

# **SITUATION, CHALLENGES AND STRATEGIES ON TRANSPORTATION OF BEIJING**

Xiaoming Liu

Beijing Municipal Committee of Communications, Beijing, China PR

[liuxiaoming@bjitw.gov.cn](mailto:liuxiaoming@bjitw.gov.cn)

Jinchuan Chen

Beijing Transport Research Center, Beijing, China PR

[chenjc@bjtrc.org.cn](mailto:chenjc@bjtrc.org.cn)

## **ABSTRACT**

This paper describes the challenging situation in Beijing to a sustainable development. Some key aspects of possible solutions to traffic problems are identified based on the review of transport demand characteristics and system operational situations. Finally, the main strategies on transport development are summarized.

Keywords: Transport demand, Traffic problems, Strategy and policy

## **1. CHALLENGING SITUATION INTRODUCTION**

What we usually call the Beijing city mainly means the central urban area of the city, located in the plain southeast to Yanshan Mountains, which is 1,058 square kilometers out of the whole municipal area of 16.8 thousand square kilometers. Just like a typical case of rapid development of economy, Beijing, the capital city of China PR, is now confronted with a challenging situation of transportation caused by modernization, urbanization and motorization.

During the past more than 10 years, the GDP of Beijing has been keeping an annual increasing rate of no less than 10% and at the end of 2006, the GDP per capita met \$ 6,210. Because of the superiority to other cities and regions in China, Beijing city has attracted more and more Chinese people moving into and living there. At the end of year 2006, the population living year-round was 15.81 million, with the number of visitors living shorter than half a year about 400 million. However, at the end of year 2000, the population was only 11.08 million with a visitor number of about 200 million. More and more people living and working in Beijing makes it necessary that more and more offices, houses, shops/markets, hospitals and so on are constructed. During the past five years, there was 137.3 square kilometers urban land, about 13% of the urban area has been exploited, with the total building area of 1.7 billion square meters. The more central area the higher the construction density is. This pattern of land-use and its blooming in such a short time span makes the transportation system operation changing greatly, even day by day.

A sharp increase of ownership and usage of automobiles is the second result of a rapid economy development. Some important numbers are shown in table 1. During the past 10 years, the annual increasing rate of automobile possession is about 15%, and now, about 3 thousand motorized vehicles are given birth every day in Beijing. At the end of

year 2006, the total number of motorized vehicles in Beijing was 2.87 million and that will reach 3.00 million in May, 2007. The more important thing worthy of noting is that nearly all of the new-bought vehicles are private cars. To own a private car is a common family plan now for Beijing citizens and there are about 0.9 percent households now starting to have two private vehicles. No matter to the aspects of infrastructure, policy nor administration, this seems to be unexpected to the city and it is of a challenge great indeed.

Table 1 - Motorized vehicle possession in recent years

Year	2000	2001	2002	2003	2004	2005
Motorized vehicles	151	169.8	189.9	212.4	229.6	258.3
Private vehicles	85.5	101.1	119.5	138.9	154.7	179.8

## 2. BASIC CHARACTERISTICS OF TRANSPORTATION

### 2.1 Supply of facility

For a long time, Beijing takes facility construction as a basic route to supply more and more capabilities for travel demand. During the past more than ten years, the annual investment on transport infrastructure is more than 5% of the total GDP of the same history period. By the end of the year 2006, there have been 4,459 kilometer highway networks in urban area, with an increase of 386 kilometers than the year 2005. Among them, the urban expressway is 334 kilometers. In the year 2006, there were 305 kilometer freeways being constructed and the total rural highway networks reached 20,381 kilometers.

Rail construction becomes the focusing area of government investment in recent years. Now there are 114 kilometers rail routes in Beijing. In 2006 there are another 114 kilometers rail routes being constructed and most of them will operate after the Olympic Games in 2008. However, it can be imagine that before the year 2015, rail system can not be the backbone system of public transportation. Now the bus system is the mainstream of public transportation in Beijing and will be before 2015. The government invests greatly on bus system every year to start new bus routes, change new bus vehicles, establish intelligent bus dispatch devices and so on. At the end of 2006, there were more than 500 bus routes and nearly 20 thousands bus vehicles. Everyday, about 10 million passengers ride buses all around the city.

### 2.2 Travel demand

In the year 2005, there was the 3<sup>rd</sup> Person Daily Travel Survey by means of Household Interview carried out in Beijing [1]. Here are some results and conclusions from that survey.

With the expansion of population, the total daily trips made by citizens are about 26 million which were 23 million in 2000. On the other hand, with the sprawl of the urban area, the average trip length is 9.3 kilometers which was 8.0 kilometers in 2000. Moreover, car usage is more and more popular now in Beijing everyday life because with the improve of

income level people now like purchasing their own cars to use everyday and to go around further and further. It is 29.8% of the total daily trips that are implemented by cars, which was 23.2% in 2000 and only 5.0% in 1986. The average trip length of 14 kilometers and the average time usage of 39.8 minutes make it more convenient for cars than buses and metros. Normally, the average trip length of bus or metro is shorter than car, but on the contrary, the average time usage is longer. As a result, even though the government invested so much on public transportation system, the market share of public transportation on total daily trips is up to 29.8% in 2005, the same level of car with a very difficulty.

Work and school is still the top trip purpose of daily trips, which is 47.5% in 2005 with a decrease of 10.3% to that of 2000 and 26.0% to that of 1986. People spare more trips to enjoy their daily lives because the ratio of private purpose is 48.3% which was only 20.8% in 1986 and 30.3% in 2000.

## 2.3 System Operation

### *Traffic flow*

From 2000, the volume/capacity ratio (v/c) has kept nearly the same level of about 0.9 on the main street network. The urban expressways and primary streets are still backbone corridors operate most of peak hour traffic flow. The volume of the second ring road and the fourth ring road in peak hour are all more than 16 million vehicles per hour, with three lanes in one direction. On the fifth ring road which is located around the outer part of the urban area, there has a increase of 40% of the annual average daily traffic than 2005, especially 80% in the north part. As a response to the urban sprawl, the radiating freeways suffers more and more heavy traffic burden in peak hour. The annual increasing rate of volume in peak hour is from 20% to 40%.

### *Speed and journey time*

However, since the ability of self-adjustment by the system, the peak hour travel speed and journey time keeps unchanged. Speed on main network in peak hour about from 20 kilometers per hour to 30 kilometers per hour. The journey time of bus and car increases 6 minutes and 3 minutes respectively and that of bicycle and walk keeps the same compared with 2000.

## **3. INSIGHTS ON TRAFFIC PROBLEMS**

Here, we don't mention the common problems of transportation system such as congestion, pollution, safety and so on, even though congestion is the most basic one among them. Instead, what we concern about is the causing elements because problems are phenomenon and it is the causes of problems that give us objectives and ideas of solving them.

Firstly, Beijing is of a long-history city with great high residential density. It has a very core area namely the relic-city area of more than 60 square kilometers which was the so called Beijing city some thirty years ago. The relic city, now skirted by the second ring road, have the highest residential density and great shops, parliamentary buildings, institutes,

museums, hospitals, theaters, etc. because of the history. It is reported that 37% of the total daily trips going to and from this area because of the land-use pattern. On the other hand, during the city sprawling, the newly developing area circling around the city is mainly of single function of land-use, for instances, just housing or just industry. There lacks of high qualified hospitals, schools, museums and libraries in these newly developing area. All of the above makes it into reality that everyday the radiating traffic is very heavy and is of tiding pattern, just like the figure 1 shows as an example in AM peak hours.



Figure 1 - An example of tiding traffic in Beijing

Secondly, as mentioned above, car is more and more popular in Beijing's everyday life and one thousand a day is a surprising speed of increasing. Besides that the length and numbers of car trips are increasing, the occupancy rate of car trips is decreasing, from 1.54 persons per car per trip in 2000 to 1.26 persons per car per trip. Moreover, there is no difference in the frequency of trips per car per day between the central part of the city and the outer part. By and large, car using frequently is the main reason why traffic problems come into being because when there were not so many car trips there was little such problems and there were not so many people involved either even the residential density is high too.

Thirdly, the service of public transportation system is relatively poor than cars. There are only 114 kilometers rail routes in Beijing with such a great population. The daily trips carried by rail are less than 5% of the total. Though there are more than 500 bus routes and nearly 20 thousand bus vehicles, some numbers also reveal the poor level of service. In one typical bus trip, one should spend 35% of his journey time on feeder walking, waiting and exchanging. Though the trip length is about 5 kilometers shorter than that of car, the time spent is 27 minutes longer than car. It is important to notice that in peak hours, the compartment of metro/light rail or bus is crowded with traveling people and passengers on the platform are always difficult to get on in a certain time span. The low traveling speed and joggling driving because of traffic congestion is also a common complain on bus.

Fourthly, traffic stream in Beijing is always a so called mixed traffic stream, especially motor vehicles mixed with bicycles because of the large amount of bicycle possession and usage.

Figure 2 is a typical road section in Beijing, either with a physical barrier between bicycle lane and motorway lanes for instance in one direction in figure 2 or not in another direction in figure 2. However, more and more cases are the later type because motor vehicles need broader and broader space to drive. So, not only in intersection but also along street does bicycle traffic disturbs motor vehicle driving and vice versa. The result is when the bicycle traffic volume is heavy enough the road operates inefficiently with threat of instances and even chaos, especially for intersection signalization harmony. There's few control system that can match this requirement.

Finally, there ought to be some other disadvantage factors. Among them are the institutional inconsonance, poor behavior of travelers, lacks of important legislations and so on. However, these are mainly out of the domain of engineering and technology.



Figure 2 - Typical road section in Beijing, lanes for motorway and bicycle

From the above, we can draw conclusions as follows:

- Improvement of traffic conditions should be achieved by considering how to solve the more background problems of city development such as land use, institutional affairs, administration and so on;
- There is little opportunity and space to build more and more roads and streets because of the relics and environment protection;
- Even more money invested on road construction than it really is, it is still difficult to meet the requirements of capability and level of service by these increasing vehicles, mainly by cars;
- To improve the public transport system is an urgent task for Beijing in order to succeed in overcoming the challenges caused by car increasing and finally in raising its strategy of Priority to Public Transport;
- According to the inborn advantages and disadvantages of each transport mode, measures on the limitation of car usage is necessary to alleviate traffic volume and to give prominence to public transport;
- In order to achieve an inhabitable city, solicitude should be given to bicycle and pedestrians. Walking and bicycling are also good assistant mode to public transport.

#### 4. ALTERNATIVES OF FUTURE DEVELOPMENT

Some developing patterns have been considered for Beijing as alternatives to choose. These alternatives vary in the way how we tackle with different transport modes and what a kind of transportation system we want to establish in the future. Generally, these alternatives can be divided in to the following five types [2].

### Type 1: Dependence on cars

For this type of development, no limitations will be given to car and it will develop freely. Because of the rising of living level and the convenient and privacy protection to the driver, cars will be dominant mode of urban transportation. At last, the city will depend mainly on car transport and the city will have to sprawl bigger and bigger and roads needs constructing much more than present. Many cities in developed countries are this type.

### Type 2: Necessary limitation to car for certain area and certain time

Generally, the central areas such as the CBD area, the downtown area, the historic area and so on is the most suitable to take some limitations to car driving. Peak hour is of course the key time period limited to cars. In these special time and area, public transport system should serve at a relatively high level.

### Type 3: Dependence on rail system

Many European cities are this type. The rail system including metro, light rail and city railway usually come in to being much earlier than the boom of car. Even so, car booming also brings difficulties for the city to overcome. Beijing has no condition to do so because the history avoid coming over again.

### Type 4: Dependence on bus system

Theoretically, this is not a thorough type of development but a transitional strategy. With the population becoming great enough and the economy starting a certain level, bus system suffering the same congestion but taking no advantages of convenience and special speed will be defeated by cars. Rail system is always the alternative mode of bus and bus-only lanes always need to build.

### Type 5: Multi-modal system

Different modes have different economical fetch distance and suitable for different level of service requirements. This type of development emphasize on the harmony of transport system and urban land use pattern. For each group of people residents in certain area of the city provide combined service of multi-modal to realize the optimal configuration of resources and the greatest efficiency.

Based on the research of above five types of developing pattern, knowledge can be summarized as that even though a city can choose a certain pattern during certain era, however, once the city has a certain population and covers certain areas, its economy steps up to a certain level and the transportation demand becomes great enough, the multi-modal system will be a best solution.

## **5. STRATEGIES OF BEIJING**

With a view to the developing trends of economy, urbanization and motorization, Beijing should have to take something as its strategies on transportation development in case of

there is nothing can be done for traffic congestion in the future. These strategies are generated from the checkup of our history and present situation, the findings out of our thoughts on problems and the knowledge we learned from other cities' experiences.

### *Supply of facilities*

Even we know already that construction can not clear traffic problems, we still insist on continuing providing more supply of facilities, such as roads, parks, metros and buses etc because the modern life of Beijing is only short time and what we inherit from an agricultural economy can not met the requirements of transport demand of a industrializing society.

In present urban area, more local and living roads will be considered to construct in order to enhance the network overall function and do good to living communities. In the new urban group area, a relatively new network of roads will be constructed and freeways connecting between groups will be nearly finished in 2010. Sufficient traffic signals and signs will be equipped with these roads.

### *Integrated development of urban land-use and transport*

The distribution, density and function allocation of urban land affects traffic operation greatly. A thorough scattered urban pattern will induce more car use in daily life and is conflicted with the natural, historical situation of Beijing. A tough single-center compact city as it is now can not serve too much more population and transport than present. So a group-scattered pattern should be a better one to choose, like what is defined in the master plan of Beijing city. However, besides freeways rail and bus routes are more important in connecting groups each other. To avoid tiding trend of traffic volume, the land-use should be of equilibrium in aspects of function arrangement, density of building and spatial distribution.

The emphasis in the future will be the exploitation of new urban groups rather than the historic Beijing city area. Sufficient transport capabilities connecting the new urban area and the historic one will be provided simultaneously with the land use and among them, public transport such as metro lines and light rails will be one of the important modes. Moreover, an important case of integrated development of land and transport is Transit Oriented Development (TOD) mode. In the future, Beijing will emphasize on the exploitation above /around stations of rail routes instead of a uniform density of buildings all around a city or a district. [3]

### *Priority to public transport*

To give priority to public transport is the mainstream of transport policies, including the priority given to planning of land-use for public transport stations and terminals, priority given to investment on public transport at a level of more than 50% of the total investment on transportation, priority given to right of road to public transport by means of such as bus-only lanes, bus rapid transit routes and dedicated signals.

By 2010, there will be 270 kilometers rail routes operating everyday and by 2015 this number will increase into 561 kilometers and the network of rail system will come into reality

then. Meanwhile new buses with high technologies will be provided. They will bring more comforts to passengers and emit more lower and be much safer. By 2010, there will be 21 thousands bus vehicles, 63% of them with air condition and all of them are of the emission standard of Euro 3. The total length of bus-only lanes will be 450 kilometers in 2010, with a increase of about 300 kilometers than it is now [3].

Besides the facilities and devices, an intellectual dispatching and passenger information system will be constructed at the same time. The skirting area and the suburb area will receive high level of public transport service too.

The aims for public transport are that in 2010, the mode market share will be more than 40% and the total riderships one day will reach about 210 million.

#### *Car usage management [3]*

In order to maneuver transport demand by mean of reducing car driving, there will be a series of suitable policies of TDM to induce the behavior of car users.

- In certain area, cars will be prohibited to enter during certain time period.
- Sometimes, a changeable standard system of parking fees will be established to adjust the car driving demand.
- There will be some tolling gates on the radiating roads in order to shift the tiding car traffic into other modes. High Occupancy Vehicle lanes would be specialized at appropriate time.

However, policies on car driving will be decided to take very seriously in case of objections from the public.

#### *Information system*

Intelligent Transportation System (ITS) brings great opportunity to alleviate traffic problems with high-techs and devices. In the recent future, Beijing will firstly enhance its information system of transportation. To avoid the institutional data isolation, a comprehensive data platform will be constructed for data exchanging and communication. Under the support of this platform, passengers will receive better services of information provision on public transport and road operational conditions and even taxi pick-up.

Information provided omnidirectionally also helps people adjust their travel time and route choice, leading to more effective employ of transport resources. For designers, engineers and decision makers ideas will be wiser with perfect information on system operation than without it. To sum up, ITS will bring a revolution to traditional transport technology and will establish milestones of fighting traffic problems.

#### *Bicycle and walk*

In order to build a livable city and to support public transport system, bicycle and walk deserve being noted. The travel environment of bicycles and walkers should be more safe and delightful. The connection between them and other modes should be more smooth and convenient. A series of measures will be taken for guarantee of bicycle storage and



avoid stealing. Some dedicated areas to bicycles and walkers where avoid motor vehicles.

## **REFERENCES**

1. Beijing Transport Research Center, Report on the 3<sup>rd</sup> Person Daily Travel Survey in 2005, 2007
2. Beijing Municipal Government, Beijing Transport Development Outline 2004-2020, 2004
3. Beijing Municipal Committee of Communications, the 11<sup>th</sup> five year plan on transportation, 2006