

TOWARDS A SUSTAINABLE URBAN TRAFFIC SITUATION: TRAFFIC CONGESTION AND MEASURES IN MEGA-CITIES

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abstract: With the growth of economy, the car ownership in Beijing is increasing dramatically. As the result, traffic volumes on the road network become larger and larger, traffic congestion, traffic accidents, and pollution become the serious urban problem in Beijing. This paper takes Beijing as an example, on the basis of analysis of congestion mechanism and comparison study, proposed the measures to relieve the traffic congestion.

1. INTRODUCTION

One of the mega-city, the economy of Beijing is growing at a high speed from 1980s. The GNP of the Municipality doubled among 1980 and 1990. In the Municipality's Ten Year Plan (1991-2000), a 5.5% to 6.5% annual increase was targeted. With the growth of economy, the car ownership in Beijing is increasing dramatically. Until 1995, car ownership has arrived 1.3 million. As the result, traffic volumes on the road network become larger and larger, traffic congestion, traffic accidents, low speed and pollution become the serious urban problem of Beijing.

In order to meet the need of traffic demand, Beijing has rapidly upgraded its transport network to cater for the increased growth in vehicles. The Third Road was built, construction on the Fourth Ring Road commenced and plans for a Fifth Ring Road considered. The Second Ring Road was upgraded to form an expressway with no at-grade junctions or crossings. The Third Ring Road is currently completed. However, traffic congestion is still becoming worse, the speeds of buses have even dropped into 10 kilometre per hour during the peak hour. How to create a sustainable urban traffic situation? How to solve the traffic congestion in mega-cities? This is what should be answered in order to keep the continuous growth of Beijing. This paper takes Beijing as an example, on the basis of analysis of congestion mechanism and comparison study, proposed the measures to relieve the traffic congestion in Beijing.

2. URBANLIZATION AND TRAFFIC CONGESTION

The ownership of automobiles and traffic volume in urban road network are increasing rapidly with China's quick economical growth. Specially in large cities, traffic accidents, environmental pollution and traffic congestion have become one of the serious urban problems. It is the bottleneck that influences economical development. Taking Beijing as an example, the traffic jam is becoming more and more serious year after year, the average bus speed is decreasing accordingly. For example, buses experienced a series of change.

During the Fifth-Five planning period, it was 19 km/h, 17km/h in the Sixth-Five planning period, 15km/h in the Seventh-Five planning period, 13km/h in the Eighth-Five planning period. This trend is still continuing in the Ninth- Five planning period.

Not only can the intensifying traffic jam cause great economical loss, but also can paralyse urban functions. The larger traffic delay causes more loss of time; low-speed driving increases fuel fare; More gas-discharge into the atmosphere worsens the environment. Moreover, the traffic jam results in more-traffic accidents that intensify the jam once again, thus urban traffic into a very bad cycling. The Transportation Research Institute of Texas, U.S.A, made a research of 39 cities of America. It is estimated that the annual economical loss is about \$410 billion and 12 largest cities' loss is all over \$10 billion. Comparing the special transportation cost of 1985 and 1980 of Tokyo, Japan, We find an increase of Japanese yen 842 billion with annual cost, which is the result of decreasing daily truck travel length caused by traffic jam. In Japan, the time loss of traffic participants is equal to 123,000 billion yearly.

If we set the driving speed of the Fifth-Five planning period as a standard to calculate the time loss, trolley and bus passengers only incur RMB 79.2 billion with which one hundred kilometre long subway can be built! Totally, a solution to traffic problem is very important to the society, and it is also an essential condition to grantee the continuing of economical development.

3. REASONS TO TRAFFIC CONGESTION

Why the traffic congestion become worse? How to solve the problem of traffic jam in large cities? Totally, Unbalance of traffic demand and supply is the main reason. Figure 1 and Figure 2 show the change of density, length of road with time in Beijing respectively. Figure 3 and Figure 4 show the change of national income and car-ownership with years in Beijing respectively.

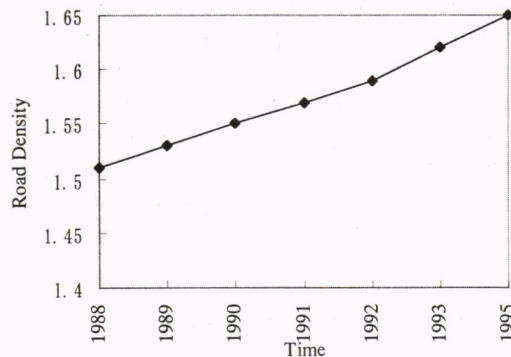


Fig. 1 Change of Road Density with Years

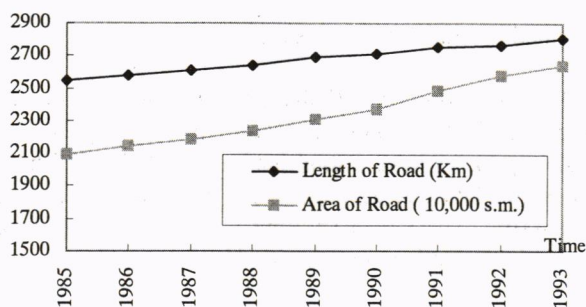


Fig. 2 Change of Road Length with Years

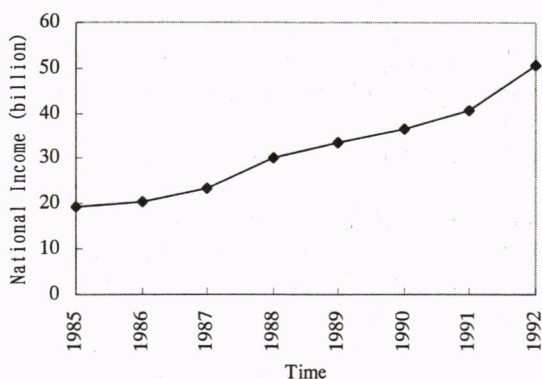


Fig. 3 Change of National Income with Years

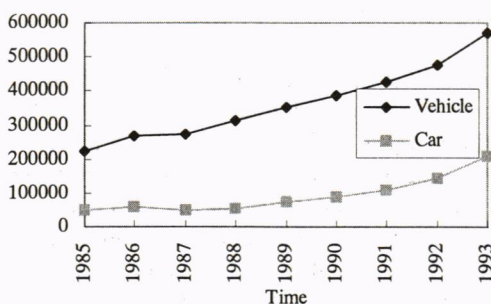


Fig. 4 Change of Car-Ownership with Years

From the Figure 1, 2, 3 and 4, it is very clear that the construction of traffic infrastructure is very slowly, and car-ownership is increasing dramatically in Beijing. As the result, the traffic supply can not meet the requirement of traffic demand increasingly.

Moreover, there are a number of concrete reason that is key reason to cause the traffic congestion in each city. We can realise the main measures to solve the traffic congestion in mega-city by analyse the a few examples below, which are thought-stimulating.

- Capital of developed country Japan' -Tokyo

Tokyo has a 8,160,000 population on 23 districts with the total area of 6178 square km. In this area there are 4,600,000 autos running. The highways are 157-km long road network; Twelve subway routes have a total length of 210.5 km; There are also national and private trains that run into city areas. You can reach almost any place as you desire with the quick-track traffic. The modal splitting is in such a proportion: subway-39.6%, bus-2.8%, private car-16.4%, walk and motor car-41.2%.

Though the subways and road network are highly developed in Tokyo, the city's traffic situation is very serious. The degree of congestion of the most crowded railway sections are below: subway-217, national railway-277, private railway-209. At the morning and evening peak time, commuters cannot get aboard by them selves. The railway has to hire a lot of temporary workers to push the commuters into the trains. With the road traffic, there are 50 main congestion points, the longest queue in Tokyo expresses way can be 9.87 km and the worst situation of congestion could last 17 hours -- almost a whole day.

- Quickly developing country Thailand' capital- Bangkok

The economical growth rate of Bangkok was 8.3% from 1984 to 1993. Thailand is among the most quickly developing countries. With the expanding middle class, car ownership is also increasing. Now, there are 3,400,000 autos in Bangkok, about one car per 2.5 persons. Because of the high traffic volume, driving speed in CBD is decreasing dramatically. The average speed is about 3 km/h, sometimes even 1.2 km/h, and the jam duration can last 1 to 2 hours. Now, the car ownership is increasing at a rate of 400 to 500 vehicles per day. This problem cannot be solved during a long period and is becoming more and more serious. It is reported that the economical loss reached \$40 billion in Thailand each year.

- Rapidly modernizing city-Beijing

By the end of 1995, inside the first highway ring road of Beijing, there are 1070.47 km long roads with the width over 6 m, covering an area of 30.79 km². The road density is 1.65 km/km², and the ratio of using land is 4.74%. Among all the transportation modes, trip by automobiles is developing with a dramatic rate. Automobile ownership is increasing at a 13.8% average rate, including motors and tractors. Now, there have been 1,030,000 motors (including taxi) in this city. The parking capacity supplying 8.5% of all the cars is 3.86 million, among which 47% are on-the-road type. There are many reasons to reduce driving speed (about 15 km/h), such as the scarce road capacity, non-perfect traffic management at intersections, incomplete traffic control and management facility, pedestrians and riders' behaviour of violating traffic regulations, jam caused by traffic accident and illegal parking.

The intensity of land-use in the CBD of Beijing and non-reasonable modal split make the traffic demand increase dramatically. In recent three years, the annual construction area extends 10.8 square km. In the 30 developing zone and industry zone, there is 106 square km planning using land, in which 42 square km is of requisition. This is equal to 56% of the total industry using land from 1949 to 1994. At present, in the urban district, there is 76 square km land area for reconstruction and development. Especially in the redevelopment area, because of its advantageous location and paid use, developer will intensely develop

for the high repay, which must induce the more obvious unbalance relationship between the traffic supply and demand in CBD. Furthermore, the modal split has the trend to be more abnormal, thus the transportation efficiency decrease sequentially. According to the traffic survey data in 1994, It is shown that the taxi, occupying the 29% traffic on the road, only undertakes 6% passenger trips, and the private car, occupying the 48% traffic, also only undertakes 6% passenger trips. That means 77% traffic on the road only undertakes 12% passenger trips.

The Transportation Research Institute of Tsinghua University did an on-site survey at the intersections of Baishiqiao, Xijiekouhuokou, Xijiekou, Xidan. At the morning and evening peak time, the motor queues at many intersections are over 200 meters long; The average delay is about 2 to 3 minutes; The actual saturation traffic volume is about 60% of that of the developed countries.

Analysing these examples, we can deepen our understanding of the factors affecting urban traffic and find the scientific methods to solve these problems. Many factors influence the traffic situation, but they influence it from different side.

Tokyo of Japan has a large track traffic system, perfect bus system, good in-city highways and general road network, why the problem is still so serious? There are several basic reasons: the high population density, intense land use and over-concentrated urban functions.

problem in Bangkok is so serious that it cannot be solved notably over a long time. The main reason is the scarce scientific predictions about the rate and scale of motorization and urban traffic developing strategy based the predictions. The public transportation system suited to the economical situation was not built before the large amount of cars entered families. In other words, the apposite transportation environment did not come into being before the motorization.

There are comprehensive reasons for transportation problem in China. In Beijing, the construction of transportation facilities cannot keep up with the rapidly increasing traffic demand. This long-existing Scarcity results the low supply capacity. The more serious problem is the scarcity of large-volume and quick track traffic system; The traffic participants do not pay much attention to regulations, and have not a modern traffic idea. These three factors make the traffic jam more and more serious.

4. "THREE-LEVEL AND TWO-SIDE" STRATEGY

4.1 The Systematic Method to Solve the Urban Transportation Problem

Many reasons cause the traffic jam, so the situation is a system engineering issue. The "Three-level" is described as follows : (1) By beginning with "Three-level and Two-side", a series of methods can be taken to avoid the problem of low traffic capacity caused by the over-concentrated city entrances and functions, over-use of city business districts. (2)The modal split should be optimised by taking effective measures, which give transit system priority in order to develop a mass and high-speed transportation system. (3) By improving road network capacity, using modern traffic management to make a full use of the existing

traffic facility.

"Two-Side" refers to take measures from both traffic demand and traffic supply. Since 1950's, though most countries took various measures, the jam problem has not well resolved yet. Long-time practice indicates that we must use "Two-Side" method, otherwise, beginning with only one of the two will not do the magic and probably cause the reverse results.

So there are two keys to the traffic problem: one is to consider it from two sides and the other is to take measures at three levels.

4.2 The Mission for Solving Transportation Problems in Beijing

On the worsening traffic situation in Beijing, the following subjects should be emphasised.

- **Harmonising the urban land use planning and transportation planning**

The land resource for road is limited, thus the distribution of large building and large trip sources can not be random and should adapt to the capacity of traffic supply of the surrounding traffic facilities.

- **Improving the road system**

A perfect road system must have the reasonable function structure and adapt to the normal traffic demand. Considering the present road system and traffic conditions, we should predict the transportation development in 5 or 15 years later and the feasibility of capital, then propose the necessary road projects.

- **Adjusting the modal split and promoting the development of transit**

Building subway is the critical way to solve the passenger transportation problem. However, subway can not become a main traffic mode in a short time in Beijing. Thus we should also promote the traditional transit not only in quantity but also in quality.

- **Discussing the method to control the vehicle ownership and traffic account**

There is successful experience of controlling the vehicle ownership to solve the urban transportation problem in Hongkong and Singapore. The method to control the ownership could be discussed thoroughly.

- **Strengthening the traffic management**

The purpose of traffic management here is that how to enhance traffic capacity of the network and ensure the traffic safety, including how to lighten the disturbance to vehicles by the walkers and bicycles, perfecting the traffic signal control system, reducing the non-traffic occupying road phenomena and carrying out some measures such as one-way passing, forbidden passing, transport in different time or at night to use the road more efficiently.

- **Solving the capital problem**

There should be a reasonable relationship between the capital invested on transportation and the whole fixed investment, and a fixed capital source. A deep research should be made to obtain the reasonable ratio and channels.

5. SOME SUGGESTIONS TO SOLVE THE TRANSPORTATION PROBLEMS IN BEIJING

5.1 Promotion of Scientific Decision-Making

The urban traffic must be analysed systematically. If any one of the three levels and two sides is neglected, the problem cannot be solved thoroughly. Even if it is about to consider enhancing road capacity, for example, the reconstruction of intersection, it cannot be concentrated only on the intersection. An analysis about the road network is needed. To avoid such a phenomenon as "a local problem is solved, the jam area as a whole is expanding correspondingly", it is necessary to promote the scientific decision-making in developing country.

At whatever levels we solve the problem, several viable plans must be made out according to transportation planning and traffic economics theories, then compare them and make predictions. Experts shall lead the arguments and evaluation on this basis. The city government set some experts counsel committee from which some members can be selected to form an argument committee which report to the government. Without scientific argument and evaluation, scientific decision-making cannot come into reality. Again the improvement of intersection: which intersection? What measures to take to a concrete intersection? What effects after the measures? All these must be scientifically considered before taking any action.

5.2 Coordination of Urban Planning and Land Use

Considering city capacity limit, while making city design and land use planning is what should be done. On the basis of thorough argumentation, the urban developing axis can be located, city developing mode, business and land function distribution can also be determined at the same time. The city development can be managed, and relation between traffic and land use can be harmonized simultaneously.

There is correlation between traffic and land use. They influence and promote each other. From the transportation planning side, different land use pattern determines the traffic volume of both origination and attraction, traffic distribution and traffic structure to some degree. If the land use is unreasonable or over-developed, the traffic demand cannot be met. On the other hand, the construction of traffic infrastructure can change a urban structure and land use pattern, make the population concentrated in the centre disperse to the surrounding areas. The city business district becomes more concentrated and large. The difference of function between land use becomes more distinct. At the same time, transportation planning and its carrying out can guide a city's development.

5.3 Perfecting Urban Transportation Strategy Planning

A good urban transportation strategy is critical to the traffic problem and also an important guarantee of optimum resource distribution. The proportion and relative priorities among suburb train, subway, expressway network, and road traffic must be considered as a system from two aspects of quantitative analysis and qualitative analysis. The long-term and short-term should be considered as combined, and the short-term measures must be an element of the urban transportation strategy planning and follow up with it.

5.4 Several Imperative Problems

- Suburb railway coming into downtown area

Suburb railway should come into downtown area, and operate with subway as a whole, which is the main transportation mode and successful experience in the world wide. Long-term planing should take them into action.

- Quickening the building of subway

Traffic jam causes a large amount of economical loss. For the benefit of the whole society, subway building must be quickened. A critical problem is how to get the capital. Special research must be done to seek the financial source and propose practicable capital collecting policy. We had better do our best to develop subway.

- Constructing urban expressway network

Before the subways come into a network, urban expressway network, bus-only network should be built. The key work is the network, not just one or two bus-only roads. So the planning of traffic network and the subsequent economic effects must be analyzed as the first step, then determine how to carry out the measures step by step. If feasibility study isn't done well, the investment will be easily wasted and the objective remains unreachable.

- Paying more attention to argumentation of measures to traffic jam

Many reasons cause the traffic jam. Research of a comprehensive measure should be done to enhance the whole network's capacity. The research focuses on the objectives, relative priorities and evaluation of effects. Also some more work must be done to improve the participants' traffic morals. Regulations should be carried out strictly. Traffic management policies should be evaluated by building an evaluation system to analyze their effects during the whole process.

- Creating reasonable bidding system

With the building of market economy system, economy of china becomes more energetic. Under this condition, some department put its own benefit at the first place and may be bring obstacle to scientific decision-making. If a reasonable bidding system can be created, the important projects can be carried out smoothly and fruitfully.

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