Study on the operation mode of suburban railway at home and abroad and the inspiration to Beijing

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Abstract: As China's urbanization gradually enters the era of ‘urban circle’ and ‘urban agglomeration’, the suburban railway which is regarded as the way of connecting urban centers and suburban areas, such as Satellite city, as well as reshaping the layout of urban space, has been highly praised by the central government. In May 2017, the five ministries and commissions jointly issued the guidance on ‘promoting the development of the urban suburban railway’. In the guidance, it is clear that the effective supply of the transit service of the suburban railway should be expanded. But in China, the city railway system and city traffic system belong to different traffic management department, and another problem which leads to such situation is that the division of labour and the function of railway system and urban traffic system are different for a long time. So how to operate the suburban railway in Beijing is an significant problem that needed to be solved.

1. Introduction

The conception of ‘suburban railway’ was first put forward by the School of Traffic and Transportation of Tongji University in the ‘863 Project of the National 11th Five-Year Plan’. And Wikipedia defines the suburban railway as a kind of urban rail transit system, which is located between the city centre and the suburbs or satellite cities with the advantages of large capacity and high speed. Meanwhile, the commute distance is usually more than 15 kilometers. In this paper we hold the idea that suburban railway is a railway passenger transport system which serves in the economically developed urban areas, maintaining the economic and social links between the central urban areas and the satellite cities, mainly undertaking the commuters of the surrounding cities. Besides, its transportation distance is usually within 100 kilometers[6].

Throughout the world experience, the development of metropolis in developed countries is inseparable from the support of suburban railways. The current mode of transportation in Beijing is dominated by subway and highway. So it’s difficult to complete the task of long distance commute between the city center and the outskirts of town, and cannot solve the ‘Big city disease’ effectively such as traffic congestion, environmental degradation, energy shortages and so on. In May 2017, the five ministries and commissions jointly issued the Guiding Opinions about Promoting the Development of Suburban Railways, which emphasized that efforts should be made to expand the effective supply of public transport operation services of suburban railways, and encouraging the development of multi-level, multi-mode and multi-system rail transit systems. As China's urbanization gradually enters the era of ‘urban circle’ and ‘urban agglomeration’, how to promote the development of suburban railway and improve the integrated transportation system has become the primary task of Beijing and other major cities in China.

At present, the suburban railway system in China is still at an early stage with problems, such as insufficient infrastructure and lagging development concepts compared with developed countries. In
addition, the current operation model of suburban railway in China is also difficult to meet the needs of commute transportation in big cities. The main service target of the suburban railway is the commuter flow between the central city and the suburb. The tidal characteristic of suburban railway determines that it needs to have the advantages in terms of capacity and speed. However, the existing operation mode in China has caused the departure time and departure frequency of suburban trains hard to meet the needs of commuting, and the separation of railway hubs and urban functions leads to a poor connection between the different transportation mode, such as subways and buses, which weakens the attraction of passenger flow to a certain extent, and finally the development of suburban railway is difficult to keep up with the pace of urbanization in China.

2. Introduction to the operation of suburban railways in major cities at home and abroad

The reason why the foreign suburban railway system is relatively mature is that on the one hand, the railway construction activities in foreign developed countries is earlier than the planning and development of highways and modern cities, leading to a good suburban railway network structure, as well as the quantity and the quality advantages. On the other hand, the time for the railway to participate in urban public transportation is basically earlier than that of the subway and highway commute transportation and has accumulated lots of management experience. Therefore, most suburban railways in large cities of developed countries have been relatively well-developed from the beginning of planning and design to the construction and operation. It’s worthy of our in-depth study and research.

2.1. Tokyo, Japan

In the Tokyo metropolitan area which is 100 kilometres from Tokyo Station, the rail transit system is mainly composed of suburban railways operated by private companies represented by metro companies and JR (National Railways). Its railway network includes 2 loops and 25 rays. According to statistics, JR East has 37 suburban railway lines in the Tokyo metropolitan area, accounting for 56.7% of the network scale; private railroads who use suburban railway to participate in transportation have railway lines of 4475.9 kilometres, accounting for 80.8% of the total network scale; some subways lines and suburban railways are designed to be connected so that they can participate in the suburban commute transportation together in the Tokyo metropolitan area.

On the operation level of suburban railway, Tokyo adopted the mass transit type periodic system. For example, the suburban railway of JR East in the Tokyo metropolitan area can achieve a minimum departure interval of 2 to 3 minutes. In order to improve operational efficiency while attracting passengers and maximizing the convenience of transfer, the suburban railway in Tokyo adopts the method of splitting the line, that is, the passenger train and the freight train are driven separately and they’re operated independently. The single line runs the same type of trains. In this way, it’s possible to reduce the situation of staggered parking of trains and achieve parallel operation map tracking, finally improving the transportation capacity and efficiency of the suburban lines.

The suburban railway of the Tokyo Metropolitan Area is operated jointly by multiple companies including the JR East, the private railway companies, the public-private joint venture companies and two metro companies, these companies mainly adopt the operation mode of ‘Network-Transportation Integration’, supplemented by the way of opening access rights to third parties. The conception of ‘Open Access Rights’ actually means that the users who own the railway network under the ‘Network-Transportation Integration’ mode, or the main users of the railway network under the same mode authorize the secondary users to have the corresponding rights of rail transportation. Because of the opening access rights, the operators of suburban railway have opened up the ‘interconnected service’, which greatly improved the accessibility of subways and private railways, providing conditions for suburban railway to enter the city center.

2.2. Paris, France

The Paris metropolitan area is located in the north of France, with a total area of 12012 square
kilometers. It is mainly composed of Paris and the surrounding seven provinces, covering a radius of about 45 kilometers, and its total population reaches 12.2 million. In 1937, Paris opened its first suburban railway and started large-scale construction in the 1840s. By the early 20th century, the early forms of the suburban railway network of Paris had been formed. During this period, the government invested a large amount of special funds for the development and expansion of suburban railways. In 1978, the government’s subsidy reached 2.63 billion francs which was the highest in history, and then stabilized at around 1.5 billion francs. At present, the eight suburban railways in the Paris metropolitan area are distributed in different directions in the city, taking the train station as the end. The total length is about 1296 kilometers. It aims to use the existing railway resources to realize the commute transportation in Paris and closely maintain the economic and social connections between the city center and the surrounding area. The proportion of rail transit in the metropolitan area is as high as 89.8%.

In France, the management mechanism of urban public transportation is localized based on municipalities, and supplemented by provinces and regions, so the national government just needs to give proper management over the aspects of top-level design and policy. The Paris metropolitan area is unique and its public transportation network is managed by the Syndicate des transports d'Île-de-France (STIF). Established in 1959, the agency is responsible for the planning, operation, investment and financing activities of public transportation in the Paris metropolitan area. It also coordinates many transportation companies, such as France Railway and Paris Bus Company, so as to achieve smooth cooperation based on the integration of interests.

2.3. London, England
The suburban railway system of London is one of the most advanced in the world. The total length of suburban railway network is 3071 kilometers with characteristics of high density and uniform distribution. The existing 16 suburban railways in London connect the central city, the suburbs and the remote suburbs in series. The farther away from the central city, the larger the station is, and the distribution of stations is correspondingly sparser. The suburban railway network in central London is about 788 kilometers. And there are 321 stations with an average distance of 2.5 kilometers. In the suburbs with a radius of 50 kilometers, the network is about 923 kilometers, the number of stations is 254, and the distance between stations is usually 3.5 kilometers. In the remote suburbs with a radius of 100 kilometers, the network is about 1360 kilometers, but the number of stations is only 173, and the average station spacing is 7.5 kilometers.

Historically, the suburban railway of the London metropolitan area was owned by the British National Railways who was responsible for the operation of it. After the privatization reform of the railway in 1994, the suburban railway was owned by the state through franchising under the ‘Separation of Network And Transportation’ mode. That is, the suburban railway network is transferred to the National Road Network Company for unified management, and the operation rights of passenger and freight transportation are transferred to 25 passenger transport companies and 2 freight companies. After obtaining the franchise rights, the passenger and freight transportation companies start their transportation service by borrowing lines from the Road Network Company and borrowing vehicle from the locomotive companies.

2.4. Shanghai Jinshan
As a suburban railway, the Shanghai Jinshan Railway is converted from the Jinshan Railway branch. It is a national Grade I two-lane railway with a top speed of 160 km/h. The starting point of the line is Shanghai South Railway Station and the ending point is Jinshanwei Station, with a total length of 56.4 kilometers. There are 9 stations along the line with an average station spacing of 7.05 kilometers.

The Jinshan Railway is the first suburban railway in China that adopted the mass transit type periodic system. It is operated by the Shanghai government who mainly purchase transportation services and entrusts it to the National Railway. The ownership and operation right of the Jinshan Railway Xinqiao—Jinshanwei section belongs to Shanghai Jinshan Railway Co., Ltd., which is mainly
responsible for financial liquidation and asset management; the Shanghai South-Xinqiao section is invested by the National Railway Transportation who has the assets of this part. The Shanghai Railway Administration and the related railway units are entrusted to be responsible for the transportation organization, passenger transportation services and equipment maintenance of the Jinshan Railway. In order to realize the mass transit type periodic system, the manager of Jinshan Railway has specially modified its fare system to meet the needs of Shanghai public transportation card, and improved the construction of the station square, the inbound road and the public transportation facilities of some stations, which provided good external conditions for the operation of the Jinshan Railway.

3. Possibility Analysis of Beijing Suburban Railway Operation Mode

At present, the existing resources of the National Railway in Beijing are abundant, and the formation of the passenger dedicated line network has effectively released the capacity of the existing resources, so the Beijing suburban railway has a hardware foundation and development space. The ‘Guiding Opinions on Promoting the Development of Suburban Railways’ pointed out that priority should be given to the use of existing resources to operate suburban trains, and based on it the new railway lines should be promoted in an orderly manner. According to the demand characteristics and service targets of the suburban railway in Beijing, selecting appropriate operation mode based on local conditions is the key to make suburban railway participate in the urban transportation as soon as possible.

3.1. Self-management and self-operation mode of local government

The self-management and self-operation mode of the local government means that the local government directly manages and operates the suburban railway through establishing an independent operation company, which can be adopted when the local government needs to build a new suburban railway. Under this mode, the local government generally has ownership and control over the line, so it’s easy for the government to make independent decisions.

Local governments have many advantages under such operation mode: suburban railway operation companies, which are controlled by local government, can better follow the master plan for urban spatial layout in the specific construction and operation activities, and improve the efficiency of land use at the same time. Also, it can promote the connection between suburban railways and other urban transportation systems, and improve the integrated transportation system. In addition, adopting self-management and self-operation mode allows the government to have more independent decision-making power, which can greatly reduce the cost of negotiation with the National Railway, and can effectively avoid the financial or operational information asymmetry if the suburban railway is operated by National Railway. Compared with other operation modes such as operated by the National Railway or government procurement, mode of self-management and self-operation can better ensure the quality and efficiency of transportation services, and there are sufficient incentives to improve the level of management.

At present, the suburban railway that has been opened or still under planning in Beijing is mainly built through renovating or expanding the existing railways of the national railway or directly use the existing railways to run suburban trains. But self-management and self-operation mode of local government is relatively simple, it’s suitable for new suburban railway projects, so according to the recent city plans, this mode may not be considered right now. However, for Beijing, when the resources of the existing lines are fully allocated, in view of the long-term plans for suburban railway and the demand for transportation capacity, the government's building new suburban railway would be the preferred choice in the future, then the self-management and self-operation mode will work.

3.2. Local government franchise

For the suburban railway projects, the franchise usually refers to granting the operation rights of passenger transportation or freight transportation to the most efficient bidder by means of bidding under the mode of ‘Separation of Network And Transportation’.

The essence of franchise is to realize the ultimate ownership of the railway infrastructure owned by
the national government. On the one hand, the government can design the franchise terms, such as the fare, minimum service standards, franchise cycle, etc. to better meet the requirements of suburban railway for socio-economic development, attracting investment and improving efficiency at the same time. On the other hand, maximizing competition in bidding process of franchise can encourage the companies to reduce costs and improve their service, ultimately improving the overall economic efficiency of passenger transportation of suburban railway. Finally, such operation mode can also reduce the government's financial constraints on the locomotive investments to a certain extent. From the perspective of regulatory economics, the purpose of government franchise is to maximize the efficiency of public interests and benefits by maintaining a balance between monopoly and competition in the process of issuing franchise rights.

However, government needs to be familiar with the investment and economic characteristics of the operation projects if the franchise mode is adopted, and at the same time the professional laws and regulations are needed to support the external environment. Therefore, this mode has not been applied in China’s railway transportation.

3.3. Entrust operation to the National Railway

Under the mode of entrusting operation to the National Railway, usually the principal is a joint venture railway company established according to law and obtaining the corresponding railway transportation operation license. Generally speaking, the entrusted party usually has a transportation management enterprise that is compatible with the entrusted business and has the ability to independently undertake the entrusted transportation business. The principal entrusts services such as transportation organization management, fixed equipment management, mobile equipment management, and transportation safety management to the entrusted party through contract, and the entrusted party will hand over the earnings from transportation business to the principal, also the transportation costs and profits should be liquidated to the principal.

The main characteristic of this mode is that the operation and management of transportation business are separated. The principal is the operation entity who controls the entrusted party through the contract. And entrusted party is the management entity of transportation business.

Currently, most joint venture railway company and the suburban railway that have been in operation in China, such as Shanghai Jinshan Railway, line-S2 in Beijing, and line-Subcenter, all adopt this operation mode.

The main advantage of entrusted transportation is that this mode can improve the operational capability of joint venture railway company and the professional quality of staffs to a certain extent, and can strengthen the command of transportation dispatch and ensure the safety of railway transportation. In addition, this mode is also beneficial to the rational allocation of railway transportation network resources, and can enhance the professional management while giving full play to the advantages of scale operation in railway transportation.

However, due to the monopoly position of National Railway, the entrusted transportation mode also has following problems: Firstly, the market-oriented competition pattern has not yet been fully formed, which put entrusted party in a weak position compared with railway bureaus who have rich management, operation and technical experience, because there is usually only one entrusted party in the entrusted business. Secondly, the principal (joint venture railway company) cannot carry on integrated control over the operation and the management of transportation business, which is not conducive to income increase and savings. The principal generally has problems such as simplified organization and insufficient professional staff, making it lack bargaining power when negotiating problems of liquidation standards.

Purchase of transportation services means that the local government or the joint venture railway company purchases suburban railway transportation services from the National Railway in terms of a purchase service agreement, in accordance with the quantity and quality stipulated in the agreement. In addition to having the advantages of entrusted transportation, this mode can better guarantee the interests of the entrusted party when the entrusted transportation project is in deficit, and the
**principal** can promote the **entrusted party** to improve its efficiency by designing a valid performance appraisal mechanism. Its disadvantages are similar as the mode of entrusted transportation. When it comes to determining the price of purchasing transportation services, information asymmetry exists between the government and the National Railway to some extent, and the price of transportation services controlled by the National Railway is monopolistic.

Such operation mode is mainly used in China’s suburban railway, such as Shanghai Jinshan Railway, Beijing line-S2 and line-Subcenter, and is mainly applicable to the direct use of the existing railway resources of the National Railway to run suburban trains, and is also suited to the reconstruction and expansion of existing railway resources.

4. **Suggestions and Countermeasures**

The development of suburban railways is of great significance for the improvement of urban rail transit systems. Only by extending and expanding its railway lines, can it shoulder the task of long-distance commute and increase the proportion of using urban public transport. With the accelerating process of regional integration in China, the development of Beijing’s suburban railways will usher in a new era. Also, the government should prepare and arrange its work for the operation mode of suburban railways, and support it from relevant policies and safeguard measures.

4.1. **Integrate the suburban railway planning with the coordinated development strategy of Beijing, Tianjin and Hebei.**

From the perspective of coordinating the development of capital metropolita area and Beijing-Tianjin-Hebei area, Beijing municipal government should learn from the experience of planning and organization of the international metropolitan, break the concept of administrative divisions, and comprehensively consider the relationship between Beijing satellite city, commute circle radius and suburban railway network, as well as the interaction between suburban railway and urban development. The rights and responsibilities of central government, Beijing and Tianjing municipal government, Hebei provincial government and China Railway should be clearly defined in the construction and operation activities of suburban railway in the capital metropolita area, laying a solid foundation for exploring a construction-management system of suburban railway that is line with China's situation.

4.2. **Innovate the operation and management mode of suburban railway and improve the level of operation service.**

Under the current railway organization system, it is difficult to change the shortage of the National Railway in the entrusted transportation. It is suggested that in the future, the suburban railway projects operated and managed by the local government should draw on the method of ‘open access right’ under the ‘Network-Transportation Integration’ mode of Japan, as well as the experience from the ‘Separation of Network And Transportation’ mode of UK. And the government should correspondly innovate the operation and management system. In terms of operation services, the government should focus on improving the level of intelligence and information of suburban railway services, providing safe and convenient services guarantee a certain frequency of departure.

4.3. **Improve the compensation mechanism of operation mode and adjust the fare system**

As an important part of urban public transportation, suburban railway should be based on the comprehensive consideration of government financial subsidies, operation costs of enterprise, social affordability, market supply and demand as well as a multi-level, differentiated fare system in order to better carry out the functions of serving the society. In addition, in the early stage of suburban railway operation, the government can increase subsidies to ensure the smooth operation of suburban trains. And later, the government can achieve operational sustainability of suburban railway through government purchases.
4.4. Improve relevant laws and regulations and improve the supervision mechanism

In order to build a sustainable structure of city, explore an operation mode suitable for Beijing suburban railway, improve the operation efficiency and reduce operation costs, relevant laws and regulations should be established and improved to ensure that its development is law-abiding and rules-based. At the same time, the construction, operation and other links of Beijing's suburban railway should be regulated by law. At present, China's main railway regulatory departments are the Ministry of Transportation, the State Railway Administration, and some comprehensive social supervision departments including the National Development and Reform Commission, the State-owned Assets Supervision and Administration Commission, and the Ministry of Finance. In the future supervision work, attention should be paid to clearing the powers and responsibilities, and establishing an appropriate power distribution mechanism while formulating unified operation standards of suburban railway to ensure operational supervision efficiency and improve supervision quality.

5. Conclusion

With the increasingly serious problem of “big city disease” and the continuous improvement of urbanization level in China, it is particularly important to reshape the urban layout and optimize its spatial structure. The experience of suburban railway in developed countries shows that the development of suburban railways is a necessary means to realize the sustainable development of China's big cities, especially the metropolitan areas and urban agglomerations. Under the current background of Beijing-Tianjin-Hebei integration, it's of great importance to explore the operation mode suitable for the suburban railway in Beijing to make it participate in the urban rail transit system faster and better, strengthening the economic connections between Beijing and surrounding areas.

According to the distribution of railway resources and construction mode of Beijing suburban railway, this paper shows some operation modes. I believe that in the actual operation activities of suburban railway, how to flexibly combine multiple operation methods according to the local conditions will become a problem worthy of long-term thinking.

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