Visualization Method of TOD Development Process Based on Big Data

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Abstract: With the rapid development of urbanization and motorization in China, the urban problems such as low-quality land spread and low efficiency of transportation are becoming increasingly prominent. It has become an effective method to solve the traffic and environment problems by using TOD theory, while mass rail transit has become the best carrier of TOD model. TOD is a powerful means to optimize land use, traffic development and urban planning, which provides a possibility for the organic combination of land use and traffic development. This paper mainly studies the visualization method of TOD development process based on big data. In TOD model of urban development guided by public transport, this paper studies and analyzes the planning points of TOD mode, and also studies the advantages, disadvantages, opportunities and threats of urban rail transit(URT) to prove the reliability of TOD development process. This paper studies the scale algorithm of rail transit network, and also analyzes the environmental pollution caused by various traffic modes and the land use ratio of TOD types by chart analysis. The experimental results show that the most important vehicle in cities is automobiles, while the energy consumption of Metro light rail is only 0.84, carbon dioxide emissions are 1.21 and noise pollution is 0.42. The pollution caused by it is the smallest, which is worth expanding. In terms of the proportion of type land, residential land is the core of neighborhood, accounting for 62.5%, while urban TOD is mainly used for core land, accounting for 55%. In the type land, different types of land use main functions are different.

1 Introduction

Tod traffic oriented urban development is not a new topic. Traffic orientation has been accompanied by the mileage of urbanization and the synchronous evolution of social and technological progress [1-2]. Urban rail transport capacity has an overwhelming advantage over other transport modes, and the concept of TOD has been pushed to the front [3-4]. TOD mode is mainly manifested in the guidance of the overall urban space expansion and the stimulation of land use around the site. In the process of TOD, the practice and research of planning decision guidance and technical measures in various levels [5-6]. History and practice have proved that the development of transportation industry in a country or region largely determines the development of its economy, politics, culture, social life and other aspects [7-8]. China's basic national conditions and the advantages of rail transit determine the irreplaceable role of rail transit in urban transportation [9-10].

In the research of TOD URT development process, many scholars at home and abroad have made some achievements. Xia h and others pointed out that rail transit has the basic characteristics of short time fixed point, timing, huge transport capacity and passenger flow, strict boundary and closure of the system, established interface, lack of variability of time and space, high cost and operation and maintenance costs [11]. Loo B and others pointed out that the realization of the overall urban development strategy depends on the guiding role of TOD mode of URT. Therefore, the overall development strategy of the city and TOD mode are mutually dependent [12].

This paper mainly studies the development process of TOD based on big data, and uses visualization method to study it. In the TOD mode of urban development oriented by public transport, this paper studies and analyzes the planning points of TOD mode, so as to effectively drive the maximization of land value utilization. This paper also analyzes the SWOT under TOD mode, and studies the advantages, disadvantages, opportunities and threats of URT to prove the reliability of TOD process. This paper studies the algorithm of the scale of rail transit network, measures the service level of URT by the total length, density and daily passenger turnover of the network, and studies and analyzes the environmental pollution caused by various modes of transportation through chart analysis method, which proves that urban public transportation is the most resource-saving, energy-saving, safe, environmental friendly and efficient mode of urban passenger transportation, It's really green transportation.

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2   TOD Urban Rail Transit

2.1 Key Points of TOD Mode Planning

Tod area adopts three-dimensional land ownership development mode. Based on the review and superposition of modules with different land use properties and functional properties, centralized land development is carried out in a certain range around the site. While driving the maximization of land value, it can effectively integrate the closed loop of residence travel work consumption. If the development intensity is not enough and the population density around the station is low, it will be unable to meet the passenger demand of rail transit and reduce the service level of public transport, which will lead to some travelers choosing cars. Therefore, it is necessary to improve the ride rate of rail transit system to ensure the operation income of rail transit, maximize the surrounding land price and promote the improvement of property value; Pay attention to the compactness of land development around the site, so as to improve the efficiency of land use and the convenience of life. When planning URT, we should improve the degree of mixed use of land, increase the convenience of various activities and reduce motor vehicle travel; Improve the quality of life around the station, avoid the excessive burden of land development on the environment, and ensure the traffic service level around the station.

2.2 SWOT Analysis of TOD Development

(1) S analysis

The nationalization of land is conducive to the development and construction of land in the process of TOD implementation, and the relevant government agencies play a leading role in the allocation and control of land. At present, China's relevant policies clearly point out that "giving priority to the development of public transport is an important means to improve the utilization of traffic resources and alleviate urban congestion", which is undoubtedly an opportunity for many cities to develop TOD mode. Most cities in China develop intensively in a single center mode, with mixed distribution of various types of land, dense population in the central area, and huge potential for public transport development. At present, the car ownership rate in China's cities is not very high. We should give priority to the establishment of urban transportation system with mass transit as the backbone before the car is developed. The concept of TOD was introduced relatively late in China. Before that, many foreign scholars have done mature research on the theory and practice of TOD, and there are many successful cases to learn from. Therefore, when conducting TOD research in China, we can learn from the existing mature theory and experience, combine with the actual situation of our country and relevant laws and regulations to use, establish a public transport oriented urban development model, effectively avoid urban sprawl, make public transport and land use closely combined, and realize the sustainable development of the city.

(2) W analysis

The development pattern of cities in China is mostly single center mode. Although this mode provides high density population for TOD, it also causes the overload of facilities and population in the central city. The whole city relies too much on the central area, so it is difficult to realize the development of "bead string" through TOD mode, and it is easier to form a pie shaped urban development mode. In the urban master plan, land use and traffic planning are often mechanical superposition of land use and traffic planning. There is no thorough and comprehensive research, which makes the land use layout and traffic development incongruous. The implementation of TOD mode needs reasonable planning, which combines urban land use with traffic development effectively. Therefore, Tod concept is difficult to effectively implement in the construction process of URT and guide the correct development of the city. The core of TOD mode is to make the city develop along the public transport line. URT has the characteristics of large traffic volume, fast and safety, and becomes the first carrier for the development of TOD mode. However, the long construction cycle, large investment and uncertain profit expectation of rail transit are not to be ignored. TOD mode requires that all systems of the city can cooperate effectively, and make it form a whole and develop together through the connection of URT. In the field of urban traffic planning, management and construction, the government agencies lack reasonable operation mechanism and coordination, which leads to the management agencies' insufficient attention to the overall interests of their departments in the process of their functions. The urban public transport system in China is not perfect and lacks system integration. To effectively play the guidance role of TOD mode, it is necessary to form effective connection between various modes of transportation and road network, and provide more safe and convenient public transport services.

(3) O analysis

As far as the current situation of urban development in China is concerned, the greatest opportunity for the development of TOD mode of rail transit is the opportunity of urban transformation. Most cities are facing the problems of old city reconstruction and outward expansion. The traffic infrastructure of the old city with single center is weak, and the continuous influx of population leads to the rapid expansion of the city scale, which hinders the future development. Tod concept can guide the reconstruction of the old city, adjust the land around the station appropriately, make it more intensive and economical, and emphasize the use of public transport while improving the accessibility of the old city; In the new town construction, Tod concept plays a role in coordinating traffic and land use, so as to guide the city to form a better urban form and functional layout.

The central and local governments have issued policies to give priority to the development of public transport. For many cities in China, it undoubtedly provides a good opportunity for the development of TOD mode, and the development of TOD mode of rail transit is particularly urgent.

(4) T analysis

China is in the period of rapid urbanization. The scale of the city is expanding, and the excessive number of cars causes serious road traffic congestion. Compared with public transport, the utilization rate of energy and road is very low. It is necessary to restrict the travel of cars and encourage residents to use public transport to alleviate urban problems. As the pillar industry in China, the policy of encouraging the automobile industry is not conducive to the development of TOD model of URT, which has become a huge challenge for TOD model.

2.3 Network Scale Algorithm of Rail Transit

The scale of rail transit network refers to the overall composition of the rail transit system, which reflects the service level that rail transit can provide from the side. It is measured by the total length, density and daily passenger turnover of the network. The total length formula of wire network is as follows:

$$L = \sum_{i=1}^{n} l_i \qquad (1)$$

The total length of line network l reflects the overall scale of line network, which can determine the corresponding management system and operation mechanism. Line network density is a major factor to measure the service level of URT, the line network density formula is as follows:

$$\sigma = L/S \text{ or } \sigma = L/Q \qquad (2)$$

Where, s is the area of URT network planning area, q is the total population of URT network planning area, and URT network density. The daily passenger traffic turnover of line network is an index to evaluate the capacity output of URT system, the formula of daily passenger traffic turnover of line network is as follows:

$$P = \sum_{i=1}^{n} p_i l_i \qquad (3)$$

Where, p_i is the daily passenger volume of the i-th rail line, and ,l_i is the average distance of the i-th rail line in the URT network.

3 Experimental Study

3.1 Subjects

This paper mainly studies the development process of TOD based on big data, and uses visualization method to study it. This paper proves the necessity of TOD development by studying the TOD mode of urban development oriented by public transport.

3.2 Experimental Process Steps

This paper mainly studies the development process of TOD based on big data, and uses visualization method to study it. This paper studies and analyzes the key points of TOD mode planning, analyzes the SWOT under TOD mode, and studies the advantages, disadvantages, opportunities and threats of URT. This paper studies the algorithm of the scale of rail transit network, and analyzes the environmental pollution caused by various modes of transportation through the chart analysis method.

4 TOD URT Experiment

4.1 Various Modes of Transportation and Environmental Pollution

At present, the promotion of urbanization has caused many problems. Resource consumption and environmental pollution are one of the problems. It is urgent to accelerate the development and construction of TOD urban rail. In order to prove the advantages of TOD URT development, this paper compares and analyzes energy consumption, carbon dioxide emissions and noise pollution caused by various traffic modes. The results are shown in Table 1.

Table 1. Various modes of transportation and environmental pollution

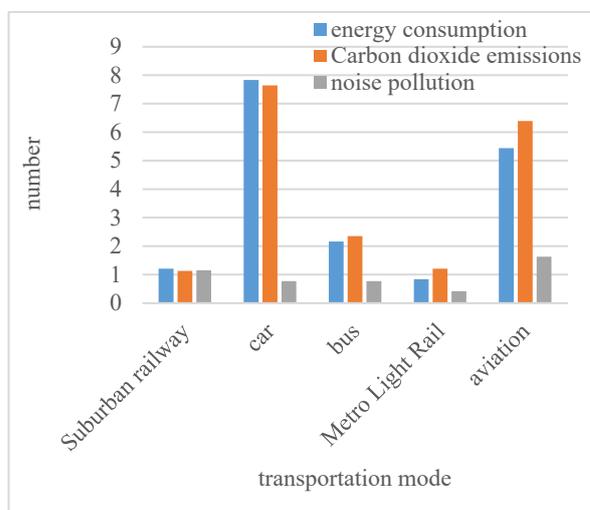|	Suburban railway	Car	Bus	Metro Light Rail	aviation
energy consumption	1.21	7.83	2.16	0.84	5.44
Carbon dioxide emissions	1.13	7.64	2.35	1.21	6.39
noise pollution	1.15	0.77	0.77	0.42	1.63

Figure 1. Various modes of transportation and environmental pollution

As can be seen from Figure 1, by comparison, urban public transport is the most resource-saving, energy-saving, safe, environmental friendly and efficient mode of urban passenger transport, and the pollution caused by automobiles is the largest. However, at present, automobiles are the most popular means of transport in cities, while energy consumption of subway light rail is only 0.84, carbon dioxide emission is 1.21, and noise pollution is 0.42, which causes the least pollution, It is worth promoting.

4.2 Proportion Analysis of Various Types of Land Use in TOD

Mixed use of land is still common in China's cities, but this kind of mixed development usually exists in the form of low-density spread, which neither forms an attractive community center nor promotes public transportation. This paper uses big data to analyze the land use types of neighborhood TOD and urban TOD to study China's TOD model, and the results are shown in Table 2.

Table 2. Proportion of land use types in TOD

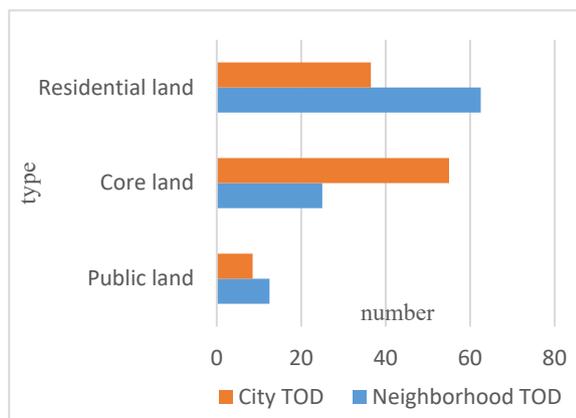|	Neighborhood TOD	City TOD
Public land	12.5	8.5
Core land	25	55
Residential land	62.5	36.5

Figure 2. Proportion of land use types in TOD

As can be seen from Figure 2, residential land is the core of neighborhood, accounting for 62.5%, while urban TOD is the core land, accounting for 55%. Different types of land use have different functions.

5   Conclusions

TOD mode emphasizes the efficiency of land use and the construction of supporting facilities. It suggests that the utilization rate and plot ratio of unit land area should be appropriately improved, the construction of large-scale urban complex around the station and people-oriented walking space should be emphasized, and the community residents should be guided to change their travel mode through perfect supporting services, so as to improve the

economic operation efficiency and save non renewable resources, Reduce air pollution, protect urban environment, and promote the coordinated and sustainable development of cities and towns. In the process of TOD research and development in the future, we can build a precise vertical transportation system from connectivity to linkage, realize compact and intensive efficient utilization, compound and diversified format planning, and realize long life cycle sustainable value creation and symbiotic development of multi-body industries.

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