

Comprehensive Transportation Planning Oriented by Green TOD Mode under the Background of Dual Carbon

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Abstract

Since the reform and opening up, China's cities have entered a period of rapid development, and the planning and design methods that meet the needs are far behind the economic development speed. The influx of people and the development of the automobile industry have made the space of the city crowded, and the problems of urban traffic congestion have become increasingly prominent. In the era of accelerating urbanization, urban transportation design planning is more and more important, urban transportation design is a large system, this paper focuses on the green TOD model as the guide for introduction, through the analysis of the current urban transportation development challenges to put forward green transportation priority strategy, on this basis to introduce the relevant concepts of TOD mode and the combination of green transportation, and then by citing examples of Chengdu TOD development to summarize the problems solved by TOD, and finally make suggestions for urban transportation design.

Keywords

TOD Mode; Green Transportation; Urban Transportation Design; Urbanization Process.

1. Introduction

The 14th Five-Year Plan period (2021-2025) is the first five years for China to start a new journey of a modern socialist country, and it is also the first five years to comprehensively promote the construction of a transportation power. According to data from the National Bureau of Statistics, China's urbanization rate exceeded 60% in 2019, and cities have become the main bearer areas for population and socio-economic activities[1]. With the acceleration of urbanization, among the many problems that follow, urban transportation is a complex and important key comprehensive problem, which is the foundation of modern urban social and economic development, and carries the transformation of urban people and logistics. China is the world's largest developing country, and China's rapid development and population size now ranks first in the world make China's urban transportation problem more important than other countries. The so-called urban traffic problem refers to a series of problems such as the non-benign operation state of the urban transportation system, serious traffic congestion, parking difficulties, low public transportation sharing rate, lack of walking and non-motor vehicle systems, and the negative impact on the urban economy, society and environment[2]. Poor urban transportation seriously affects socio-economic losses and causes physical and psychological distress to traffic travelers. The science of urban transportation planning directly affects the level of urban transportation decision-making. Traditional urban transportation planning has not adapted to the rapid development of cities, and urbanization calls for more scientific urban comprehensive transportation planning[3].

2. New Challenges for Urban Transport Development

2.1. Resource and Environmental Constraints are Irreversible

At present, the evaluation of resources and environment carrying capacity has become the basic condition for formulating national space planning. The openness of urban transport system determines the constant exchange of material, energy and information between it and the external environment. For a long time, urban transport development has been excessively dependent on the input of resource elements such as land resources, water resources and fossil fuels to resist the entropy increase of the system[4], while exporting waste, noise and other pollutants to the external system. Mobile source pollution has become an important source of air pollution in large and medium-sized cities[5], thus exacerbating the entropy increase of atmospheric environmental system. For urban transport system, its input and output both bring huge and irreversible losses to the resource and environment system. Under the premise of limited resource and environment carrying capacity, the current development mode is not sustainable.

2.2. The Subsystems of Urban Transportation are Not Coordinated

The insufficient degree of coordination between various subsystems of urban transportation leads to the phenomenon of "involution" of the transportation system, and the subsystems work independently and seize resources from each other, which aggravates the loss of resources and environment to a certain extent. For example, the separate planning and construction of external highways and railway passages in cities lacks overall planning, resulting in waste of land resources and disorderly cutting of urban space. Cars are rapidly entering the home, and the proportion of cars in short-distance travel suitable for walking and non-motor vehicles is too high, and irrational overuse occurs, aggravating road traffic congestion and pollution emissions; At the beginning of the rise of shared bicycles, the vicious competition of enterprises led to the disorderly release of vehicles, seized land resources around roads and rail transit stations, and affected the normal road traffic order.

2.3. The New Era Requires Further Establishment of the Concept of Green Transportation

In March 2014, the National New-type Urbanization Plan (2014~2020) was officially promulgated, as a programmatic document guiding China's new-type urbanization construction, the plan, together with the spirit of the Central Urbanization Work Conference, put forward a number of clear guiding directions and requirements for urban comprehensive transportation system planning. First, the concept requires that the concept of "people-oriented, respect for nature, inheritance of history, green and low-carbon" should be integrated into the whole process of urban planning. This requires that in the preparation of comprehensive transportation planning, gradually change the concept of "motor vehicle" to "people", vigorously advocate intensive transportation such as public transport and rail and green transportation such as walking and bicycle, and strengthen the planning and design of corresponding facility policies. Second, the perspective requires that "urban agglomerations should be taken as the main form to promote the rational division of labor, complementary functions and coordinated development of large, medium, and small cities and small towns". This requires that the perspective should be improved in the planning, urban transportation should be examined from a regional and even larger perspective, and a scientific and reasonable intercity and intra-city passenger and freight transportation system that can adapt to the new environment[6]. Li Xinghua, Dean of China Institute of Transportation, Tongji University: To achieve the "dual carbon" strategic goal, doing a good job in transportation planning is the first link, and the key needs to consider the relationship between transportation layout and land space and new-type urbanization, as well as the relationship between transportation supply

and social production and life. At the same time, it is necessary to use mode innovation and emerging technologies to optimize the transportation structure, do a good job in the coordinated integration of the traffic network with the energy network and information network, use advantageous technologies to reduce redundancy, and form a closed-loop system of "ecology-strategy-action-supervision"[7].

3. A Review of Traditional Integrated Transportation Planning Methods

3.1. Integrated Transportation Planning Model

3.1.1. Phased Forecasting Pattern

With the continuous progress of industrialization, the number of automobile ownership has gradually increased, and the traffic planning theory for automobile roads has gradually formed. The traffic planning model at this stage has a three-stage prediction method and a four-stage method that is widely used in the later stage. Among them, the three-stage forecast refers to the use of road traffic volume survey for road traffic planning. The three stages refer to: traffic generation from attraction, traffic distribution and traffic volume distribution. Personal income, socio-demographic structure, and car ownership are used as socio-economic and technical parameters for traffic forecasting. The four-stage rule is to rationally allocate transportation investment through comprehensive transportation planning to achieve the goals of long-term planning. At this stage, parking fees for motor vehicles are introduced. To a certain extent, the four-stage method belongs to the product of the gradual maturity of transportation planning theory, and has been used to this day, including four stages: traffic occurrence, traffic distribution, traffic mode division and traffic distribution. This forecasting method is widely used in integrated transportation planning.

3.1.2. Non-aggregated Models

Application and development of non-collective model, non-collective model is due to many traffic problems brought about by the development of industrialization, in order to solve these problems in planning. In the past, the collective model was to divide the traffic community, and the traffic activities of individuals in the community were statistically processed and analyzed by the traffic community as the statistical unit, and the final result was the resident travel analysis model based on the traffic community. Unlike the non-aggregation model, it takes the individuals who actually generate traffic activities as the unit of statistical analysis, and does not use the method of dividing traffic cells to analyze and predict. Instead, the model is built directly from individual survey data. Comparing the two, it can be seen that there are obvious differences between non-aggregate analysis and collective analysis in terms of analysis units, data efficiency, model prediction methods, application level, explanatory variables and policy embodiment. Later, with the development of computer technology, various transportation planning software was continuously developed and applied. As a traffic prediction planning model that emphasizes micro and part, the non-aggregation model has also been widely used and developed.

Summarizing the traditional comprehensive transportation planning model, although the theory and method are constantly improving and innovating, the traditional comprehensive transportation planning model is still project-oriented based on demand forecasting, changing the previous method of forecasting traffic by mode of transportation, and changing to the construction project of predicting the overall transportation demand first, and then combining with the established comprehensive transportation system development goals on this basis, to implement the construction projects of various modes of transportation in the planning project.

3.2. Problems with Traditional Integrated Transportation

The traditional comprehensive transportation planning mode mainly aims at meeting the needs of urban transportation and travel, and ignores the concept of green and sustainable development in the development. Public transportation and slow traffic are not paid attention to in the traditional comprehensive transportation planning, so it is not conducive to the development of comprehensive transportation planning under the concept of green travel.

(1) Limitations of the four-stage method

Firstly, in the division of transportation mode, the traditional transportation planning assumes that the future transportation mode remains unchanged, while in the actual situation, the change of the future transportation mode will cause partial errors in the division. Secondly, the acquisition of OD form requires a large number of traffic surveys, so it requires a lot of manpower, material resources and time. Thirdly, the four-stage prediction method generally does not contain variables reflecting traffic service level, so it is impossible to use the model to discuss the relationship between traffic service level and traffic demand. Finally, the division of traffic districts is subjective, and the prediction model and results obtained will also change due to the subjective will of the planners, so that the forecast results will lose objectivity.

(2) Deviation in planning emphasis

The sharp increase in the number of cars makes the focus of urban traffic planning biased to solve the problem of traffic congestion and ignore the increasingly serious environmental pollution in the city; The expansion of the road can solve the traffic jam at the moment, but it will attract more traffic at the later stage, which will lead to the congestion again, forming a vicious circle. Road congestion will also affect the operation of public transport to a certain extent, reducing the efficiency of public transport operation and making urban residents more and more inclined to use private cars to travel.

(3) The green concept in planning is not deep enough.

With the development of motorization and urbanization, urban traffic becomes more and more diversified. Therefore, most of the attention is paid to the smooth urban road and the coordination of economic development, which leads to the lack of reflection of the green travel concept in planning. Planning that aims only at improving transportation capacity is not well reflected.

4. Research on Improvement of Integrated Traffic Planning Method based on Green TOD Mode

4.1. Green Transportation Priority Strategy

Over the past year, China has shown unprecedented momentum in its efforts to reduce carbon emissions. The transportation sector is the third largest source of carbon emissions after industry and buildings. At present, low-carbon transportation with high energy efficiency, low energy consumption, low emission and low pollution has become an important development direction and research field of urban transportation, especially the development planning of ecological new town transportation [8].

4.2. Concept and Definition of TOD Model

TOD (Transit-oriented development, that is, the public transport-oriented development model) originated from the theory of new urbanism. The urban planning guidelines are mainly aimed at the problems caused by private cars in western countries, such as traffic congestion, urban low-density spread, urban hollowing out and environmental deterioration. This model aims to establish an urban land use model suitable for public transport services, emphasizing the concept of public transport priority, and comprehensive development and utilization of land

around the bus corridor. TOD, as a land development tool based on the concept of new urbanism, takes high-density land development mode as the basis and large-capacity public transport as the backbone of the city, which promotes compact urban development, restrains suburban sprawl, reduces urban residents' dependence on private cars and promotes low-carbon travel for residents. TOD stands for Transit-Oriented Development, which can be divided into the following three points:

(1) Transit

TOD emphasizes the role of public transportation. At present, most problems in urban development around the world are related to transportation. A large number of people flood into cities, resulting in urban traffic congestion and long commute time, reducing work efficiency and wasting resources. Under the condition of good public transport, it can effectively reduce the use rate of car travel and shorten the commuting time.

(2) Oriented

For a long time, transportation planning and land planning have not established a good communication and feedback role, which has led to demand-based transportation planning and urban land use schemes. Demand-based planning can effectively relieve the pressure of the city in the early stage of urban development, but without forward-looking planning and long-term vision, demand-based planning lags far behind the development speed of the city, and the urban development model of spreading the pie is inevitable. The TOD model is guided, guiding the development and population flow of the city through the guided development mode, which can effectively reduce the disorderly sprawl of the city and alleviate the spatial pressure of the city.

(3) Development

TOD mode is an urban development mode that can well cope with urban problems, and its importance is reflected in its guidance and future benefits. Changing the way of urban demand planning can achieve more benefits in the future, thus promoting the development of urban economy [9].

4.3. Planning Philosophy and Policies

4.3.1. Planning Concept

In the traditional urban comprehensive transportation planning, the relevant planning strategies are more from the perspective of motor vehicles, considering the accessibility of vehicles, for this reason there is less consideration for slow traffic, but comprehensive transportation requires the coordinated development of chronic traffic and motor vehicle traffic, and the two are not exclusive. The planning concept of comprehensive transportation planning based on green TOD mode under the background of dual carbon emphasizes transit-oriented urban concept planning.

In each planning stage of the planning process, the concept of public transportation development is the mainstay, public transportation is prioritized, and the land around the bus corridor is comprehensively and high-density development and utilization. Prioritised urban public transport planning approach. The requirements of "bus priority" for public transport planning are put forward, and the urban bus hub distribution planning model with the goal of the largest accessibility level of residents arriving at the bus hub and the optimal coupling relationship between the bus hub and the urban center system and the urban bus network planning model with the largest service range, the least number of transfers, and the most economical total bus travel time are established. Convenient urban transportation hub layout planning method. The layout model and application operation process of hub facilities are established with the goal of minimizing the transfer turnover of passengers per unit time in the hub and the priority constraint of the transfer intensity between modes of transportation [10].

Sustainable cities have evolved with the concept of sustainable development. "Our Common Future" puts forward the concept of sustainable development of "development that meets the needs of the present generation without jeopardizing the ability of future generations to meet their needs", which theoretically expounds that "sustainable development" is the fundamental principle of human beings to solve environmental and development problems, and is based on the coordinated development of economy, society and nature on the basis of resources and environmental bearing. The concept of sustainable urban development is the specific application of the concept of sustainable development within the city limits. In this study, we will take "sustainable and livable city" as the development goal, analyze its connotation, and study the corresponding TOD urban space design strategy.

Transit-led urban development TOD is a land development model based on the interactive relationship of "land use one-to-one urban transportation", around subway, light machine or bus rapid transit line stations. It guides land development and utilization based on public transportation, promotes the reasonable and orderly growth of urban space, and finally forms an urban form with compact layout, complex functions and humanization [11].

4.3.2. Planning Policies

(1) Adjustment and formulation of policy measures. The strategies for the implementation of transportation are all formulated by the government, so the government plays an important role in the choice of residents' travel methods, and the government must formulate appropriate laws and policies to ensure effective guidance for residents' travel choices. Local governments should establish an effective system of laws and regulations according to local conditions, encourage the development of green transportation modes such as public transportation and slow traffic, and at the same time need to plan the effective cooperation of transportation departments at all levels of the city, improve the efficiency of law enforcement, and ultimately achieve coordination and unification between transportation, environment and resources.

(2) A reasonable urban land use layout can not only meet the transportation demand, but also make full use of the urban space, so as to achieve the coordinated development of urban transportation with the economy, resources and environment [12]. If the urban land is more scattered, there will be a separation of residential areas, work areas, and entertainment areas in the city, which will reduce the attractiveness of traffic, residents will choose motor vehicles with good mobility, and this land use layout will also increase the waste of land resources in the city. Therefore, in the planning, due to the relationship between the allocated land layout and the functional area, the phenomenon of separate separation of the functional area is avoided.

4.4. Typical Characteristics of TOD Mode

The strategic objectives of the transportation and land use development strategy are to adopt an integrated urban transportation development model to realize the benign interaction between transportation and land use and support the sustainable development of the city. It is the convergence of transportation and land use that provides a model for urban development to rely on public transportation to make transportation and land use coordinated. The TOD model has four main typical characteristics: First, public transportation is the core element of TOD, and the joint development of large-capacity public transportation and land is an important way to realize the interaction between land use and transportation. The theoretical research and practice of TOD show public transport. In particular, land development and utilization along high-volume public transport routes are extremely active, and various social infrastructures are mostly concentrated around high-volume public transportation corridors. Second, high-intensity development within the allowable range of pedestrians around bus stops. One of the goals and principles of TOD is to increase the efficiency of land use by increasing the intensity of land development. The high intensity of land development provides a high density of housing and jobs, which can provide sufficient footfall for the public

transportation system and support the consumer market base required for retail, commercial and other activities within the scope of TOD development. Third, mixed use of land. The mixed use of land provides convenience for residents, balances the distribution of residence and employment, and helps to reduce the distance traveled, thereby reducing dependence on private transportation, especially cars. Fourth, build a pleasant pedestrian environment. Walking is a mode of travel that is in harmony with the dominance of public transportation advocated by TOD, and the construction of a good walking environment is determined by the relationship between public transportation and land use. Based on the spatial scale of walking, the quality of the walking environment is directly related to the success or failure of the project. Priority should be given to walking, convenience and comfort in the streets and their ancillary facilities, crossing facilities and signal control within the block. The core idea of TOD is that public transport leads urban development, and the public transportation used is different for different city sizes and different stages of development [13].

4.5. Example – Chengdu

The positive role of TOD development in China includes optimizing urban spatial layout, promoting land-use employment and housing systems, and leveraging the efficiency of public transportation.

According to the 26th Symposium of China Urban Transport Development Forum, the 2021 urban experience includes: average motor vehicle speed during peak hours in built-up areas, urban road network density, average one-way commuting time of urban permanent population, proportion of population with commuting distance less than 5km, proportion of commuting around rail stations, density of dedicated bicycle lanes, and green transportation sharing rate. Taking the Chengdu TOD project as an example, its outstanding feature is that the subway station radiates to the surrounding area as the center of the circle. At present, 16 TOD projects cover the Chengdu rail network to Chengdu urban area, forming one district and one demonstration. The TOD model follows the 137 principle, that is, the extremely high-density development of the 100m core area creates an urban landmark with display, focusing on business and commercial functions; 300m of sub-core high-density development to shape a flexible and diverse urban scene, focusing on cultural activities and public service facilities; The low-density development of the 700m non-core area creates a poetic habitat from "city to nature". The green space rate of each project will reach more than 35%, and 16 projects will cover the entire Chengdu rail transit line network from the point connection network to form a surface covering the entire Chengdu urban area, building a new form of the city with a new pattern."

4.6. Problems Solved by Integrated Transportation Planning under the Green TOD Model

The model proposed in this paper mainly solves the following urban problems and contradictions:

- (1) Reduce the travel of cars through good public transportation and relieve the pressure of urban traffic;
- (2) The reduction of car travel rate can effectively reduce energy consumption and environmental pollution, and improve residents' life satisfaction;
- (3) Distribute urban space and urban population in a balanced manner, improve the efficiency of urban land use through high-density building forms, and control the disorderly sprawl of cities;
- (4) Effectively share urban functions, alleviate the problem of unequal urban public infrastructure construction, and distribute public goods in a balanced manner;

(5) Guide the development of the city through the form of public transportation, change the demand-oriented planning mode to the guiding planning method, and reasonably realize the road of healthy urban development through planning.

5. Conclusion

TOD model development more than 20 years has made a lot of achievements, but China introduced TOD model relatively late, is also in the research and practice stage, many cities for TOD model is suitable for China still have doubts, this paper through the domestic and foreign model development experience summary and analysis, while introducing green transportation strategy, further combined with the current dual carbon background green transportation oriented through TOD model urban comprehensive transportation planning.

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