



Journal of Applied Sciences

ISSN 1812-5654

science
alert

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Study on the Traffic Congestion in Beijing

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Abstract: As the the rapid growth of city economy, a traffic congestion has become a common sight in almost every big city. On the surface, the infrastructure construction is incompatible with the rapid expansion of the city cars. In fact,the root cause lies in the careless and easy style of management of traffic which leads to the low traffic efficiency. This study mainly describes the traffic system, the causes of traffic congestion, discussing on the optimization to the network traffic, thereby reducing traffic congestions.

Key words: Capacity of traffic, flow of traffic, urban diseases, intelligent transportation system

INTRODUCTION

The people living in Beijing have been accustomed to seeing that not only the commuters are packed into metro/bus like sardines in a can, but all the buses are also squashed together in a road like sardines in a tin.

It had been reported by the UK and US news media and well known all over the world that thousands of drivers on the Beijing-Tibet Expressway just outside the Chinese capital had been snared by roadworks ever since 14 August, 2010 and the disruption was expected to last a further month.

On 17 September, 2010, during 17:00-20:00 pm, the congested sections added up to 140 in Beijing urban district, which set a world record of traffic congestion.

How can it happen in Beijing?

Traffic congestions happen whenever the flow of traffic in a road section exceeds the capacity of traffic limit,with the result that large numbers of cars or trucks have to be held up forming a unbearable super queue, each vehicle with a low speed and continuous stops.

Traffic congestions fall into two broad categories according to its probable causes, the periodic congestion and the sudden congestion:

- **Periodic congestion:** it often happens during 7:00-9:00 am or 17:00-20:00 pm because that's the starting/ending-working time for most of enterprise/institution unit in Beijing. It has its time-regularity and is often predictable, what's more important,it can often be controlled by fixing the ballanced starting/ending-working time
- **Sudden congestion:** It often happens without any regularity, fully in a sudden, and it is unpredictable. It often arises from the country's large movement, such as a meeting or a march; or a sudden traffic accident; or a bad weather(raining/snowing/fog/road icing or accumulated water on road)



Fig. 1: Traffic congestion in BEIJING

ANALYSES FOR TRAFFIC CONGESTIONS

And what does it mean that Traffic congestion happens so frequently?

More and more large cities in China are on the brink of a major shortfall in resources and infrastructure capacity, under a problem termed "urban diseases", a new report has warned (Fan, 2007).

However, that's only the superficial reason for traffic congestion of Beijing.

According to the data in Table 1, we find that the data of the area/population/motor vehicles of the city, cannot explain the fact that Beijing's traffic congestion is the most serious problem of all cities listed above.

Due to the rapid growth of the city's economy, the attendant is that the infrastructure construction can not adapt to the rapid expansion of the city cars.

The balance between the traffic demand and the traffic supply is upset. But all those above cannot result in traffic congestions of Beijing.

As the city scale is expanding day-to-day unavoidably, the Road Traffic is coming into being as a bottleneck of the development for the city economy.

Table 1: Gives the parameters of some large cities in the world

2012	Beijing	HongKong	London	Tokyo	Newyork
Area (km ²)	16800	1106	1577	2188	1214
population	2000	700	1500	1300	2000
motor vehicle	500	60	400	800	800

Table 2: Parameters of beijing development

	2008	2009	2010	2011	2012	rate of growth (%)
motor vehicle	300	400	476	497	520	15%
road mileage	19909	20670	21114	21347	21454	3-5%

Discussion for the problems: What on earth is the deep reason for the traffic congestion of Beijing?

In order to make the problem clearly, we had to study some basic items of the road traffic:

In Queueing Theory, a Road Traffic system is a system which a road(or a road section) as a service organ gives its service(being occupied) to the customers(the cars/buses/trucks) constantly with a rule of service like FIFO(First In First Out).

When the speed of any fore-vehicle outstrips the behind-one, the capacity of traffic is infinite. Only if the behind-one changes its route and raises its speed can it outstrip the fore-vehicle.

On the contrary, when the speed of the behind-vehicle outstrips the fore-one and has no other route to choose so as to outstrip the fore-one, a queue is forming.

When the speed of more and more fore-vehicles gets to 0, a traffic congestion may happens.

Ever since then, the drivers involved in the congestion have nothing to do just like a vegetable but to wait in the queue until the congestion is alleviated.

No one would like to afford such a waste of life. In order to keep a high speed of movement, civilized people managed to design a lot of inventions such as dividing a road into many ring roads; driving a vehicle individually in a ring road; overpasses; expressways.

Despite all these talented inventions, congestions occurs all over the world every now and then. There is a variety of items which hinder the vehicle's speed, which can be summed up in two points (Xiao and Yu, 2009).

Intersections analyses: Intersection is an installation connecting many roads. The more intersections are installed in a given road section, the more slowly the vehicle goes by. It is the most important cause of traffic congestion because the flow of each direction shares the road resource at this spot with the flows upset each other. The loss of traffic efficiency by installing an intersection is inevitable and it is the price we have to pay for the traffic democracy. Frankly, the standard of traffic managing at intersections is a very important sign for judging the traffic civility of a city.

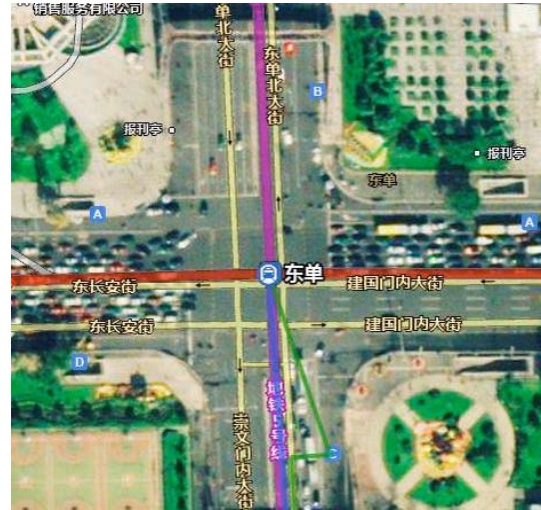


Fig. 2: Dongdan Crossroad

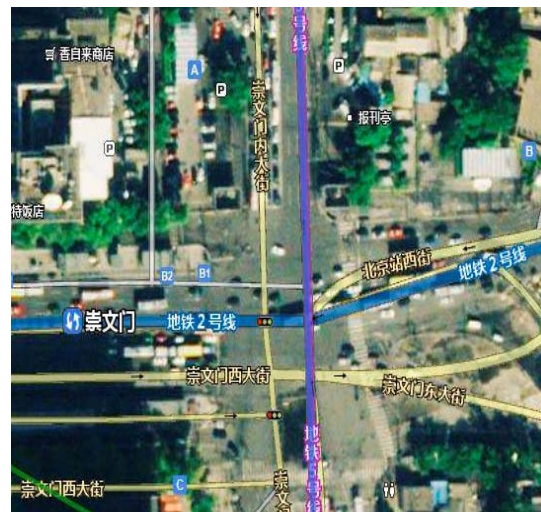


Fig. 3: Chongwenmen star-shaped-crossing

According to its shape, the intersections can be divided into three kinds:

- **T-junction (3-derection):** T-junction is the most simple one because of its simple flow formation of traffic. The flow formation of T's head is made up of the flow of going forth, the flow of turningover and the flow of turning right/left while the flow formation of T's foot is made up of the flow of turningover and the flow of turning right and left. Once the T-junction is congested, it can be alleviated by cutting off the flow of T's foot
- **Crossroad (4-derection):** The crossroad is the most universal one for its great number. The flow

formation of crossroad is made up of the flow of going forth, the flow of turning over and the flow of turning right and left. Once the crossroad is congested, it can be alleviated by cutting off the flow of each direction

- **Star-shaped-crossing (5 or more-direction):** The star-shaped crossing is most easy to be congested on account of its complicated flow formation of each direction. A roundabout should be set up so as to alleviate the congestion of a star-shaped crossing
- **Road state analyses:** As soon as a vehicle gets into a road, its driver has to adapt himself to the dusty world, that is to say, the road state, including the weather, bumps and holes in the road, signal lamps, safety-warning signs, and the states of other vehicles, plays a potential role as to affect the driving speed or traffic congestions

We have to study more about the micro-process of transportation for that each traffic congestion is only a problem in a sector of transportation.

This is the basic unit of the transportation construction.

The circle in the Figure represents a traffic joint that may be a city district or a business center or a overpass or a charging station while the arrow between the joints represents the traffic flow from a joint to another and the short-arrow represents the traffic flow in/out a joint. There are two balances of flow between ins and outs either for a single joint or for a section (two joints), which means the flow of ins equals to that of outs: 2 Ins and 2 outs for a single joint; 3 Ins and 3 outs for a section.

This is a combination section of the former units.

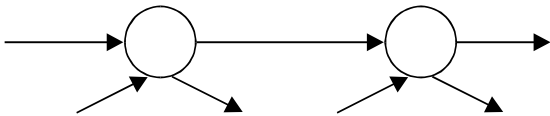


Fig. 4: One Road Unit (3I3O)

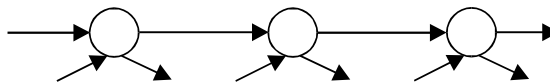


Fig. 5: Two Road Unit (4I4O)

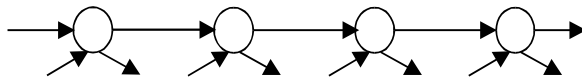


Fig. 6: Three Road Unit (5I5O)

There are two balances of flow between ins and outs either for a single joint or for a section: 2 Ins and 2 outs for a single joint; 4 Ins and 4 outs for a section.

This is another combining section of the former units. There are two balances of flow between ins and outs either for a single joint or for a section: 2 Ins and 2 outs for a single joint; 5 Ins and 5 outs for a section.

Take the first model for example, if there is only one ring road in the road, the vehicle is affected by either the fore one or the behind: If the fore drives too slowly, there is a trend of being outstripped at a risk of being run into, so is for the behind.

But if there are more ring roads in the road, the vehicle is affected not only by the fore one and the behind in the same ring road, but also by the vehicles from the other ring road: It is well known that at least half of the traffic accidents on expressways resulted from the process of changing route and outstripping.

No matter how complicated the road state is, it can be seen as the combination of these three basic units.

Once the accident occurs, soon or later, there may be a following traffic congestion.

About city planning: The city planning belongs to the field of macro-management, being fundamental and foresighted and strategic. And it is well known that anyone could get half the results with twice the effort if he uses tactical ways to compensate for a strategic fault (Shao and He, 2008).

According to an exhausting hard-work in nearly 2 months, we tried to find several shortplanks as follows, in Beijing's traffic management:

- The Road-Net Construction of Beijing develops too slowly to keep in accordance with the increase of vehicles
- Unfortunately, the urban motor vehicle ownership of China is growing at a rate of 15%, while the growth rate of urban road is only 3-5% (Table 2)
- Both the Road Managing Department and the Transportation Managing Department should be responsible for the managing fault
- The public service resources are distributed without a ballance. Many high-quality resources such as schools, hospitals, banks, libraries, cinemas and theaters are far too highly concentrated in the urban center, both violating the principle of public servicing and giving rise to a lot of unnecessary traffic demands. Anyone can see it clearly how many congestions arised from sending/meeting pupils outside the gate of an elementary school

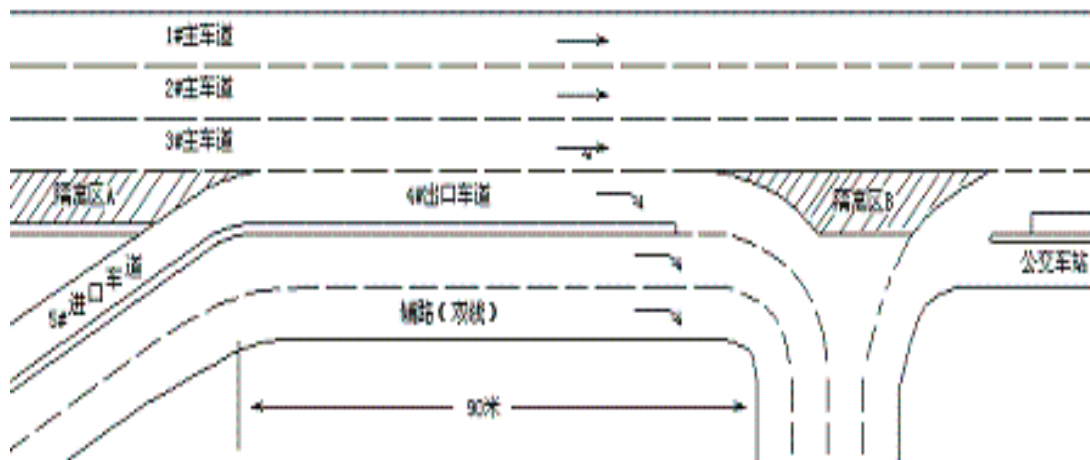


Fig. 7: Road traffic system



Fig. 8: A sight of smart city

- For the lack of parking-lots, more and more cars have to treat the non-motor-vehicle road as a parking-lot with the result that non-motor vehicles have no way to go but to compete with the motor vehicles. There is no surprise why fewer and fewer bikes are seen in the street of urban districts
- The supply of the public traffic resources is not only in-sufficient, also of a bad quality. Anyone would rather to bear the congestion than to be packed as a sardine either in a bus or a metro
- The category of the Grand Transportation is far away from fulfilling. Road transportation develops out of proportion of railway
- Provided that there were a special railway line for coal-transportation between Beijing and mining area of Inner Mongolia, the congestion on Beijing-Tibet Expressway in August 2010 might have been avoidable

- The Urbanization Construction expedites the occurrences of many Great Population Inhabitant Communities, like Tiantongyuan”, ”Huilongguan” and “Tongzhou”... Periodically, millions of commuters who arrive and leave like the migratory birds add frost to snow to the city congested traffic

About intelligent transportation system: "We can't simply build our way out of congestion no matter which city," said Vinodh Swaminathan, IBM's director of intelligent transportation systems, in a statement.

In 2011, detailed Smart City plans were made in the first-tier Chinese cities; so it is with over 80% of the second-tier cities. China is increasing the investment in the Intelligent Transportation System (ITS) and the Smart City (SC)

At present, the investment in ITS is concentrated on urban roads and highways.

With the help of the ITS' Data Collection Devices based on video cameras, sensors and the GPS, there will be no blind area all over a road.

Intelligent Transportation System is a developing trend of Transportation Management in the 21st century. About the Elasticity of Traffic Law:

There is an old saying: "No driver should be punished unless he gets into a traffic accident" in China.

Until recently, a Chinese pop singer, best known for his campus ballads, faces prison after he was caught drunken driving. People came to give zero tolerance to Drunk/Drunken Driving whether the driver gets into a traffic accident or not.

Astonishingly the Chinese Traffic Law shows a much more great elasticity to the evildoers, especially when a congestion happens.

When a congestion occurs, most of drivers drive at ease as if there were no Traffic Law at all, that means, he can overlook all safety-warning signs in the course of changing routes or outstripping.

Presently, four circumstances are very popular: the first is for the large vehicle to get into the inner ring road; the second is for a vehicle to change route through a solid line; the third is for a vehicle to drive on an emergent road; the fourth is for a vehicle to alter or hide the numberplate. (Li, 2007)

The vitality of a law lies in its rigidity instead of its elasticity. And I wonder when such a condition can be changed.

SUMMARY

Traffic congestions come into being as a global difficult problem, which is connected with both the laws and morals, both macrocosmic plan and microcosmic control, both intelligent transportation and the “urban diseases”.

Essentially it is a comprehensive problem of both management and efficiency.

Its difficulty lies in the process of planning, implementing and controlling the efficient flows, services and related information from the starting point to the end of consumption for the purpose of conforming to the customers' requirements in a much smaller logistics' environment.

It is a balance of service efficiency maximization and cost minimization in a queuing theory technically; as well as an improvement of managing-efficiency essentially how to get rid of the traffic congestion.

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