

Traffic Network Optimization in Adjacent Areas of Chengdu's Comprehensive Transportation Hubs

Wang Peng*

School of Economics and Management, Dalian University, No.10, Xuefu Avenue, Economic & Technical Development Zone, Dalian, Liaoning, The People's Republic of China (PRC)

email: wangpeng1@dlu.edu.cn

**corresponding author: Wang Peng*

Keywords: *space syntax; city comprehensive transportation hub; hub's adjacent areas; traffic network optimization*

Abstract: *The urban integrated transportation junction is the most important visitor assembly and evacuation area in modern cities. However, adjacent areas are prone to crowd and traffic congestion, which affects the normal operation of the junction and even the whole urban traffic system. Therefore, it is necessary to optimize the traffic network of adjacent areas to ensure the efficiency of the hub service. Taking four major junction stations in Chengdu as examples, the paper establishes research models for the urban metro and urban road traffic network based on Space Syntax. Moreover, through analysis of the macro and micro levels of integration, it evaluates the mean depth and connectivity, accessibility, centrality and permeability of the traffic network state. The paper then proposes some suggestions to optimize the traffic networks in the adjacent areas of the four major junction stations, which could be used to guide the spatial developments of adjacent areas.*

1. Introduction

The urban transportation network is the link between various types of space within the city. The optimization and improvement of the urban transportation network is an important prerequisite and guarantee for the sustainable development of urban space and the healthy operation of various social and economic activities in the city. As the core node of the urban transportation network, the urban comprehensive transportation hub is a passenger flow distribution center integrating multiple modes of transportation. The social and economic activities in its adjacent areas are frequent and complex, and a good transportation network is needed to ensure service efficiency and level. Therefore, it is especially important to study the transportation network in the adjacent urban transportation hub. However, scholars' research on the adjacent areas of the hub has focused on land use and spatial planning and design, and there are few studies on the adjacent area transportation network^[1].

At present, scholars' research on the adjacent areas of transportation hubs mainly focuses on land use and spatial planning. The research on urban transportation networks is mostly concentrated in the transportation network of the whole city, and there is a need to deepen the transportation

network in the adjacent urban transportation hubs. Therefore, this paper proposes the research idea of traffic network optimization based on spatial syntax in the adjacent area of the hub, and quantitatively analyzes the traffic network in the adjacent area of the hub from a new perspective, and proposes corresponding optimization suggestions ^[2].

2. Research Ideas and Contents of Transportation Network in the Adjacent Area of the Hub from the Perspective of Spatial Syntax

2.1. Conception and Scope Definition of Adjacent Areas of Urban Comprehensive Transportation Hubs

Combined with the previous research, this paper defines the adjacent area of the urban comprehensive transportation hub as: the urban area adjacent to or close to the urban comprehensive transportation hub, which is the closest urban environmental carrier of the hub. The hub carries out material, energy, information, etc. through the adjacent area and the city and the area. The range of the adjacent area of the hub can be preliminarily defined within the radius of 1500m around it, and because the traffic function of the road above the secondary trunk road is obvious, and the branch road is mainly based on the life service function, the integrity of the block can be considered comprehensively. On the basis of natural conditions and other factors, the roads above the secondary trunk road are used as the boundary of the analysis scope, and then the adjacent area of the urban comprehensive transportation hub is delineated (Figure 1) ^[3].

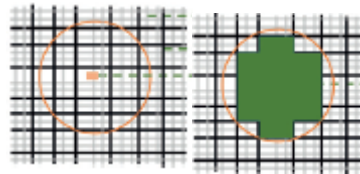


Figure1 Scope of adjacent areas of urban comprehensive transportation hub

2.2. Parameter Selection of Space Syntax Theory

When applying spatial syntax to study the adjacent areas of the hub, it is necessary to consider the composition of the urban transportation network system. Because the national railway realizes the external connection of the city, the analysis of the topological relationship of the national railway network in a single city has no practical significance. Therefore, this paper only studies the subway and urban road transportation network system, and mathematically models the two transportation systems, using the convex space method. The simulation method such as the axis method analyzes the traffic network in the adjacent area of the hub. By analyzing the accessibility, centrality and permeability of the traffic network in the adjacent area, the internal logic of the topology structure is studied, and corresponding optimization and development suggestions are proposed.

Analysis model selection: The axis model is a topological relationship model formed by the intersection of axes. The urban road traffic network presents an obvious linear intersection state, so the axis model is adopted. It should be noted that the model's central axis analysis needs to consider the original length factor of the road axis, which can be realized by the "Weight by Line Length" command in Depth Map.

Analysis content: Under the reasonable consideration of the reasonable service scope of road vehicles such as cars and buses, this paper takes the Chengdu area as the macro-level analysis scope and the adjacent area as the micro-level analysis scope.

3. Analysis of Traffic Network in Adjacent Areas of Chengdu's Four Major Hubs

3.1. Research subject and data source

The four comprehensive transportation hubs in Chengdu include Chengdu East Railway Station, South Railway Station, West Railway Station and North Railway Station. These four hub stations form the “two main (east station, north station) two auxiliary (south station, west station)” pattern. Among them, the East Railway Station, the North Railway Station and the South Railway Station are in operation, and the West Railway Station is currently under construction. Although the West Railway Station has not yet been officially operated, its main works and ancillary facilities have been completed and installed, and the Metro Line 4 has been opened through the station. Therefore, it is still included in the research object, making the research more comprehensive and systematic. .

3.2. Macro level analysis

There are 4,077 road axes in Chengdu, and the overall integration degree is 1.09. The overall performance shows a state of decreasing from the center to the periphery. The spatial axis with high integration is called integrated core, and the form of integrated core can reflect the basic form of the city. Chengdu's overall integrated core presents an obvious “freewheel axle” feature. The network with this integrated nuclear form can avoid the center-isolated trend caused by urban growth, and make the center, the adjacent area of the hub and the edge mutually Get easy access. Among the four major hubs, only the integration value of the adjacent road network in the West Station is lower than the overall average value, because the road network in Chengdu is in a ring-shaped radial shape, and the overall integration degree of the ring line and the radiation is relatively high, while the adjacent station of the West Station is relatively high. The number of related axes is small. In addition, the closer to the city center, the higher the overall integration of the road axis, and the West Station is farther from the city center than the other 3 stations.

Overall integration. The average integration degree of the axis axis of the four adjacent areas of the four hubs is above 1.3. Among them, the South Station has the best accessibility and centrality, the East Station and the North Station are slightly lower, and the West Station is the lowest. In addition, the overall integrated core of the four adjacent zones presents different forms. The East Station and the North Station are linear, the South Station is a network, and the West Station is radial (Figure 4). The linear integrated core is easy to cause a single state of the traffic flow line. The mesh integrated core is conducive to the distribution of traffic flow, and the radial integrated nuclear is easy to cause the vehicle flow to be highly concentrated and not easily evacuated. Through the observation of Baidu's thermal map, the actual state of road traffic is basically consistent with the analysis results.

4. Traffic Network Overall Evaluation and Optimization Development Suggestions

4.1. Evaluation of traffic network in the adjacent area of the hub

Through the analysis of the subway and road traffic network in the adjacent area of the hub, it can be seen that the traffic network in the adjacent areas of the four hubs in Chengdu is generally in good condition, and all have good accessibility, centrality and permeability. Among them, the traffic network in the adjacent area of the South Station is the best, and the overall integration degree of the subway transportation network is the highest, and the average depth value is the lowest. The overall integration, average depth and connectivity of the road transportation network at the macro level ranked first, and the overall integration, average depth and intelligibility at the

micro level were also the best. The overall status of East Railway Station and North Railway Station is second. The overall integration and average depth of the subway and road transportation network of North Station is better than that of the East Railway Station, but the connection degree is worse than that of the East Railway Station, reflecting its high accessibility, strong centrality and low permeability. The overall integration and average depth of the subway station's subway transportation network are at the bottom, and the road traffic network also shows the highest average depth and the lowest overall integration, reflecting its relatively poor accessibility and centrality.

4.2. Optimization Suggestion and Effect Evaluation of Traffic Network in the Adjacent Area of the Hub

Optimization proposal for subway transportation network. The overall integration degree of the four hub stations is relatively low, and their values are all less than 0.7, indicating that the current subway lines in Chengdu are still relatively small and the system is weak. The overall integration degree of the West Station is the lowest among the four stations, and the accessibility and centrality are the weakest. The reason is that the distance between the West Station and the downtown area is large, and there is no other line conversion except Line 4. Therefore, in order to strengthen the connection between the hub and the city, more subway lines should be gradually built to improve the network system, and the topological distance between the end branch station and the hub station caused by the excessive number of feeder stations at the end of the traffic network should be avoided as much as possible.

Optimization proposal for the adjacent area of the East Station. The road traffic network in the adjacent area of the East Railway Station is relatively good in the four stations, but there are many “T-shaped” roads and end-end roads in the adjacent areas, which makes the local space inconvenient, so it is recommended to meet the current urban space. Under the premise that the basic functions are not destroyed, consider extending the end of the road to other roads, and try to transform the “T-shaped” road into a “cross” road to optimize the road and make the east station reachable, central, etc. Better. In addition, it is recommended to comb the road structure on the west side of the East Railway Station to strengthen the integrated nuclear form of the adjacent station in the East Station, and change the single straight line into a mesh shape to increase the connection between the East Railway Station and the urban area.

Suggestions for optimization of the adjacent area of the North Station. Since the overall integration degree of the urban integrated transportation hub has a clear relationship with the distance of the city center, the axis of the adjacent road network in the North Station of the Second Ring Road is highly integrated, but the average depth value at the micro level is relatively high. It exhibits high accessibility, high centrality and low permeability, and is prone to traffic congestion in the adjacent area causing congestion. Therefore, it is recommended to sort out the roads in the adjacent areas of the North Station and improve the existing single-line curved roads and the lower-connected branch lines. The integrated core of the adjacent area of the North Station is a single straight line, and it is recommended to dredge or construct a plurality of highly integrated axes to form a mesh integrated core.

5. Conclusions

In this paper, the spatial syntactic theory is applied to the analysis and research of the transportation network in the adjacent urban transportation hub. The four comprehensive transportation hubs in Chengdu are selected as the main research objects. The convex space model is established based on the Chengdu metro transportation network, based on the urban road. The traffic network and the

road traffic network in the adjacent area establish an axis model, compare and evaluate the operation status of the traffic network in each adjacent area of the hub, and propose corresponding traffic network optimization suggestions for each adjacent area of the hub, which is the urban and traffic planning and management department of Chengdu. In the next step, the planning, construction and management of the adjacent areas of the hub will provide reference. At the same time, this paper also provides a new research perspective and ideas for the study of the transportation network in the adjacent traffic hub of the city. It provides a new reference for the study of traffic quantification, traffic network prediction and evaluation and optimization development in the adjacent area.

Acknowledgements

This article was specially funded by Dalian University's 2019 Ph.D. Startup Fund (20182QL001) and 2019 Jinpu New District Science and Technology Project.

References

- [1] TIAN Sheng. (2017) *An Organizational Scheme for Metro Traffic Based on Longshort Route Optimizatio*. *Journal of Transport Information and Safety*, 35, 121-124
- [2] ZHONG Qingwei. (2014) *Optimizing Rolling Stock Deadhead Routing Problem Before Operation Period of Urban Rail Transit Line*. *Journal of the China Railway Society*40, 29-35.
- [3] JINAG Zhibin. (2014) *Optimal Model for Using of Transit Unit Based on Shared-Path Rail Transit Route*. *Journal of Tongji University (Natural Science)*, 2, 1333-1339.