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Views & Comments

China's Urban Infrastructure Challenges

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1. Introduction

To meet people's needs in daily life, production, and recreation, city infrastructure including a wide variety of structures, such as stores, factories, office buildings, houses, roads, and pipelines, have been built. The rapid growth of urban populations, along with people's pursuit of a better life, have led to a greater demand for buses, railways, airways, cars, and subways; to larger scales of production, logistics, transportation, and waste; and to the establishment of service facilities, such as malls, banks, sewage treatment facilities, telecommunication infrastructures, data centers, healthcare centers, and senior care centers. As a result, cities expand rapidly and urban physical systems become increasingly complicated. Poor urban planning and management inevitably result in traffic congestion, pollution, unemployment, monotonous building, and other "urban malaises." The current issues confronting Chinese cities primarily arise from a misunderstanding and poor management of the complexity of physical systems in the process of industrialization and urbanization, bringing great challenges to economic and social development.

2. Urban traffic congestion: Situation and solutions

2.1. Challenges in urban transport

For countries experiencing an upsurge of urbanization, traffic congestion is common. However, traffic congestion in China is steadily growing worse. In 1990, there were only 800 000 private cars in China. By 2012, this number had surprisingly increased by 110 times, to a total of 90 million cars. This dramatic increase in the number of private cars has caused severe traffic congestion (Fig. 1). In Beijing, the average time to drive to work was 52 min in 2012, with an average speed of approximately 15 km·h^{-1} [1]. Similar situations are occurring in other cities across China.

Traffic congestion does not only lead to wasted time on the road; it also causes increased fuel consumption, air pollution, and noise pollution; decreased traffic safety; and other issues. Relevant studies indicate that traffic congestion comes at a huge cost in Beijing, accounting for approximately 4.2% of the city's annual gross domestic product (GDP) [2].

2.2. Solutions to urban traffic congestion

At present, the main solution to traffic congestion is to rely on real-time traffic sensor information to disperse and manage traffic. When serious traffic congestion exists, a traffic restriction policy can be applied. However, this is a shallow and temporary means that cannot solve the issues at the root of traffic congestion. Three more effective solutions are suggested below.

Improving urban street networks. Loose networks with excessively wide streets comprise the majority of China's urban street networks. Table 1 [3] displays a comparison of street networks in different blocks. In the table, "Beijing New Area" refers to the part of Beijing located outside of the second and third rings. The average number of intersections per square kilometer in this area is 14, while in Shanghai, this number is approximately 17. In contrast, Turin, Italy has roughly 150 intersections per square kilometer, a number similar to that of Paris, France. Thus, urban streets in China typically have fewer intersections and are wider than those in other large cities. For example, Chang'an Avenue in Beijing has 10 to 12 lanes, but very few intersections.

As Table 2 [3] shows, the distance between intersections in a

Fig. 1. A typical traffic situation during rush hour in Beijing.

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Table 1
A comparison analysis of street networks in different cities [3].

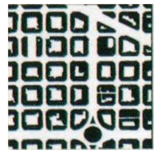
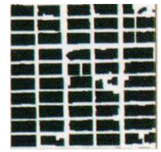
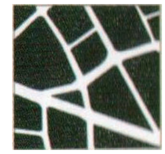
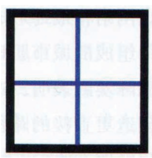
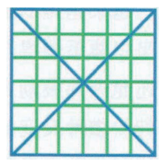
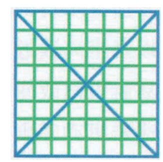
	Turin, Italy	Barcelona, Spain	Paris, France	Pudong, Shanghai, China	Beijing New Area, China
Urban street network					
Number of intersections per square kilometer	152	103	133	17	14
Average length between intersections (m)	80	130	150	280	400

Table 2
A comparison analysis of new and dense blocks per square kilometer [3].

Venue	New block in Beijing	Medium block	Dense block
	Distance between intersections: 500 m	Distance between intersections: 170 m	Distance between intersections: 130 m
Block type			
Motorized street description	Black line: 10-way motorized street Dark blue line: 6-way motorized street	Light blue line: 4-way motorized street Green line: 2-way motorized street	Light blue line: 4-way motorized street Green line: 2-way motorized street
Street length (by type)	Motorway: 32 000 m Bikeway: 8 000 m Walkway: 8 000 m	Motorway: 39 200 m Bikeway: 29 600 m Walkway: 29 600 m	Motorway: 472 000 m Bikeway: 37 600 m Walkway: 37 600 m
Population density (work + residence)	7 500 persons·km^{-2}	15 000 persons·km^{-2}	20 000 persons·km^{-2}
Street cost	5 514 CNY per person	4 033 CNY per person	3 700 CNY per person

new block in Beijing is 500 m, compared with 130 m in a dense block. Congestion is less persistent in a dense block, since vehicles can move to other roads to avoid it. The total street length varies greatly between different block types: In a dense block, the total motorway is 472 000 m·km^{-2}, while in a block with wide streets and a loose street network, it is only 32 000 m·km^{-2}. This difference explains why congestion is less prone to occur in dense blocks. The population density of a new block in Beijing is 7500 persons·km^{-2}; this number is far lower than that of a dense block, which is 20 000 persons·km^{-2}. Thus, a dense block has a greater population tolerance, which is related to the fact that the urban street cost per capita in a dense block is far less than that of a loose block. To sum up, if the issue of urban traffic congestion is not solved by city planning, it cannot be resolved from the root by only controlling transport and vehicles.

Using intelligent logistics management. China has a huge logistics capability. Logistics costs have increased dramatically with an average annual logistics growth rate of over 12% (as shown in Fig. 2), generating a large quantity of exhaust emissions. In addition, logistics costs in China are extremely high, making up 18% of the annual GDP and 20%–40% of sales; in Europe and the US, the respective percentages are 10% and 10%–15%.

Research reveals that freight vehicles contribute 76% of the particulate matter and 36% of the carbon monoxide produced by all vehicles. According to statistics, 40% of trucks on roads are unladed and there is an average 72 h waiting time for the next loading of a truck in China. Therefore, the average daily mileage of a truck is only 300 km in China, compared with 1000 km in the US, indicating low transport efficiency in China [4,5]. To tackle these problems, the China Transfar Group takes an active part in intelligent logistics, from both an online and offline perspective. For online logistics, the group has created a logistics information platform; for offline logistics, Transfar has built a logistics transfer center. After a period of development, more than 2 million of the approximately 12 million commercial

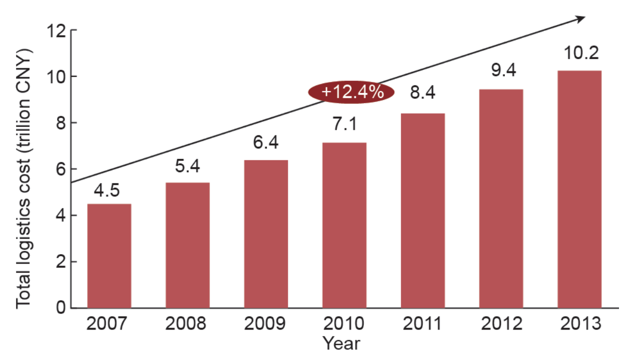


Fig. 2. Total logistics cost in China from 2007 to 2013 in trillion CNY, with an average logistics growth rate of 12.4%.

freight trucks in China (16.6%) are now included in Transfar's logistics information system, which possesses the functions of freight matching, capacity scheduling, and real-time monitoring nationwide. Transfar also constructs logistics handling and transferring centers, centralizing goods-to-truck and truck-to-truck handovers, as well as providing various service facilities in 68 hub cities across China. By these means, the sorting time has decreased from 72 h to 9 h, and the number of unladed trucks has also decreased significantly. Transportation costs decreased by an average of 40%. These results show that information technology can play a huge part in logistics and relevant discharge reduction.

Using intelligent traffic management. common traffic management practices in many countries involve traffic information display and the Internet of vehicles. Researchers in China, however, have a new idea, based on the increasing popularity of electric bicycles here. Compared to cars, electric bicycles have many unique advantages in urban transportation.

As shown in Table 3, electric bicycles occupy about one-