures

List of Tables

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