Urban traffic congestion in China: causes and countermeasures

Liu Zhiyan, Yue Xiaoyan, Zhao Rui, Zhang Ying*

Based on the analysis of the current situation and causes of urban traffic congestion in China, this paper points out that the rapidly rising gap between demand and supply in transportation, inappropriate urban space arrangement, and inefficient traffic management are the underlying causes of traffic congestion. Drawing on the advanced experience of foreign countries, this paper also offers suggestions for countermeasures against urban traffic congestion in China.

Keywords: urban traffic, traffic congestion, countermeasures

During the course of on-going urbanization and the continuing scale expansion of cities, traffic congestion has become an increasingly prominent problem. This "disease" has threatened the healthy development of Chinese cities. It is even more acute as more Chinese people buy cars. Urban road construction has lagged behind the rapid increase in the total number of privately-owned cars. A certain amount of traffic congestion occurs everywhere, be it first-tier, second-tier, or third-tier cities. It causes inconvenience to people's lives and increases cities' operating costs. Comprehensive studies and analysis are needed to find effective countermeasures against traffic congestion.

1. Current situation of traffic congestion

China is now entering a new phase in which its cities are improving road conditions for its people. As more Chinese families buy private cars, it is inevitable that traffic congestion will occur as long as China does not improve its transportation infrastructure. Traffic congestion mainly occurs in the following forms.

1.1. Ever-increasing congestion areas

In China, the definitions of congestion junctions and congestion sections are as follows: "a

* Liu Zhiyan (Corresponding Author, email:citycen@163.com), Professor, Institute for Urban and Environmental Studies, Chinese Academy of Social Sciences, Beijing, China; Yue Xiaoyan, Postdoctoral Researcher, Institute for Urban and Environmental Studies, Chinese Academy of Social Sciences, Beijing, China; Zhao Rui, Graduate Student, Institute for Urban and Environmental Studies, Chinese Academy of Social Sciences, Beijing, China; Zhang Ying, Postdoctoral Researcher, Institute for Urban and Environmental Studies, Chinese Academy of Social Sciences, Beijing, China.

congestion junction is a road junction that has no traffic lights in control, where vehicles are not moving and the queue is longer than 250m, or a road junction that has traffic lights where vehicles fail to pass through after three green lights; a congestion section is a road section where vehicles are not moving and the queue is longer than 1km." Judged by these definitions, 2/3 of the 655 Chinese cities suffer from traffic congestion during rush hours, and the phenomenon is spreading to second-tier and third-tier cities.

1.2. Ever-increasing travel time

Traffic congestion increases travel time. According to "2010 China's New Urbanization Report," Beijing ranks first among the top 50 cities in terms of average commute time (52 min). Guangzhou comes in second (48 min), Shanghai in third (47 min), and Shenzhen in fourth (46 min).

1.3. Ever-increasing economic costs

In addition to causing delays, traffic congestion may easily make people agitated and impatient, reduce work efficiency, and even induce more traffic accidents. Meanwhile, traffic congestion is costly. According to Niu (2010), 15 Chinese cities currently have to spend nearly 1 billion *yuan* ($153.8 million) per day on traffic congestion management. Among them, Beijing ranks first with its citizens spending 335.6 *yuan*/m on traffic congestion. Next come Guangzhou and Shanghai, with the losses standing at 265.9 *yuan*/m and 253.6 *yuan*/m respectively.

1.4. Ever-increasing pollution

Traffic congestion exacerbates air pollution. The research results of the Beijing Municipal Research Institute of Environmental Protection show that if the speed of a car increases from 20km/h to 50km/h, carbon monoxides (CO) and hydrocarbons emitted can be reduced by about 50%. It is thus clear that frequent speed changes during traffic congestion will exacerbate air pollution, thus threatening people's physical health.

2. The causes of traffic congestion

From a macroscopic perspective, the underlying cause is that during the rapid advance of urbanization, road use increases fast while the traffic supply remains limited; from a microscopic perspective, the direct cause is that inefficient traffic management leads to traffic dispersion. The causes are manifested in the following aspects.

2.1. Rapid urbanization widens the gap between supply and demand for transportation

Traffic supply capacity is an integral part of a city's population carrying capacity. It is estimated that in 2010, China's urbanization rate approached 47.5%, and is projected to exceed 50% by 2013. Based on the Logistic Growth Model, China's urbanization rate will reach 57.7% by 2020, and 67.8% by 2030. In a nutshell, China's urbanization rate will increase by an average of about 1 percentage point per year in the next 20 years. After that, the growth of the urbanization rate will slow down. That is to say, in the next 20 years, the urban population in China will increase by about 14 million per year, an increase equivalent to the total population of Beijing. Therefore, it is inevitable that Chinese cities will face more traffic pressure.

2.2. The increase of private cars outpaces the increase of roadways per capita in urban areas

As Chinese cities develop, roadways in urban China are expanded and the traffic conditions are greatly improved. Motorbikes, electric vehicles, and bicycles are rarely seen on the street now. More people are choosing private cars instead of walking. Figure 1 and Figure 2 show that from 1991 to 2008, road areas per capita in urban China increased by 14.7% on average per year. However, during the same period, the number of urban transport vehicles increased even faster, especially that of private cars, which were up by 19.7% per year. For example, in the first half of 2010, the average net increase of motor vehicles in Beijing was 1,900 per day. If the trend continues, by 2015, the number of motor vehicles owned by Beijing's citizens will reach 7 million, and the average speed will be lower than 15 km/h. Such a speed is even lower than current levels during the worst traffic congestion (Guo, 2010). Road conditions would be even worse than that those on July 13th, 2009 when the traffic system in Beijing failed due to a severe rainstorm. In order to mitigate traffic congestion, Beijing introduced a new regulation to restrict the purchase of private cars. In some second-tier cities, private car ownership has also grown dramatically. For example, in

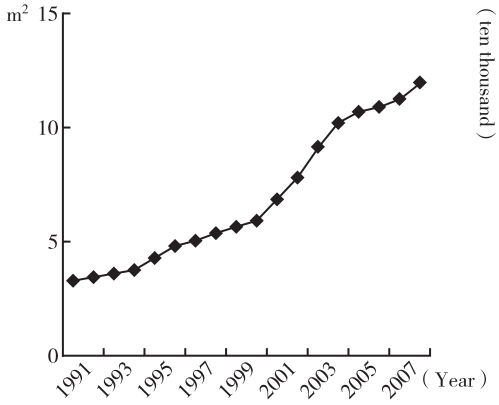

Figure 1. Variation curve for urban road areas per capita

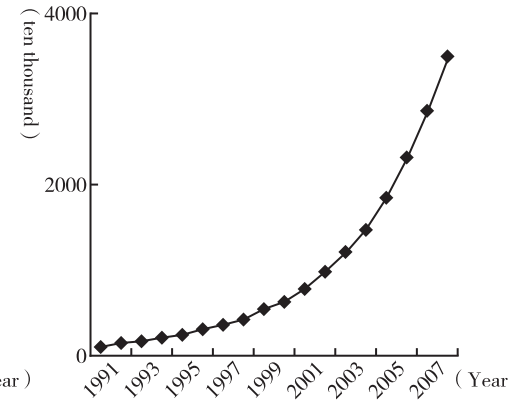

Figure 2. Variation curve for private car ownership

Nanchang, the number of private cars jumped from 17,751 in 2005 to 86,624 in 2009, up by almost 5 fold. It can be concluded that although China has committed itself to urban road construction, urban roadways have not increased rapidly enough to match the speed of motor vehicle ownership. Traffic congestion is therefore becoming more serious.

2.3. Short-sighted and inefficient urban planning aggravates traffic congestion

Due to short-sighted and inefficient urban planning (esp. medium and long term planning), megacities and super cities in China adopt an "Urban Sprawl" model of space arrangement which includes spreading outwards from the suburbs of a city to its outskirts. During this process, due to a shortage of sound infrastructure, the functions of the newly-formed cities are not sufficient. For example, when conducting urban planning, Tian Tongyuan of Beijing considered only the issue of housing and not the employment for its residents. As a result, suburban residents have to go to work in the city every day, making Tian Tongyuan a super-crowded area. It can be said that such kind of "working-and-living-in-separate-places" space arrangement will definitely aggravate traffic congestion. Other urban planning, though systematically sound, strategic and forward-looking, may encounter some problems during enforcement due to the tug-of-war between different stakeholders. Therefore, it is difficult to conduct scientific urban planning.

2.4. Poor design of urban road networks is the direct cause of traffic congestion

The current urban road network features low density and poorly constructed subsidiary and branch roads. The space between main roads is excessively large, and the functions of insufficient branch roads are confusing. Bottleneck roads, dead end roads, and road intersections are the main areas where traffic congestions occur. In addition, when dealing with traffic congestion, China does not efficiently disperse traffic flow between main roads and branch roads, between road nodes, and between different main areas, nor does it have a sound micro-circulatory system. For example, as influenced by traditional thinking, Chinese organizations and communities all set up walls. For them, unfamiliar vehicles are prohibited from entering. As a result, cars are stranded on the streets while traffic lanes within the communities are empty of cars.

2.5. The choice of trip modes is not diverse enough, which exacerbates traffic congestion

Since the 1990s, the amount of urban public transportation has grown in step with the length of road networks (See Figure 3). The average annual growth rate for urban public transport was 35.5%, and that for road networks was 31.1%. Although such improvement has enabled more people to travel in motor vehicles, the speed of public transport has decreased due to its disproportional growth, which offsets the enhancement of efficiency. Since public transport is no longer the optimal choice, passengers have had to find alternative modes of transportation. As a

result, the use of private cars has increased. According to statistics, 1/3 of Beijing citizens choose public transport, another 1/3 choose cars, and the rest choose bicycle or walking. Such a lineup of trip modes is not diverse enough, so the functions of urban roads usually fall into disorder. Thus, in many cities, severe traffic congestion occurs at a definite time or suddenly without any warning.

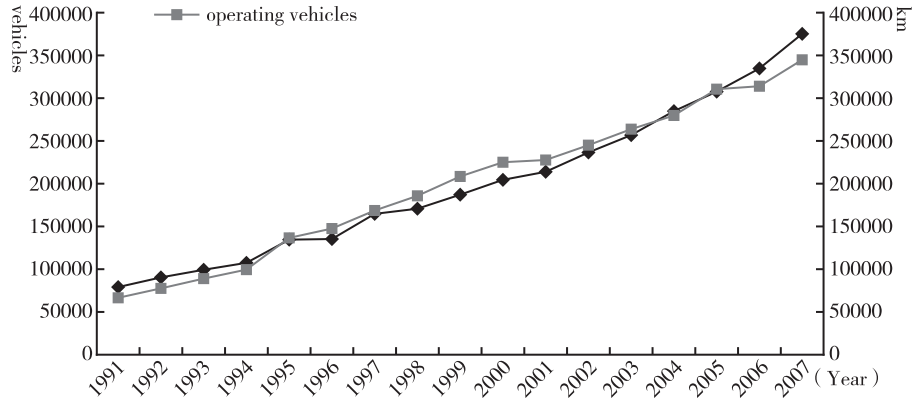

Figure 3. Urban public transportation operating vehicles and length of operating lines

2.6. Relatively lagging urban rail transit fails to effectively disperse traffic flow

Currently in China, subways are mainly concentrated in Beijing, Shanghai, Tianjin, Nanjing, Guangzhou, and Shenzhen (See Figure 4). Other cities in China do not have subways. Those under construction are also located in Beijing, Shanghai, and Guangdong (See Figure 5). Subways in these three cities account for 56.3% of China's total subways. No matter whether completed or still under construction, these rail transit systems are short and insufficient, and are mainly concentrated in Beijing and Shanghai. The limited resources of these rail transit systems cannot sufficiently share the burden of public transport. Such a situation, to a large extent, worsens the scenario of traffic congestion.

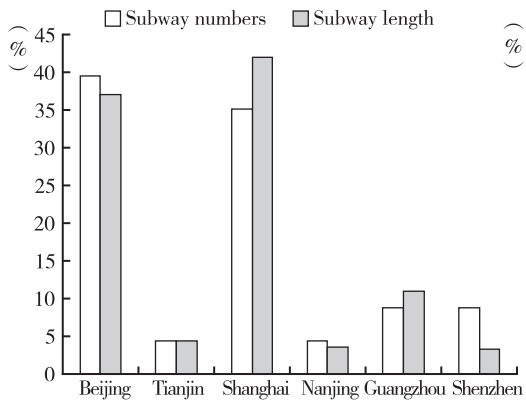

Figure 4. Urban subways completed in 2009

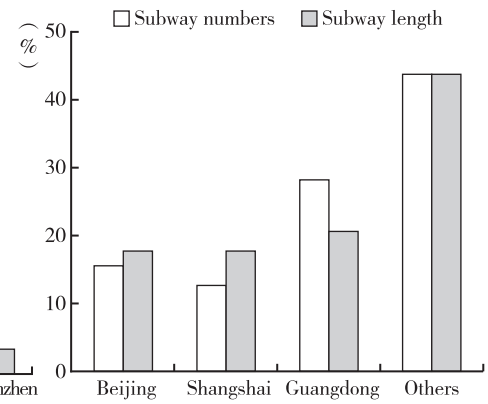

Figure 5. Urban subway under construction in 2009

3. Lessons learned from foreign countries and countermeasures

The relation between urban roads and traffic flow is similar to that between blood vessel and blood. Tackling traffic congestion means utilizing all kinds of mechanisms to regulate traffic flow in order to prevent congestion from occurring. The goal, in essence, to adjust the proportion of various trip modes (cars, public transport, bicycling, and walking), to optimize the spacial arrangement of roads, and to balance urban traffic supply and demand. Therefore, urban traffic flow can resume to smooth conditions and traffic congestion can be relieved.

3.1. Lessons learned from foreign countries

Traffic congestion is a thorny problem of common concern around the world. Although governments around the world have taken various measures to mitigate these issues, the results are not all satisfactory. A comparison between measures taken by different countries shows that, usual countermeasures include the followings: to ensure traffic supply; to manage traffic demand; and to improve urban space arrangement (See Table 1).

Table 1
Lessons learned from foreign countries

Lessons learned from foreign countries	Case study cities
Focus on traffic dispersion, road expansion, improvement of traffic facilities, and construction of three-dimensional traffic systems; in recent decades, commitment to road expansion; focus on the design of road networks, especially the design of branch roads; develope public transport and rail transit on the ground.	Tokyo
Introduce automatic traffic control systems; collect real-time information of traffic conditions through platforms like GPS, mobile phones, cameras, and online resources; publish the information through media like radio and television to road users.	Melbourne, Sydney, and London
For those entering controlled areas during morning peak, traffic jam fees are charged; introduce ERP Electronic Toll Collection System to shorten queuing time.	Singapore
Charge expensive parking fees; raise parking fees to 10 times the amount of those in similar cities.	Tokyo
Impose weekly traffic restrictions based on the last digit of license plate numbers.	Athens, Mexico
On the streets of Manhattan, only those in possession of special license can be allowed to park for loading and boarding; other vehicles are prohibited from parking; whoever breaches this rule must be fined.	New York
Create an ideal combination between urban planning and urban traffic planning; separate footways from motorway; motorways are constructed at different heights.	Brasilia
Optimize urban space arrangement; develop a radial traffic pattern with ring roads; develop polycentric cities; improve city functions.	Paris and Tokyo

Tokyo is the role model in mitigating traffic congestion through regulating the traffic supply. The major advantages of such methods are as follows: widening roads can enhance the traffic capacity of the entire road network; improving the design of road networks can bring

their best functions into full play; and increasing the amount of public transportation can offer more travelling choices to people. These are all necessary elements for a city to tackle traffic congestion.

Singapore, Tokyo, New York, and Athens have all taken various measures to control traffic demand in order to mitigate traffic congestion. Auctioning Certificates of Entitlement, charging traffic jam fees and expensive parking fees are more effective. The major advantage of such a method is that ownership of vehicles and the number of vehicles entering city center are sharply reduced within a short period of time, which forces people to use vehicles less frequently, hence relieving traffic pressure. The major disadvantage of such a method is that it will lead to the formation of "A City of Wealthy Persons." In a sense, such a method deprives middle and low income groups of the right to choose the trip mode they prefer. Some western countries prefer traffic control where they impose weekly traffic restrictions based on the last digit of the license plate number. It is effective because it can reduce traffic flow in a short period of time. However, it may encourage people to buy another car, which increases car ownership.

Tackling traffic congestion by rearranging urban spaces is a method being taken on by Paris, Tokyo, and Brasilia. Optimizing urban space arrangements and improving city functions can decentralize city centers, relieve traffic pressure, and reduce long-term traffic demand. However, it is capital and time intensive.

In conclusion, China can draw on the experience of foreign countries in taking countermeasures against traffic congestion. However, instead of just mimicking other attempts, China should proceed from its specific situation to conduct and implement comprehensive traffic control.

3.2. Countermeasures against traffic congestion

Traffic congestion is the disease of modern cities. It is too complex an issue to be solved completely at this point. Therefore, cities in China must conduct comprehensive management from three aspects: ensuring traffic supply, managing traffic demand, and rearranging urban space. In order to achieve these goals, this paper offers the following propositions.

3.2.1. To improve transport infrastructure such as urban roads, and focus on the design of road networks

Sound transport infrastructure can enhance the transportation capacity of the entire road network, which will lay a solid foundation for preventing and tackling traffic congestion.

First of all, a sound design of road networks must include the construction of rapid arterial traffic with great carrying capacity, integrated interchange stations, and minor routes which link various communities; it must develop traffic channels on, under, and above the ground. Attention should be paid to the design of cross-roads, flyovers, and the diversification of trip modes so as to form a three-dimensional traffic system featuring an optimal distribution of arteries and by-

passes, and an organic combination of above-ground, ground, and underground channels. In recent years, many Chinese cities built up roads rapidly. However, more attention was paid to the construction of trunk roads instead of ensuring that other road facilities match the trunk roads. As a result, various trip modes are concentrated on the trunk roads. The mutual influence and interference leads to traffic jams on the trunk roads.

Besides widening roads, traffic infrastructure such as parking lots, traffic signs, traffic lights, traffic markings, and monitoring facilities also needs constructing. In terms of the construction of parking lots, basic parking lots are needed, while public and "park and ride" parking lots should also be added. Meanwhile, a small parking fee should be charged in order to encourage people to ride public transit. Parking lots should be multi-story because as to enable more utilization of space.

3.2.2. To develop mass public transport, and enhance carrying capacity

Relying only on the expansion of road areas cannot solve traffic congestion effectively. An integrated public transport system comprised of bus and rail transit must be developed.

First of all, increasing mileage is important when building subways and rail transit. However, designing interchange stations must not be ignored. An effectively integrated interchange station can relieve traffic pressure on the ground. The metropolitan cities of developed countries all value the construction of mass rail transit. For example, subway mileage in Tokyo exceeds 320 kilometers. If urban Light Rail Transport (LRT) is included, the total mileage amounts to nearly 2000 kilometers. Tokyo's subway system can meet 86% of the total traffic demand, far more than the 54% carrying capacity of New York and the 35% carrying capacity of London. However, in Beijing, the total mileage of subways and LRT only approaches 336 kilometers, meeting less than 20% of the total traffic demand. Meanwhile, it is time-consuming for commuters to transfer between rail transit and buses in Beijing.

Second, it is imperative to develop BRT (Bus Rapid Transit). As an important part of public transport, the main functions of buses are to serve areas outside the reach of urban rail transit and to link sparsely-populated communities to the rail transit system. Therefore, besides increasing buses and bus lines, relevant authorities should take the development of bus related facilities as priority, set up designated bus lanes and signals, and properly design interchange stations for passengers to transfer between rail modes or within the same mode.

3.2.3. To introduce proper pricing policy, and charge time-of-use and sectional fares for traffic jams and parking

Though convenient and comfortable, cars take up vast amounts of public space, so car users should pay for it at a great cost. Experiences of all countries show that charging expensive road tolls and parking fees reduces road use.

First of all, Chinese cities should raise parking charges by a large margin. In 2008, the per capita GDP of Beijing was $9,075, and the figure for Tokyo was $34,000, 3.75 times the amount

of Beijing. Parking fees in Tokyo were, at the most, $20 per hour, while in Beijing, at its most, parking fees were only 10 *yuan* ($1.5) per hour. That is to say, parking fees in Tokyo was 13 times the amount of that in Beijing. The hard evidence shows that in most Chinese cities, including Beijing, parking fees are relatively low. If relevant authorities want to rely on pricing measures to curb traffic demand, they must raise parking fees by a large margin.

Second, license fees should be charged, and to some extent, adopting other pricing measures such as increasing fuel tax might be effective in easing traffic congestion. For example, Shanghai has been auctioning private car licenses, which has become a form of the most expensive license fees. As a result, car ownership in Shanghai is only at 1.7 million, while that in Beijing has reached 4.6 million. It can be concluded that auctioning private car licenses is indeed an important way that Shanghai has lessened car ownership.

3.2.4. To formulate relevant policies and regulations, modify citizen's travel behaviors, and introduce control measures if necessary

As China's economy grows and the threshold of car ownership falls, car ownership in China has grown dramatically. As a result, space-consuming cars now take up even larger share of traffic volume. If car use cannot be effectively controlled, the only result will be the inability of cities to meet increasing traffic demand.

First of all, Chinese government should introduce the most effective policies and regulations, modify citizen's travel behaviors, advocate a good manner of travelling, and raise people's awareness for honoring traffic laws. If people can change from being forced to avoid traffic violations, human-incurred traffic congestions and traffic accidents will disappear. No matter whether driving or walking on streets, all of us should observe certain rules, or else traffic order cannot be maintained. The occurrence of the current traffic congestions and traffic accidents is largely because drivers and passengers lack traffic safety awareness and do not observe traffic rules.

Second, introducing control measures, such as traffic restrictions, is also necessary. Cities including Athens, Mexico, and St. Paul have all imposed restrictions on the number of days when car use is allowed. Weekly traffic restrictions based on the last digit of license plate numbers have been imposed, which to some extent, eases traffic congestion. In some stipulated areas of certain cities, only cars with permission are allowed to enter. In a nutshell, only a small fraction of cars (those with their owners living in the community) are allowed to enter the community, while thru-traffic is banned from entering. In other countries, people are not allowed to drive a car alone in certain congested areas. People are encouraged to seek car-pooling and ride-sharing strategies by establishing private car clubs and setting up taxi stands in the same direction.

Beijing has implemented traffic restrictions and purchase restrictions, namely, banning cars from entering certain areas based on the last digit of license plate numbers and issuing a monthly lottery to limit the number of license plates to be registered. An assessment report released by the Beijing Transportation Research Center shows that after the implementation

of traffic restrictions, the number of frequently congested road sections has been reduced from 422 to 249, and the mileage has fell from 99 kilometers to 50 kilometers during morning peak. During the evening peak, the number of frequently congested road sections has been reduced from 818 to 555, and the mileage has fell from 177 kilometers to 110 kilometers. During the morning peak, the average speed of vehicles running within the 5th Ring Road is 24.7 km/h, up by 13.3%. During the evening peak, the average speed is 22.3km/h, up by 19.3%. Congestion time within one day is reduced by 5 hours and 15 minutes. Meanwhile, according to the air quality data published by Beijing Municipal Bureau of Environmental Protection, during traffic restrictions, air quality in Beijing generally improves. Daily emissions of motor vehicle pollutants are down by 375 tons. Among them, hydrocarbons, carbon monoxide (CO), nitrogen oxides (NOx), and inhalable particles are reduced by 10%, 10%, 8%, and 8%, respectively. Although there is no report assessing the effect of the purchase restrictions imposed since the beginning of 2011, one can be sure that it must have some effect on easing traffic congestion in the short term.

3.2.5. To introduce policy incentives to encourage green commuting

In addition to pricing policy and control measures, other policy incentives can also be utilized to encourage people to ride public transit. Through replacing cars with inexpensive public transport, and advocating long-distance communication, car use will be sharply reduced.

First of all, the government can subsidize public transport, such as lowering ticket prices of buses and subways. Buses are highly-efficient and environmentally-friendly with lower energy consumption. Lowering ticket prices of buses and subways will make people more willing to choose buses over cars. For example, in 2008, Beijing began to lower the ticket prices of buses and subways, which greatly increase the number of people riding public transit.

Second, the government should control or even reduce the number of official state cars, promote IT application, and encourage telecommuting and flexible office hours so that people from different professions can travel less or choose different time periods for home-to-work travel. Meanwhile, the government can formulate a staggered rush hour plan to stagger the work schedules of state organs, institutions, and enterprises. Such methods can reduce traffic volume by 1/5-1/4 during peak hours and help to form a relatively smooth traffic flow, which will effectively ease traffic pressure.

Finally, China should encourage people to reduce private car use, and shift to green commuting and low-carbon living. When going to work, Japanese people usually take buses instead of cars. Private cars are used primarily for family outings during vacations. Though similar in private car ownership, Beijing and Tokyo differ greatly in terms of people's attitudes towards private car use. The attitudes of people in Tokyo help to form an urban environment of far less traffic pressure than Beijing. At the same time, promoting modern ways of living such as online shopping may also reduce unnecessary trips and excessive use of means of transportation during rush hours.

A city with cars as the dominant trip mode will consume 2.5-4 times the energy per capita than a city where public transport is its dominant trip mode. It is obvious that a city showing excessive reliance on cars will not develop in a sustainable way.

3.2.6. To accelerate the development of an ITS (Intelligent Transport System), and enhance transportation planning and management

Due to the scarcity of land resources, the traffic supply cannot meet the traffic demand. Such discrepancy has become a common concern for all countries in the 20th century. Newly-built traffic facilities will generate more traffic flow, while traffic demand always exceeds traffic supply. Increasing supply does not only mean widening roads or increasing public transport. It should also mean the proper planning and management of urban transportation, effective delivery and use of ITS, and appropriate allocation and utilization of roads and land resources.

Road networks in China's urban areas generally have certain deficiencies. The inappropriate design and arrangement, and the lagging of traffic management leads to the underuse or misuse of land resources. As a result, severe traffic congestion occurs. Ultimately, China should accelerate the development of ITS, improve traffic management, increase the efficiency of land use, and enhance the capacity of delivering an efficient traffic supply. In the 1970s, America was the first country to propose systematic traffic management. Tackling traffic congestion was closely associated with solving energy and environmental issues. At the end of the 20th century, the American government did not build more or better roads. Instead, the government improved its management of existing traffic systems. Now road and traffic authorities of all countries are exploring new measures of traffic management and control, and tapping into the full traffic capacity of existing road networks. The best practice is the wide application of ITS and ongoing technological innovation and improvement. In 2007, Japan introduced ITS, and introduced 17 million ETC (Electronic Toll Collection) devices. The penetration rate of ETC reached 70%. With the help of ETC, traffic congestion at toll stations was completely solved and carbon emissions were down by 40%. However, in China, cities did not apply ITS on a large scale, though conditions exist for cities like Beijing to rely on ITS to collect traffic jam fees and parking charges based on the time-of-use and sections used.

3.2.7. To build polycentric cities with chain-store operations of quality public services, and optimize urban space arrangement

After the industrial revolution, rural populations in advanced countries started to migrate to urban areas. Urban areas became increasingly crowded, which was first manifested in the over-crowdedness of houses. It was solved by building high-rise buildings and geographically extending housing space. Since city centers have strong drawing power, and more employment opportunities and shopping malls, a large number of people living in the outskirts come to the city center for work and shopping, causing traffic congestion. As cars are used as popular means of transportation, urban over-crowdedness, especially traffic over-crowdedness, becomes

increasingly severe. When we entered 1990s, urban over-crowdedness became more complex. It has become a mix of housing, traffic, and environmental over-crowdedness. Traffic over-crowdedness can be seen not only inside a certain city, but also between cities, not only on the streets, but also inside public transit systems. If over-crowdedness continues and hampers traffic movement for a long time, traffic congestion will occur. It is thus evident that traffic congestion is not a problem created solely by the traffic system. It is, to a large extent, a problem caused by inappropriate urban space arrangement.

In order to mitigate traffic congestion, relevant authorities should combine it with overall urban planning, construction, and management so that the trend of over-exploitation and the disorderly sprawl or extension of city centers can be reversed. With the creation of a polycentric city structure, the functions of city centers can be rearranged, travel modes optimized, and traffic pressure mitigated.

It is fair to say that the key measure of tackling traffic congestion is to optimize urban space arrangement and improve the functions of cities. Particularly for China, special attention should be paid to improving urban planning. That is to say, China should minimize the distance between places of residence, employment, schooling, and entertainment, and reduce urban third space so that people can work, go to school, visit a doctor, and go shopping at the nearest place. With the introduction of chain-store operations, schools, hospitals, supermarkets, shopping malls, and recreation areas will be arranged in a balanced manner to avoid unnecessary daily travel. Large cities should build residential areas, basic support facilities, and places of amusement around major industries. Meanwhile, industries with close business ties should be located as near as possible because it is conducive to shortening office-to-office, home-to-work, and work-to-leisure travel distances. Therefore, the growing traffic demand can be curbed by introducing proper urban planning.

Back in the late 19th century, Ebenezer Howard, a famous expert in the field of urban planning, envisaged the establishment of garden cities. He proposed that combining convenient ways of living in urban areas with a sound ecological environment in rural areas, garden cities are the ideal places for people to live. Since then, the philosophy has evolved based on the experience of various urban development, and has led to the formation of many new urban spatial structures, such as satellite cities and metropolis circles. One development mode called TOD (Transit-oriented Development) is, in particular, effective in easing traffic congestion. Its purpose is to build a mixed-use residential or commercial area surrounded by traffic routes and stations. Such a development mode will encourage travelers to take public transport and reduce private car use. Although cities like Beijing, Shanghai, and Guangzhou have realized the advantages of adopting such a development mode, the implementation still takes time.

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