

# RESEARCH ON THE CURRENT CHARACTERISTICS AND MITIGATION MEASURES OF URBAN TRAFFIC CONGESTION IN CHINA

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## ABSTRACT

In recent years, with the rapid increase in car ownership and the rapid advancement of urbanization in China, the problem of urban traffic congestion has become increasingly prominent. Exploring the current characteristics of urban traffic congestion and proposing corresponding mitigation measures has become an important way to effectively alleviate the problem of urban traffic congestion. This essay is based on the 2022 urban commuting peak congestion index data published in the big data report of Baidu Maps platform. It analyzes the traffic congestion characteristics of 100 major cities in China from four aspects: city size, economic development level, regional distribution, and spatial agglomeration. The study found that urban traffic congestion in China has typical regional differences. Finally, countermeasures and suggestions to alleviate urban traffic congestion in China, providing valuable reference for urban traffic congestion management, are proposed.

## 1. INTRODUCTION

With the continuous development of China's economy, the level of urbanization and motorization continues to improve, and the number of private cars is increasing day by day. The phenomenon of urban road congestion has become a norm, leading to chaotic traffic order and unfavorable to people's daily travel experience. At the same time, it directly affects the fundamental interests of the people and becomes an important factor restricting economic development. According to data published by the Ministry of Transport of China, the economic losses caused by traffic congestion account for 20% of the disposable income of urban population, equivalent to an annual loss of 5-8% of gross domestic product (GDP), reaching 250 billion yuan per year (Wang Huitong et al., 2020). Therefore, studying how to alleviate urban traffic congestion is crucial for urban governance.

At present, research on urban traffic congestion is mainly divided into three categories: firstly, measuring the traffic congestion status of urban road networks. Wang Liyan et al. used entropy method to measure the level of traffic congestion in Tianjin over the years and analyze its influencing factors (Wang Liyan et al., 2018). Bai Zixiu et al. constructed a comprehensive evaluation model for road congestion based on fuzzy mathematics theory to evaluate the congestion level of actual roads (Bai Zixiu et al., 2021). Shao Changqiao et al. studied the benchmark conditions and evaluation methods for traffic congestion measurement (Shao Changqiao et al., 2022). The second is to study the economic and social costs, causes, and governance strategies caused by traffic congestion. Zhong Hailong analyzed the main causes of traffic congestion and the necessity of alleviating it

(Zhong Hailong, 2023). Zuo Lu et al. studied the causes of traffic congestion in areas with scarce land construction indicators (Zuo Lu et al., 2023). Yang Jiayu et al. analyzed the causes of urban traffic congestion and the correlation between various factors (Yang Jiayu et al., 2023). The third is to study the spatiotemporal characteristics of urban traffic congestion. Wang Huitong et al. studied the spatial pattern of urban traffic congestion (Wang Huitong et al., 2020). Sun Jianping et al. studied the spatiotemporal distribution characteristics of traffic congestion caused by traffic accidents on urban roads (Sun Jianping et al., 2019). Zhang Zhenlong et al. analyzed the spatiotemporal characteristics of frequent traffic congestion within the ancient urban area of Suzhou through the ArcGIS operating platform (Zhang Zhenlong et al., 2020). But there is little research on the distribution characteristics of urban traffic congestion at the national or regional level.

This essay uses the big data of traffic congestion delay index of 100 cities in China provided by Baidu Maps to examine the distribution characteristics of urban traffic congestion at the national level, explore the correlation between urban scale, economic development level, regional distribution and traffic congestion degree, analyze the differences in urban traffic congestion characteristics, and on this basis, study the mitigation measures, providing reference and value for relevant departments to governance urban traffic congestion.

## 2. ANALYSIS OF THE CURRENT SITUATION OF URBAN TRAFFIC CONGESTION IN CHINA

The relevant data used in this study comes from the "2022 China Urban Traffic Report" provided by Baidu Maps, which includes the "Commuting Peak Congestion Index" of 100 cities nationwide. The ratio of actual travel time to unobstructed travel time is calculated, and the larger the ratio, the more severe the traffic congestion in the city.

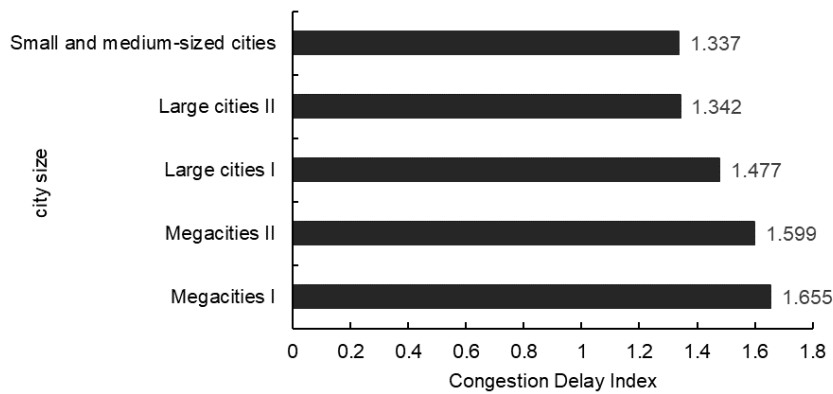
### 2.1 Analysis of Traffic Congestion in Cities of Different Sizes in China

As shown in Table 1, according to the size of urban population, cities can be divided into megacities I, megacities II, large cities I, large cities II, medium-sized cities, small cities I, and small cities II.

**Table 1: Population Size of Different Cities**

| City Size                                   | Megacities I              | Megacities II                | Large Cities I              | Large Cities II             | Medium-Sized Cities        | Small Cities I            | Small Cities II         |
|---|---------------------------|------------------------------|-----------------------------|-----------------------------|----------------------------|---------------------------|-------------------------|
| Permanent population in the main urban area | ≥1000 ten thousand people | 500—1000 ten thousand people | 300—500 ten thousand people | 100—300 ten thousand people | 50—100 ten thousand people | 20—50 ten thousand people | ≤20 ten thousand people |

As shown in Figure 1, the larger the city size, the higher the delay index of urban traffic congestion. Specifically, the average congestion index during peak commuting hours in megacities I and megacities II is relatively high; The average congestion index during peak commuting hours in large cities I is 1.477; The average congestion index during commuting peak hours in large cities II and small and medium-sized cities is relatively close. It can be seen that there is a significant difference in the average congestion delay index during peak commuting in cities of different sizes in China. Megacities and mega cities face significant traffic pressure, while Type II large cities and small and medium-sized cities have relatively small traffic pressure.



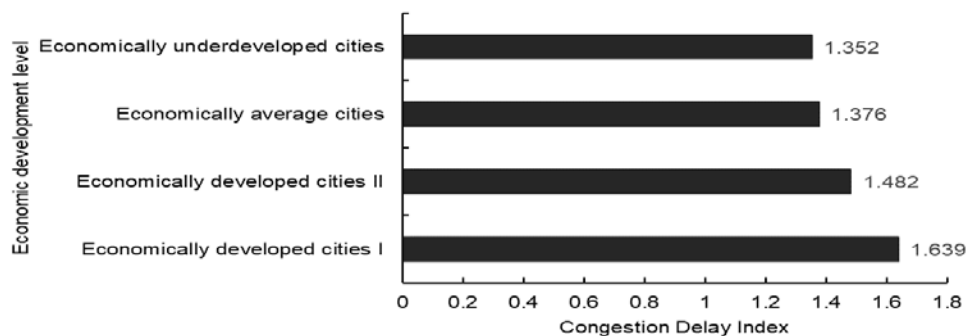
**Figure 1: Average Congestion Delay Index during commuting peaks in cities of different sizes**

## 2.2 Analysis of Urban Traffic Congestion at Different Economic Development Levels in China

In order to compare the differences in urban traffic congestion at different levels of economic development, this essay uses the GDP of various cities in China in 2022 as a measure of the degree of urban economic development. As shown in Table 2, according to the specific situation of the total GDP of each city, it is divided into economically developed cities I, economically developed cities II, economically average cities, and economically underdeveloped cities.

**Table 2: Economic development levels of different cities**

| Economic Development Level | Economically Developed Cities I | Economically Developed Cities II | Economically Average Cities | Economically Underdeveloped Cities |
|----------------------------|---------------------------------|----------------------------------|-----------------------------|------------------------------------|
| GDP                        | ≥15000 billion                  | 8000—15000 billion               | 4000—8000 billion           | ≤4000 billion                      |



**Figure 2: Delay Index of urban traffic congestion at different economic development levels**

As shown in Figure 2, the more developed cities in China's economy, the higher their traffic congestion delay index. Due to the developed urban economy and strong population attraction, a large number of people continue to flow into the city, resulting in severe urban traffic congestion. Most economically underdeveloped cities are located in the central and western regions, with low economic activity and a net outflow of population, resulting in a relatively low level of urban traffic congestion.

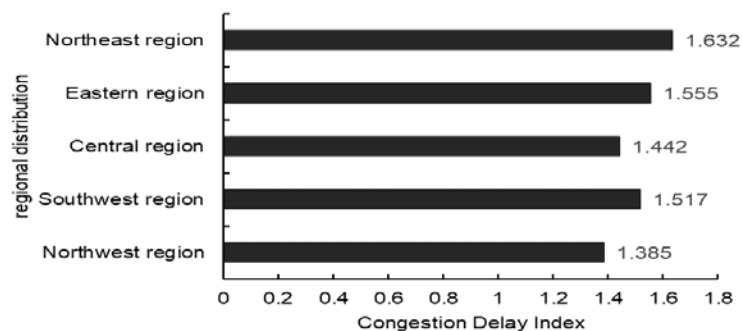
### 3. ANALYSIS OF THE SPATIAL CHARACTERISTICS OF URBAN TRAFFIC CONGESTION IN CHINA

#### 3.1 Analysis of Regional Distribution Characteristics of Urban Traffic Congestion

This essay divides 100 cities into five major regions based on their provincial administrative regions: Northwest, Southwest, Central, Eastern, and Northeast. In order to overcome the calculation bias caused by uneven distribution of sample areas, as shown in Table 3, this essay selects 50 provincial capital cities, sub provincial cities, municipalities directly under the central government, and larger prefecture level cities from 100 cities for regional distribution characteristics analysis (Wei Jingnan, 2023).

**Table 3: Classification of different urban areas**

| Regional Distribution | Northwest Region                                 | Southwest Region  | Central Region   | Eastern Region  | Northeast Region                    |
|-----------------------|--|---|--|---|-------------------------------------|
| City                  | Xi'an, Urumqi, Lanzhou, Xining, Yinchuan, Hohhot | Chongqing, Chengdu, Guiyang, Kunming, Nanning, Liuzhou, Lhasa | Wuhan, Zhengzhou, Jinan, Changsha, Hefei, Shijiazhuang, Taiyuan, Nanchang, Tangshan, Baoding, Handan, Zibo, Linyi, Xuzhou, Luoyang | Shanghai, Beijing, Guangzhou, Shenzhen, Tianjin, Qingdao, Dongguan, Nanjing, Hangzhou, Suzhou, Foshan, Ningbo, Xiamen, Fuzhou, Haikou, Yantai, Huizhou, Shantou | Shenyang, Changchun, Harbin, Dalian |



**Figure 3: Delay Index of urban traffic congestion in different regions**

As shown in Figure 3, the urban traffic congestion delay index in Northeast China is the highest, followed by the eastern region; The delay index of urban traffic congestion in the central and northwest regions is relatively low. From the perspective of urban traffic congestion in the eastern region, although the degree of congestion is not the most severe, it is still relatively severe in some mega cities, such as Beijing, Shanghai, and Guangzhou. The traffic congestion in cities in the southwest and northeast regions is relatively severe, with the exception of Liuzhou, which is the provincial capital and above. Especially in the three cities of Chongqing, Guiyang, and Kunming in the southwest region, traffic congestion is relatively severe. Although the northwest region is all provincial capital cities, except for Xi'an, the traffic congestion in other cities is not particularly severe. Except for Wuhan and Jinan, which are two major cities with severe traffic congestion, the traffic congestion situation in other cities in the central region is not particularly prominent.

#### 3.2 Analysis of Spatial Agglomeration Characteristics of Urban Traffic Congestion

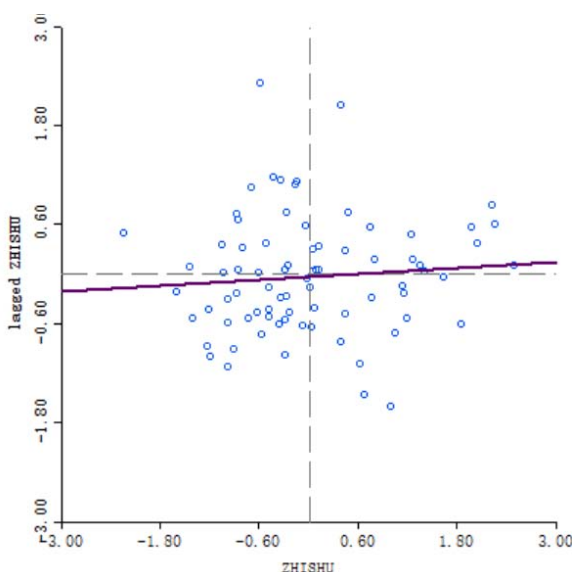
Considering the spatial agglomeration characteristics of traffic congestion among cities, this essay uses the traffic congestion delay index data of 100 cities in China published on

Baidu Map platform to measure the Moran's I index of traffic congestion delay in 100 cities in China in 2022.

**Table 4: Moran's I Index of urban traffic congestion in China**

| Quarter | Moran's I | E(I)   | sd(I) | z     | p     |
|---------|-----------|--------|-------|-------|-------|
| Q1      | 0.150     | -0.010 | 0.057 | 2.815 | 0.004 |
| Q2      | 0.267     | -0.010 | 0.057 | 4.835 | 0.000 |
| Q3      | 0.224     | -0.010 | 0.058 | 4.076 | 0.000 |
| Q4      | 0.203     | -0.010 | 0.058 | 3.705 | 0.003 |

Table 4 shows the Moran's I estimates of urban traffic congestion and their significance. According to Table 4, it was found that the Moran's I estimates of urban traffic congestion in China for the four quarters of 2022 were all positive, and through a 1% significance test, it can be found that there are significant spatial dependencies and agglomeration characteristics in urban traffic congestion in China.



**Figure 4: Moran Scatter Chart of Urban Traffic Delay Index in 2022**

Through the Moran scatter plot of urban traffic congestion in 2022 shown in Figure 4, under the weight of geographical distance, most cities are located in the first (H-H) and third (L-L) quadrants, further indicating the spatial clustering characteristics of urban traffic congestion. Geographical proximity has a significant impact on traffic congestion.

## 4. CONCLUSION AND MITIGATION MEASURES

### 4.1 Research Conclusion

- From the perspective of urban scale, there are significant differences in the degree of traffic congestion during peak hours among different cities in China. The higher the administrative level and size of the city, the more severe the urban traffic congestion.
- From the perspective of urban economic development level, the more developed the economy, the more severe the traffic congestion in cities, indicating that the degree of urban traffic congestion is highly correlated with the level of urban economic development.

- From the perspective of regional distribution, urban traffic congestion is more prominent in the eastern and northeastern regions of China, followed by the southwest and central regions, and the northwest region has the lightest degree of urban traffic congestion.
- Urban traffic congestion in China exhibits significant spatial agglomeration characteristics.

#### 4.2 Suggestions for Alleviating Traffic Congestion

- Great importance is attached to the problem of traffic congestion in mega cities and mega cities in China, strengthen monitoring of urban road traffic congestion, and conduct research and judgment on the types of urban road traffic congestion.
- Considering the new transportation demand brought about by the growth of urban population and car ownership, it is necessary to continue to strengthen the supply of urban road resources, especially to increase the construction of roads in super large and mega cities, and balance the distribution of urban traffic flow.
- In the process of formulating traffic congestion control policies, it is necessary to fully consider the actual situation of traffic congestion in various regions and formulate policies to control traffic congestion according to local conditions. In the process of managing traffic congestion, it is necessary to continue to strengthen traffic management capabilities while continuously increasing the density of the road network.

## **5. REFERENCES**

Bai Zixiu et al. Studied the impact of road congestion levels on the reliability of bus travel time Journal of Beijing Jianshu University, 2021, 37(04):34-42.

Shao Changqiao et al. Traffic congestion measurement and evaluation method based on operational efficiency Journal of Beijing University of Technology, 2022, 48(04):401-407.

Sun Jianping et al. Study on the spatiotemporal distribution characteristics of occasional traffic congestion based on speed changes Transportation System Engineering and Information, 2019, 19(02):196-201+215.

Wang Huitong et al. Research on the Spatial Pattern of Traffic Congestion in 100 Cities in China - Based on the Analysis of Gaode Traffic Congestion Big Data Journal of Shandong University of Finance and Economics, 2020, 32(01):62-72.

Wang Liyan et al., Research on the Measurement and Influencing Factors of Traffic Congestion Level in Developed Cities - Taking Tianjin as an Example City Observation, 2018, (03):109-120.

Wei Jingnan. Analysis of the Degree and Influencing Factors of Urban Traffic Congestion in China: From the Perspective of Road Traffic Supply and Demand Balance Journal of Liaoning University of Technology (Social Sciences Edition), 2023, 25(02):36-40.

Yang Jiayu et al. Systematic Research on Urban Traffic Congestion Management Journal of Systems Science, 2023, (04):101-106.

Zhang Zhenlong et al. Analysis of the spatiotemporal characteristics and influencing factors of traffic congestion based on real-time road conditions - Taking the ancient urban area of Suzhou as an example Modern Urban Research, 2020, (01):104-112.

Zhong Hailong, Research on Countermeasures and Suggestions for Alleviating Urban Road Traffic Congestion in the New Era Theoretical Research on Urban Construction (Electronic Version), 2023, (08):107-109.

Zuo Lu et al. A Study on the Causes of Traffic Congestion from the Perspective of Land Development Rights - Taking Chaonan District, Shantou City as an Example Modern Transportation and Metallurgical Materials, 2023, 3(02):54-59.