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STUDY ON THE URBAN TRANSPORT AND LAND-USE OF GUANGZHOU

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ABSTRACT: Changes in transport are likely to produce changes in land use, and these long-term effects of transport policy may be of considerable potential importance. There is a growing movement, "The New Urbanism", which seeks to reconnect transport with land use and in particular to establish transitoriented development where higher-density, mixed-use areas are built around high-quality transit systems. Based on analysis on development and pattern of urban transport in Guangzhou, this paper researches composition of urban transportation and structure of travel pattern. The urban transport system development and change in urban form as well as change in land use are closely related. The urban transport system required and promoted by the high-density land-use pattern. There are many problems in the urban transportation and land-use, one of the resolving is integration of urban transport planning and land-use planning.

KEY WORDS: urban transport; land-use; Guangzhou City

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The fast pace of economic growth, urban population growth and family-income increase since 1978 has triggered a boom of car ownership and usage. This has been accompanied by increasing traffic demand of Guangzhou and the transport land-use increased accordingly. At the same time, due to accelerated urbanization and sharp increase of residential, business and industrial land use as well as their expansion toward the periphery of the city, the conflict between land use and traffic demand has been more and more evident, which makes this study meaningful.

1 DEVELOPMENT AND PATTERN OF URBAN TRANSPORT IN GUANGZHOU

1.1 Improvement of Transportation Infrastructure

From 1978 to 1997, more than 2 billion yuan (RMB) was invested in the transportation infrastructure development of Guangzhou, which has improved the situation to a great extent. Several bridges crossing the Zhujiang(Pearl) River were built including Guangzhou Bridge, Haiying Bridge, Jiefang Bridge and Jiangwan Bridge. The Zhujiang River Tunnel was built too. Fifty-six Grade Separation Bridges were constructed on Quzhuang and on Guangyuan Road, Guangzhou Road, Zhongshan Road and Jichang Road. Ten Elevated Road such as Dabei, Xiaobei, and Renmin Road as well as the Northen Ring Expressway were built too. Forty arterial roads including Huanshi Road, Dongfeng Road, Guangzhou Road, Changgang Road, Xinggang Road, Jichang Road and Jiefang Road were built or widened. By the end of 1997, the total road length of the urban area reached 1886 km, and the road area amounted to 2229 thousand m^2, being 3.84 and 5.52 times that of 1978 respectively. Four hundred and six-

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ty-four new permanent bridges were added to make to total 604. And 4021 buses and trolley buses were in operation, all the year round, on the total of 466 routes for public transportation, taxis amounted to 15 571. The volume of passengers reached 1 039 billion and 339 billion respectively.

1.2 Change in the Road Network Pattern

At the early stage of opening and reforms, due to the small-scale road facilities, the road network pattern in Guangzhou experienced unplanned development without any distinct features. Along with the accelerated urban construction, the road facilities have been improved step by step. And today the complex network pattern composed of 2 rings, 20 east – west arterial roads, 17 south – north arterial roads as well as 12 radial roads has taken shape. The framework network is composed of roads at three levels: freeway, expressway and regional arterial road. As to the ring road network, the inner ring consists of ring expressway and arterial road of rigid pattern; and it acts as defense to the old urban center, while the outer ring refers to the ring expressway, which is unconcentric with the inner ring. In the northern part of Guangzhou, most of the roads are radioactive and appear to be centripetal. In the eastern part along with the Zhujiang River, most of the arterial roads stretch from east to west.

2 COMPOSITION OF URBAN TRANSPORTATION OF GUANGZHOU

2.1 Composition of Transport Means

After development of 19 years, the transport system composed of roads, railways, water transport and air transport has taken shaped in Guangzhou. It is famous as a coastal port city with developed transport system.

At present, Guangzhou – Kowloon Railway, Guangzhou – Sanshai Railway, Beijing – Guangzhou Railway, Guangzhou – Meizhou – Shantou Railway link Guangzhou with the outside world, and the total length of railway in its urban area is 172.7 km. In 1997, the cargo handling capacity by the city amount to 52.83 million tons and the passengers 47.06 million.

Eight docks and berths of 35 000 t have been built in the port areas of Xingang, Xiji and Xisha. Eleven floating berths of 10 000 t and 3 docks and berths of 7000 t were built and equipped. By the end of 1997, total area for storage reached more than 1×10^6 m^2, and 912 berths were available including 44 berths above 10 000 t. In 1997, the handling capacity of Guangzhou port was 75.18×10^6 t, 4.46 times that of 1978, which makes Guangzhou port ranks the fourth in all the coastal ports in the country. The Guangzhou port has established business linkage with over 140 countries and regions all over the world.

The civil aviation developed rapidly, too. Since 1980, the take-off of Baiyun International Airport has been in the front rank in China. Since 1981, innovation and expansion were undertaken in the airport, and the area of the air harbor has reached 50 000 m^2. In 1997, the amount of planes leaving and arriving at the airport averaged 306 sorties, while the handling capacity of passengers was 12.512 million person-time, which ranks the second in that of China's mainland.

The metro construction began at the end of 1993 in Guangzhou. In June 1997, the special route from Xilang to Huangsha of metro went into operation, and the volume of passengers were 0.5732 million person-time. At the end of 1998, the whole line 18.5 km. long went into operation, 16 stations and 1 vehicle station were built. The east – west line connected Fangcun District, City center and Tianhe District. Now the Line 2 from Huangshi to New Exchange Fair linking the Haizhu District, City Center and the Baiyun District is being constructed. Line 1 and Line 2 will appear as a cross in the future.

2.2 Structure of Travel Pattern

Travel pattern structure is an important indicator for the development level of urban transportation. In 1985, three patterns are predominating, i. e. pedestrianism, bicycle riding and bus taking. In 1998, the major travel patterns have been changed into pedestrian, bicycle riding, bus taking and motorcycling (Table 1). The ownership of motor cycles has been increasing sharply in the 1990s in Guangzhou. Besides, the ratio of metro in all the travel means is trifling now, being only 0.02 per cent. Yet it will have impact on the structure of travel pattern of Guangzhou as a rapid and highly efficient means of transportation.

Table 1 Travel structure of residents in Guangzhou from the 1980s to the 1990s (%)

Year	Walk	Bicycle	Bus	Unit car	Ferry	Motorcycle	Taxi	Metro
1985	39.15	34.02	19.37	4.56	2.26	0.37	0.27	-
1998	30.92	26.47	23.47	7.58	0.45	10.35	0.72	0.02

3 CHANGE IN THE LAND USE OF THE CITY

3.1 Overall Situation of Land-Use

At the beginning of the 1980s, Guangzhou is a city based on the old city center while extending its urban construction land from east to west in the conglomerate pattern. The first conglomerate is the old city center, which is the political, economic, cultural and commercial center of the city; the second one is Tianhe District, which is to be developed into science and educational district; the third one is Huangpu District, where important port and industrial bases are located.

In the 1990s, the urban land expanded toward east and toward south, and the semi-network spatial pattern based on the old city center, composed of several conglomerates took shape. The Zhujiang River and arterial road of the city acted as the axis. The whole city is composed of three conglomerates, the central conglomerate, the east wing conglomerate, and north wing conglomerate. Each conglomerate is composed of several sub-conglomerates with different functions. Due to the high-density pattern of urban development of Guangzhou, the urban land use is becoming increasingly diversified and complicated. Each unit of land has many over-lapped functions with few exceptions of business center, industrial area and expensive residential area. It can also be said that business districts are everywhere in Guangzhou. Less lands are devoted to single usage. The high-density pattern of development has such advantages as land and energy saving by shortening the distance from home to work unit and city sprawl preventing. As to Guangzhou, it consists of 8 districts and covers an area of 14.44 km^2. The population density has reached 2741 person/ km^2, which is 1.3 times that of 1978. Considering the fact that the population is highly concentrated in Dongshan District, Yuexiu District and the central part of Haizhu District, the real population density in these three districts are far beyond the Guangzhou's average. The highest population density is found in Yuexiu District, which is 50417 person/ km^2. In short, high density and concentrative development has been the pattern of land use development in Guangzhou.

3.2 Transport Land-Use of Guangzhou

According to the current transport land-use, Guangzhou can be divided into five parts, i.e. the inner city within inner ring, the region between inner and outer rings, east wing conglomerate, north wing conglomerate and Longdong conglomerate. The inner city covering an area of 28.7 km^2 is the old city center. Inner ring provides passageway for the cross line and oblique line with 4 arterial roads. The outer ring is ring expressway. The region between the inner and outer rings covering an area of 193.4 km^2 constitutes the greater central conglomerate, which is composed of 3 units of land. The east wing conglomerate is divided into 4 parts by the northern second ring and Guangyuan road. They includes the Yunpu Industrial Development Zone on the northeast corner, the Guangzhou Economic and Technological Development Zone and Huangpu New Port on southeast corner, the sub-center of Dashadi on the southwest corner and the physical culture and tourist center of Huangcun, tech-park and large scale industrial factories on the northwest. All these three above regions are high-density development zones. The north wing conglomerate lies at the north part of the city. It is west to the Baiyun Mountain and east to the Zhujiang River, and Liuxi River runs across the middle northwest part of it. By its natural conditions, it can be developed only at modest or even low density. It can be further divided roughly into the Xinshi conglomerate (south to the Huanan north road), Longdong conglomerate (south to the Liuxi River) and Jianggao conglomerate.

4 INTERACTIVE RELATIONSHIP BETWEEN URBAN TRANSPORT AND LAND-USE

4.1 Impact of Urban Transport on the Evolution of Urban Form

The urban transport system development and

change in urban form as well as change in land-use are closely related. The development of urban transport system has decisive influence on the urban form and land use. Each step of it will promote and simulate the expansion of urban form and further land development.

The pace of the urban transport system developments influences the pace of the urban form expansion as well as land development. Urban transport as an important part of the basic urban functions, is one of the principal physical components of a city, which lays the foundation for city form and development. More convenient communications will widen the radius of the city. As a result, the concentration of urban population and industries will follow, and the city is to be expanded in size. Hence, more rapid transport development will bring about more radical change in the urban form and land development. Guangzhou has experienced most rapid development in urban transport during the period from the middle 1980s to the early 1990s. Accordingly, the built-up area expanded from 170 km^2 to 259 km^2, which was most striking in its historical record. Only when the urban transport has played a leading role, can the urban economic development be promoted and further expansion of cities be supported.

As the urban development accelerates, the urban transportation gets more important and it exerts more influence on the urban form and land use. First, higher-speed transport vehicles will shrink the distance measured by travel time, ease the restriction on urban expansion and therefore promote the urban expansion. Since opening up and reforms, the transportation means has developed in Guangzhou along the path from pedestrian and bicycle to bus and motorcycle and to private and metro. Reforms in each stage have given rise to the change in the urban form. Second, high-speed transportation facilities will cause change in the nearby land-use. Since 1980, road network construction at large scale has been carried out in Guangzhou to improve the transport system, which leads to the escalation of land prices. Many industries were disseminated to the urban peripheries where cheaper land is available for production cost reduction. On the contrary, the urban area has been occupied by residential and commercial uses. Third, massive public transit facilitates the high-density development of cities. High-density land development in cities generates highly concentrated traffic demand, which can only be met by massive transport. It is estimated that the metro of Guangzhou will give rise to higher-density land development.

In brief, the development of urban transport, evolution in urban form and change in land use in Guangzhou since opening up and reforms are shown in Table 2.

Table 2 Evolution of transport system, urban form and land-use in Guangzhou

Period	Urban transport system		Urban form	Land-use
	Traffic means	Road building		
Late 1970s – early 1980s	Bicycle, Bus, Walk	The original pattern	The original form	Mixed
Middle 1980s – early 1990s	Motorized vehicles	Rigid road pattern	Urban expansion, City corridor	Basic function areas
Middle 1990 – now	Private car, Metro	Ring network, Metro Line 1	City belt	High density land-use

4.2 The Urban Transport System Required and Promoted by the High-Density Land-Use Pattern

The travel mode, volume of traffic and transport means distribution is basically a function of the spatial distribution of land use. The land development will result in new travels originating from this area or attracting from other areas. The high-density development pattern will increase the volume of traffic on unit area, and must need a coordinated and efficient transport system to facilitate it. It is generally believed that high-density will give rise to problems, such as crowding. However, Hong Kong is an exception. The success of Hong Kong is attributed to first of all two choices of it. First, the rigid road pattern was chosen to be the dominant road pattern in Hong Kong, the rigid road system, which is characteristic of regular blocks and economical land-use, makes building arrangement more efficient. Therefore, it is considered to be a good choice for high-density cities. Although Guangzhou's urban spa-

tial pattern is different from that of Hong Kong. The rigid one will dominate the road network pattern of Guangzhou. Second, Hong Kong has long been stick to the strategy of devoting major efforts to public transit development. The success of Hong Kong in developing public transit system has guaranteed the timely transport of passengers in perfect order. In recent years, for realizing the important role of public transit in the urban transport organization, related strategies have been laid down in Guangzhou. However, there existed many motorcycles and bicycles historically in the urban area of Guangzhou, and inadequate importance has been attached to the development of public transit. Different cities with different features will have different requirements on the urban transport system. But one thing will remain the same, that is, the urban rapid track system is indispensable in both meeting large volume of traffic demand and providing comfort, rapid and secure service.

Besides, multi-level road transport network will increase the capacity of the road network and meet the increasing traffic demand. In Hong Kong, in addition to 8 arterial roads linking major districts, there are 8 mountain-crossing tunnels and submarine tunnels, more than 850 skyways and bridges and 296 pedestrian tunnels, which make the total length of the road 1831 km. On the contrary, the level of development of road facilities of Guangzhou is far too inferior to that of Hong Kong. The reason doesn't lie in the total length of road in Guangzhou. Instead, it is due to Guangzhou's backwardness in developing the multi-level transport system. The total length of road in Guangzhou is 1886 km, 55 km longer than that of Hong Kong.

5 Integration of Urban Transport Planning and Land-use Planning

5.1 Primary Problems Lying in Present Urban Transport and Land-use

Three conflicts have to be dealt with by Guangzhou now. First is the conflict between high-density development and low capacity of road network. The rapid development of private transport is only to make the situation worse. Private transport, when compared with public transport, reflects the inequality of individual's rights. It is flexible, convenient and fast, and private car is considered being the symbol of social status to some extent. Recently, the growth rate of bicycle ownership has been decreasing in Guangzhou, yet that of the motorcycles and private car increased sharply to 600 000 and 222 000 respectively. The low capacity and booming of private transport not only increases the number of vehicles on the road, but also causes traffic congestion and waste in land use. The private transport is apt to lead to urban sprawl too, therefore it is fit for the low-density and scattered-development cities. As to Guangzhou which is characteristic of high-density and concentrated development, the booming of private transport will worsen the already crowded urban transport. Furthermore, a large amount of fund has been invested to build facilities such as elevated bridge, grade separation-bridge, skyways and river-crossing tunnels. Yet a multi-level network has been shaped since all the facilities are not linked to be a whole and the capacity of road networks is low. The land in Guangzhou is scarce, especially in the central areas, and it is impossible to devote large amounts of land to transport development. The road transport network itself can't meet so large traffic demand, which it partly explains the imbalance between supply and demand.

The second is the conflict between badly connected road network, imperfect public transport and the urban pattern characteristic of string shape and conglomerate development. Diversified public transport has not come into being in Guangzhou, and the metro came into operation just recently. The majority of the residents rely on regular public transport means such as bus, trolley bus and minibus, which are slow in speed and low in capacity. Guangzhou is a string-shaped city composed of several conglomerates, which poses great pressure on the transport in the east-west direction. Such pressure gets even greater when the string-shaped pattern is increasingly enhanced. The only solution will be the rapid and massive public transit. In addition, the several conglomerate of Guangzhou is closely linked to each other functionally, yet is badly connected by a few arterial roads. The low level of connectivity is apt to cause tenacity on the main roads and their form deters the conglomerates from development.

The third is the conflict between urban transportation planning and land use planning. Transport is the result of both level of land use and supply of transport infrastructures. The usual way is to carry out transport planning after the urban land use planning is laid down. Such a practice may result in the invalidation of the

transport plan due to rapid changes in land use. Tianhe District can be cited as a good example. After 15 years of development, the transport facilities there has been unable to adapt itself to the continuous urban development, and crowding and congestion have appeared on several nodes. When planning for the new areas of Guangzhou, no deep-going studies have been carried out on urban transport plan and land use, which has now brought about negative results.

5.2 Coordination Between Urban Transport and Land Use

The formation and evaluation of urban transport is the outcome of both traffic demand generated by social economic activities and traffic supply of a city, while land use is the spatial reflection of social economic activities. Therefore, to great extent, the development of land use and supply of infrastructure influence each other. Coordination between urban transport system and land use will be crucial to solving the urban transport problem in Guangzhou.

First, the private transport should be restricted while the public transit is developed according to the pattern of urban extension. Public transit includes regular public transport system, ground quasi-rapid public transport system and rapid track transport system which is high in capacity and speed while low in energy and land resources combustion and pollution. Two aspects have to be emphasized. Firsly, the special lanes for buses should be established and a network of such lines should be formed while priority is given to the development of public transit. The establishment of special lines for buses has become the most important task, which will rationalize the use of existing roads and produce the deceived result in short time with little investment. Secondly, rapid passenger traffic is to be developed to deliver the traffic tenacity on the ground level. Third, financial policy favoring the public transit development should be adopted.

Second, the complex style transport network is to be developed according to the high-density development trend. The successful story of Hong Kong reveals the fact that the coordination among different transport modes for passenger transport and multi-leveled development of transport network will raise speed of vehicles and produce a compact urban form, which will postpone urban sprawl commonly found in many developing cities. The sharp increase in traffic volume is both the prerequisite and result of urban development. No matter how rapid the road building can be, it is not able to catch up with the growth in traffic volume, since newly built road can both dredge transport and attract transport. Only when the component of the transport system has been stably combined into a whole, can it is brought into full play. Therefore, a complex style characteristic of multi-leveled development should be the choice of Guangzhou. Such a network should be systematically linked to tap the potentials of existed road capacity.

Third, the urban transport planning should be coordinated with the land use planning. To any land use plan or transport system plan, one of the basic aims is to guarantee the effective balance between land use activities and transport capacity. Western researchers have classified the transport planning into three aspects, the urban land use planning, transport planning and transport policy. Obviously, the formulation of transport plan can't separate itself from the land use plan while at the same time, the components in the land use plan won't be comprehensively coordinated without rational disposition of road network and transport system which are determined by the transport plan. Therefore, the urban land-use plan and transport plan should be carried out simultaneously in the future, in order to achieve better feedback and coordination between them.

6 CONCLUSION

Since the opening up and reform, the urban transport system and land use have been transformed greatly in Guangzhou. Judging from the evolution process of urban transport system and land use in Guangzhou, the interactive and interdependent relationships exist between them. Usually, land use is the decisive factor in generating travels, while each important structural change of the city is greatly influenced by the transport infrastructure. With the pace of economic development, urban transport has become more important. Yet the traffic problems such as crowding and traffic congestion accompanying the urban transport development is exerting more and more negative influence on the operation and further development of the city. To solve the urban transport problem, balance between supply and need is to be regained. Due to the

interdependency between transport system and land use, the coordination between them will lead to positive results.

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