How and Why did TDM Work Well in Beijing, China?

Satoshi NAKAO [a], Kosuke TANAKA [b], Yu CUI[c], Yusuke KANDA [d], Satoshi FUJII [e]

[a~e] *Graduate School of Graduate School of Engineering, Kyoto University University, Kyoto, 615-8540, Japan*
[a] *E-mail: nakao@trans.kuciv.kyoto-u.ac.jp*
[b] *E-mail: tanaka@trans.kuciv.kyoto-u.ac.jp*
[c] *E-mail: sai@trans.kuciv.kyoto-u.ac.jp*
[d] *E-mail: kanda@trans.kuciv.kyoto-u.ac.jp*
[e] *E-mail: fujii@trans.kuciv.kyoto-u.ac.jp*

Abstract: In an economic developing area, traffic congestion is a common and one of the most important issue. Beijing, the capital of China, has been plagued by traffic congestion for many years due to rapid population growth and motorization along economic growth. After 2001 Beijing got certification of Olympics, Beijing tried to relax traffic congestion with hard and soft measure approach and introducing TDM measures. During Olympics period, traffic congestion improved significantly and after Olympics, the situation has kept better. In this study, the authors reveal the effects and the problems associated with the introduction of TDM policy and identify the factors that led to success of TDM measures. As a result, it is found that a large power of a centralized government, introducing packaged TDM measures, and combination of structural and psychological strategy is important.

Keywords: TDM, Social Dilemma, Developing region, Travel Demand

1. INTRODUCTION

As the capital of China, Beijing is a central city in the business, political, and international exchange. In 1992, the socialist market economy as an economic system was introduced in China, and Beijing's economy has grown rapidly. As a result, the population of Beijing and the number of motor vehicles owned is rapidly increasing. In Beijing, over five million new cars have bought in one year, thus traffic congestion, traffic accidents, and severe local air pollution have become severe problems. Especially traffic congestion has become a serious problem for the government and the citizens of Beijing.

July 13, 2001, Beijing won 2008 Summer Olympic bid. At that time, Beijing City government promised improvement of environmental pollution and severe traffic congestion until the 2008 Beijing Olympics. Toward Olympics in 2008, development of public transportation system and infrastructure in Beijing has been greatly and rapidly developed. Additionally the implementation of TDM measures has been discussed actively. Then, during and around 2008 Beijing Olympics, TDM policy such as driving restriction by the odd-even car number plate, flexible working hours, staggered working hours, telecommuting and rental bicycle, were introduced extraordinary and extensively. As a result, the improvement of the environment and traffic was achieved, and their TDM policy was highly evaluated.

Few success examples of TDM policies have been reported which has been applied in developing countries in Asia. So, it seems helpful for cities in developing countries to study why TDM measures made success in Beijing. Also issues and problems, reaction of the

citizens are important information. In this study, we reveal the effects and the problems associated with the introduction of TDM policy. Further, the knowledge obtained in this study will be contributing to the implementation of TDM policy in other emerging cities. In the study of history, analysis to extract important factor from the point of view of psychology and citizens about the political system of China TDM was not observed, it is a major feature of this study in particular. In previous studies, there are little studies that tried to analyze important factors from the point of view of political system and citizens' psychological structure.

This study describes socio-economic situation and history of transportation policy in Beijing in chapter 2, and chapter 3 explains introduction situation of TDM measure of Beijing. Then, chapter 4 analyzes the effectiveness of TDM measures and its important factors in Beijing, considering the theory of social dilemma.

2. SOCIO-ECONOMIC SITUATION AND TRANSPORTATION POLICY HISTORY

2.1 Socio-economic Situation

Severe traffic congestion in Beijing is caused by concentration of population with rapid economic development, the expansion of traffic demand due to the spread of automobiles. Beijing is the capital of China, it is greatly affected by the policies of the central government of China. China was founded in October 1949. China's economy has evolved greatly reform and opening-up policy in 1978. In addition, it grew rapidly since the introduction of socialist market economic policies in 1992. In Beijing, there was a great change on productivity, population, and traffic conditions brought by implementation of reform and opening-up policy and market economic policies as well.

December 1978, the Third Plenary Session of the Central Committee of the Communist Party of China eleventh season will be held, plans to implement the policy of reform and opening-up policy, such as a series of reforms and openness domestic system has been submitted. Since then, economy in China moved onto the stage of market economy. As a result GDP in China grew 7.4 times from CNY 364 billion (US$ 59 billion) in 1978 to CNY 2,700 (US$ 434) in 1992. GRP in Beijing also rapidly grew, from CNY 11 billion (US$ 1.8 billion) in 1978 to CNY 71 (US$ 11.4) in 1992. As well as economic development, the population of Beijing has increased to 11.0 million people in 1992 from 8.7 million people in 1978. The average annual income of Beijing residents was about 5.1 times, From CNY 673 in 1978 (about US$ 108) in 1992 to CNY 3,402 (US$ 547).

In October 1992, the fourteenth Annual Meeting of Chinese Communist Party was held in Beijing, it is the first time in the history of the Chinese Communist Party, the policy that introduce socialist market economic system has been established. From this period, China entered a new stage of economic development. China's GDP has increased 4.1 times from 1992 to 2001, Beijing won Olympic candidate bid. In addition, GDP in Beijing has increased about 5.2 times (CNY 71 billion in 1992 to CNY 370 billion in 2001). Comparing these result, it seems that economy in Beijing have grown rapidly than national economy. Along with that, the urbanization of Beijing was accelerated, Beijing's population increased by 26% (11.0 million in 1992 to 13.9 million in 2001)

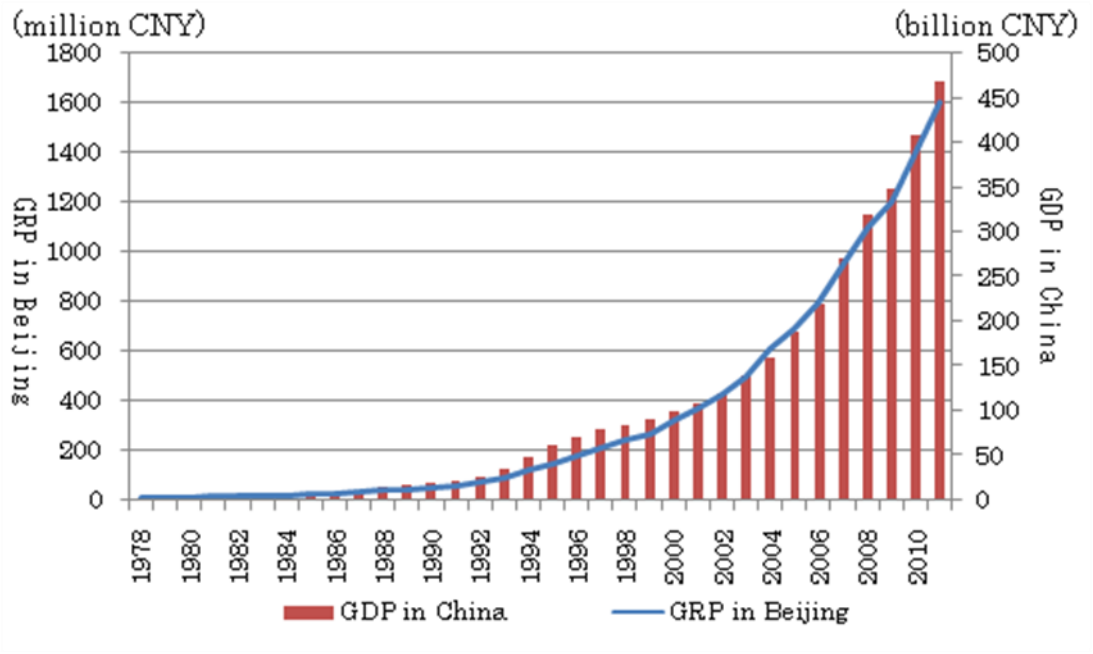

Figure 1. GDP Growth in China and GRP Growth in Beijing

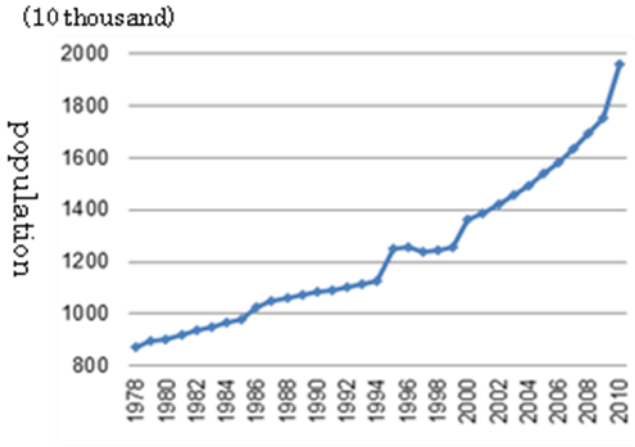

Figure 2. Population in Beijing

July 13, 2001, Beijing was qualified 2008 Summer Olympics. In addition, China became a member of the WTO (Word Trade Organization). China economy had continued high growth. After the collapse of Lehman Brothers, among other Western countries remain low growth, China's economy continued to expand. China has grown to become the world's second largest economy after the United States in 2010. During this period, GDP in Beijing has grown 4.4 times, from CNY 370 million in 2001 to CNY 1.6 trillion in 2011. Accordingly, the population of Beijing has increased 6.34 million people (approximately 50%) from 2001 to 2011. The population of Beijing in 2011 became 20.2 billion.

2.2 History of Transportation Policy

As described above, Beijing has achieved greater economic development due to the open door policy since 1978, a socialist market economic system since 1992, and join WTO since 2001. And population had increased. Thus, travel demand also increased. Beijing had been developing and expanding the transportation infrastructure in order to provide transport

facilities that meet the increasing traffic demand. However, it was not possible to satisfy the ever-increasing traffic demand, Beijing became the city's severe traffic congestion.

In the early 1980s, traffic congestion, traffic accidents, insufficient public transport has become a social problem in Beijing. In the face of this situation, the National Council, the Chinese Communist Party ratify the law "Master plan of Beijing urban construction" in July 1983, and instructed to solve the traffic congestion in Beijing in until 1990.

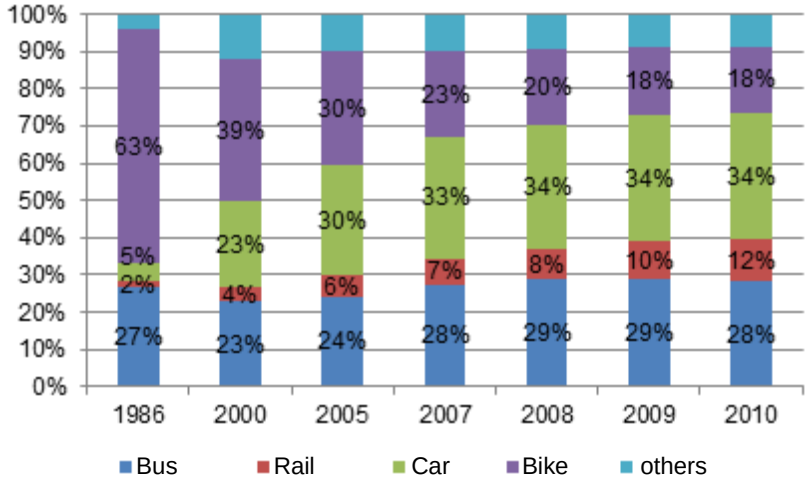

Figure 3. Modal share in Beijing

Figure shows the modal share in Beijing. Share of car in 1986 was just 5%, it was something that only a few people will use. On the other hand, that of bicycle was 63%, it seems that bicycle was an important means of transportation mode in most Beijing citizens' use. At that time in Beijing, with a population of more than 10 million, traffic congestion and traffic accidents caused by cyclists had been a problem. Generally, transportation mode of individuals are from bicycle to motorbike, car, along economic development and traffic congestion problem occurs along this order. However, in Beijing, traffic congestion has become a social problem while in the phase that bicycle is main transportation mode. For this reason, then, along with that of the individual transport mode is shifted into car, further worsening traffic situation has been more concerned.

Liu et al (1985) have suggested to develop infrastructure construction, including public transport as well as introducing of regulation of bicycle and motorcycle use, however, the development of transportation infrastructure, including public transport has not been fully implemented due to lack of infrastructure investment and transportation management skills. Additionally, Beijing did not have enough construction skills and understandings of transportation infrastructure development. Therefore, National and Beijing municipal government, was not enough investment in transport infrastructure in Beijing. Moreover, there were 10 different agencies that has responsible for transportation in Beijing, there are no organization to perform research and analysis, and implement proposed policy from a comprehensive perspective about the transportation and traffic problems of the city of Beijing.

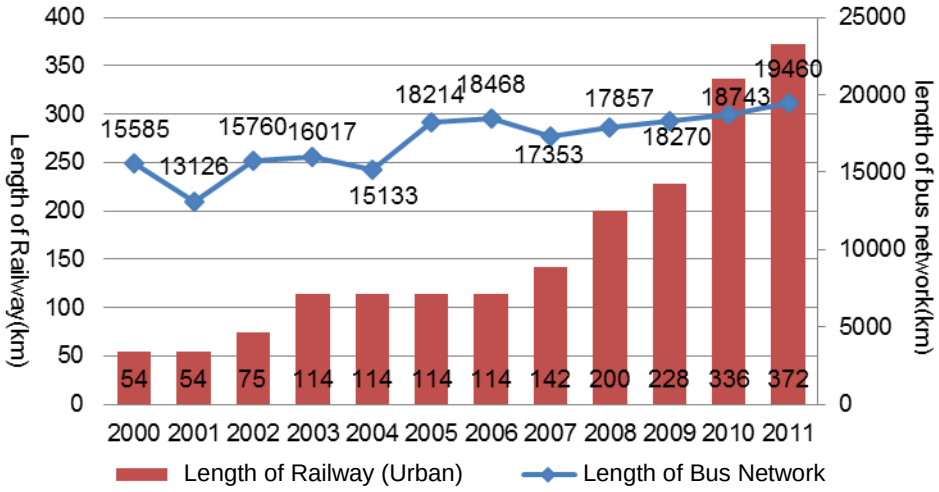

Figure 4. Public transportation Network Length in Beijing

Against this situation, car ownership in Beijing has increased significantly up to 425,000 in 1991 from 130,000 in 1982. In March 1991, the Chinese Government decided to develop automotive industry as a pillar industry of the national economy in "8th Five-Year national economic and social development reform plan (1991-1995)". And it promulgated "Automobile Industry Policy" in 1994, as expressed China's domestic auto industry regarded important on domestic market. Then, the automotive industry has played an important role in promoting the economic growth of the region and an important element to boost the GDP of China. In 2001, the Chinese government submit a policy to promote the automobile industry, then cars began to spread rapidly into individuals. Car sales in Beijing increased 12-fold over the years. Car ownership in Beijing has increased 12 times over 20 years, 425,000 in 1991 to 498,300 in 2011.

(Unit: 10000 cars)

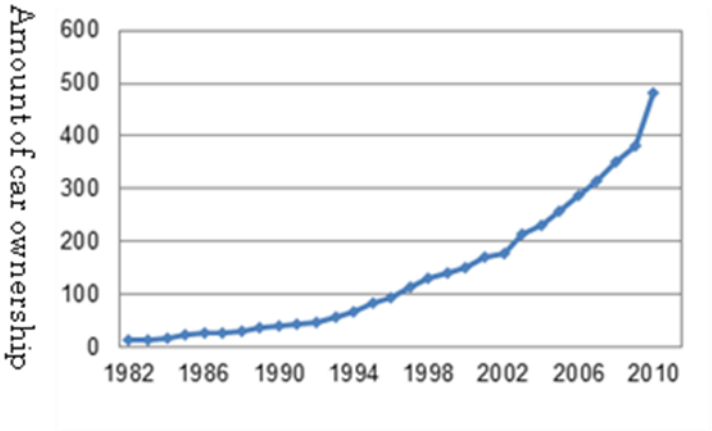

Figure 5. Car ownership in Beijing

On the other hand, road infrastructure in Beijing had greatly developed. In 1993, Beijing Municipal Government decided "Beijing city comprehensive development plan", its target year is 2010. In this plan, it is proposed that sustainable urban infrastructure development should be the highest priority of urban development, and it suggested that Beijing should invest efforts to raise the level of infrastructure development of Beijing in the next 10 years. Based on this plan, CNY 2,969 billion had been spend to invest transport infrastructure in

eleven years between 1993 and 2003. As a result, total road length of Beijing was increased to about 1.7 times, 3,285 km in 1993 to 5444 km in 1993. However, car ownership during the same period increased by about three times, the development of transport infrastructure was not sufficient for rapid increase of traffic demand. Thus, traffic congestion becomes worse, as critics such as being a "Beijing is major traffic jam of the century", Beijing residents began to complain about the traffic congestion. However it was not easy to resolve the traffic congestion problems with quick response due to multiple responsible agencies related to transportation policies in Beijing. Then, in a massive traffic congestion Beijing occurred frequently. It turned to become “Traffic Congestion Era”.

In 2001, Beijing won qualification of 2008 summer Olympics. After that, the China National Government began to develop various kind of infrastructure intensively. In February 2003, under the approval of the National Council of China and the Central Government, Beijing Municipal Transportation Committee was be established. The committee was expected to be responsible for comprehensive management of infrastructure that includes planning new road projects, construction, operations and traffic management. Immediately after the Beijing Municipal Transportation Committee has been established, SARS virus become epidemic in Beijing, it led people in Beijing to refrain from the use of public transportation and promote to use cars. The situation of traffic congestion got worth, some newspaper threw harsh criticism.

On October 18th 2003, Peter Tallberg, member of the International Olympic Committee, said "Solving traffic problems of the city of Beijing is the biggest challenge for preparing Beijing Olympics". Then October 28th 2003, the Beijing Municipal Transportation Commission has announced to invest CNY 180 billion up to the Olympics in order to solve traffic congestion in Beijing. Then, on February 10, 2004 afternoon, the Beijing Municipal Transportation Commission gave a press conference to announce "policy measures" to resolve the traffic congestion. That contained to adjust the spatial arrangement of the city of Beijing, to decentralize the urban functions, and to develop urban public transport network. In order to achieve that, together with measures for the development of a new transportation network, methodology of eliminating traffic congestion began to be explored.

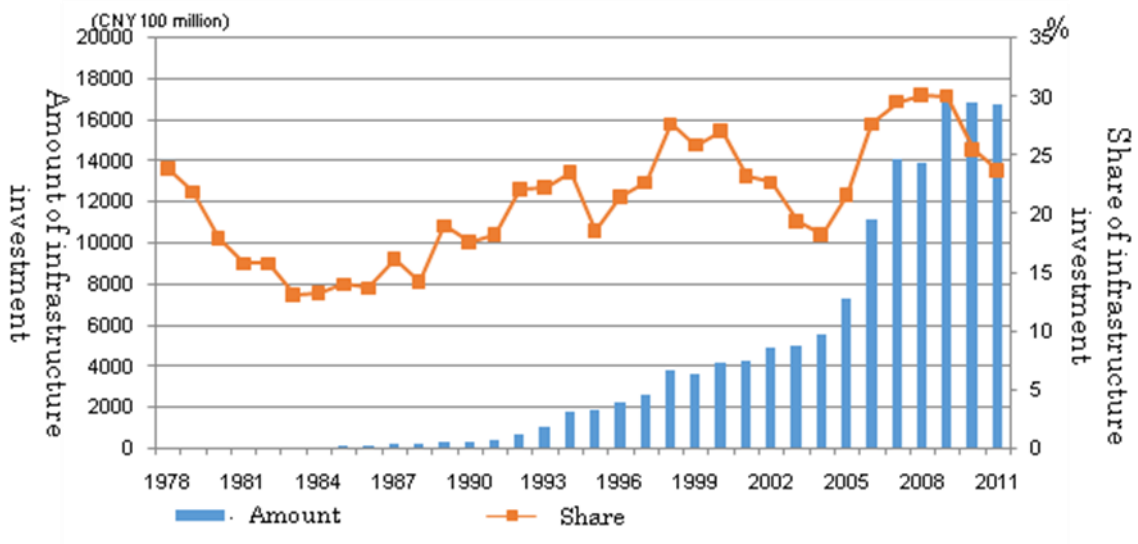

Figure 6. Amount and share of infrastructure investment in Beijing

3. TDM MEASURES IN BEIJING

3.1 Outline

As mentioned above, traffic demand was increased along population growth and spread of the automobile by the economic development in Beijing, and government implemented to develop road network and public transportation. As resource such as fund and land for transportation infrastructure investment was limited. To solve the problem of traffic congestion in Beijing, it is necessary to control travel demand-side management, only the measures on the supply side was limited effects. It was since 1990s that TDM as demand-side measures was researched and studied in China, and discussion of details, implementation, expected effects and feasibility of TDM measures began from around 2001, certified with the 2008 Beijing Summer Olympics (Zhang (2001), Zhou(2003)).

In this chapter, this paper describes to examine the circumstances that TDM measures divided in three period, before Olympics, during Olympics, and After Olympics.

The opportunity to be in 2001, qualified 2008 Summer Olympics in China, the study of TDM is being extensively studied in China. Also, because Beijing was listed as a commitment to improve the environmental pollution and traffic congestion during the Beijing Olympics, Beijing Municipal Government conducted trial measure implementation in 2006 and 2007 to explore the measures TDM that can be applied to Beijing situation.

The first trial was restriction of government car use, approximately 500,000 cars in Beijing during China-Africa Cooperation Forum in November, 2006. The trial was six days. As a result, some effects were observed, for example, average travel speed of during the morning rush hour raised 7.5%. However, the average travel speed of vehicles in urban expressway and ordinary road was 15km / h and 25km / h respectively, it was far to 20km / h and 35km / h that the Olympic Committee requested, and it was found that further regulation was needed.

The second trail was in August 2007, two TDM measures were temporally introduced, odd/even car registration plate restriction and staggered working hours. Odd/even car registration plate restriction allows that in odd day, cars with odd number of the end of car registration plate were allowed to use, and in even day, even number car were allowed. As a result, the average travel speed in the evening rush hours became more than 35km/h. Considering this results, Su et al (2009) pointed out that only a single TDM measure could mitigate the situation rush hour traffic congestion, however it seemed difficult to satisfy the criteria of traffic situation for the 2008 Olympics. And he suggested to introduce packaged TDM measures including odd/even car registration plate restriction, government car use restriction, staggered working hours in governmental office and staggered working hours in department stores and public company.

Other TDM measures that introduced before Olympics were Bicycle rental system. The system was introduced in 2005 by private company, More than 8,000 bicycle had been placed more than 100 stations in the city center of Beijing. The system collected the big topic of the public, and got a good reputation in the Beijing Municipal Government and residents. However the user was less than expected due to the price and lack of convenience.

And also, IC card and discount public transportation fare system have introduced to promote

use of public transportation since January 1, 2007. Public transportation users can obtain fare discount for 60% (80% for students). Consequently, modal share of bus transportation increased up to 28% (4% increase). But many of them are from bicycles, quite few from cars.

In order to ensure a good air and traffic condition, during the Beijing Olympics, based on two trial experiments of earlier, "Beijing transportation plan during the Olympic and Paralympic Games in Beijing in 2008", promulgated by Beijing Municipal Government on June 11 and announced the TDM measures on car use regulation, including odd/even car number restriction during the Olympics. Also, July 12, 2008, during the period of the Olympic Games, in order to reduce the load on the public transport and road traffic, to ensure the means of transportation in the daily lives of residents, Beijing Municipal Government promulgated the "Notice of implementation of staggered work hours during the Olympic and Paralympic Games", it included implementing measures of staggered working hours, telecommuting and flexible working time system. In this period, traffic congestion was relaxed as 'traffic congestion index' shown.

'Traffic congestion index' intends to represent the traffic congestion situation, and was introduced since 2007 in Beijing metropolitan area (Beijing Transportation Research Center (2011)). This index represents share of congested road length by total road length of a section. The index is 0 to 10, higher number indicate severe traffic condition. If there are no congestion, the index is zero, and maximum value of the index is 10 when the share of congested road length is more than 24%. As shown in Figure , the index was significantly improved, especially, the effect of odd/even registration plate is larger, and use of 1.95 million cars per day is limited throughout holding period. In addition, the overall TDM measures during the Olympics, average travelling speed on road network increase 28.5 percent in morning and 24.1% in evening rush hours. As a result, traffic congestion in Beijing was enhanced, air pollution was also improved.

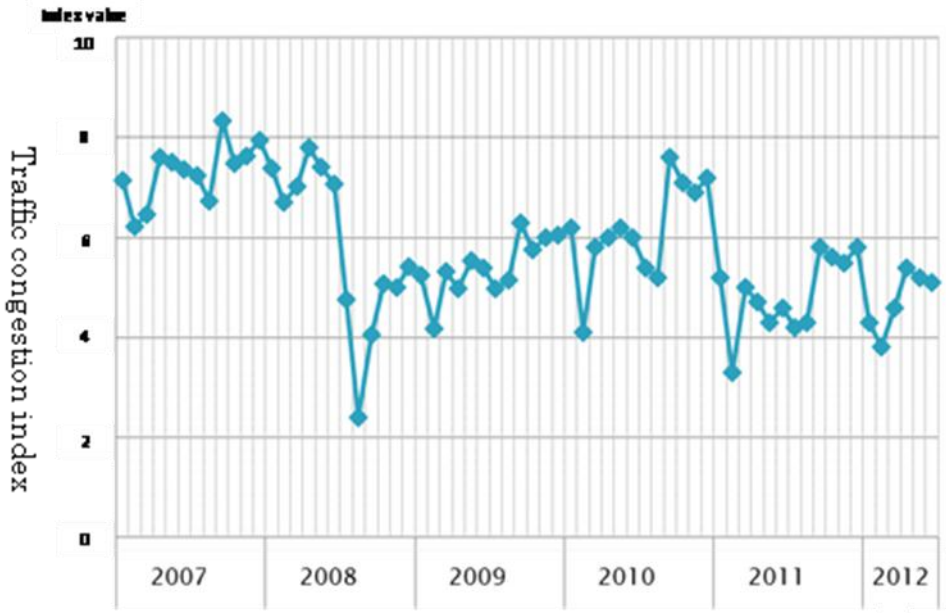

Figure 7. Transition of traffic congestion index in Beijing

With the success of TDM measures in the Beijing Olympic Games, Beijing has even more voices to try to resolve the traffic and environmental problems after the Olympics. And some

TDM measures such as odd/even car registration number regulation, staggered working hours had been continued. However, the restriction of measures were relaxed. During Olympics, the prohibited day was once on two days, but after the Olympics it became one day a week on weekdays.

New TDM measures were introduced. Parking fees control measure that raise parking fees in the daytime has been introduced in the city center of Beijing in April 2010. Fines for illegal parking and car parking fees were almost same, illegal parking soared mainly by commuters, consequently traffic congestion occurs frequently.

After the Olympics, traffic congestion index has deteriorated gradually. In September 17, 2010, traffic congestion index rose to 9.68, which indicates a "severe congestion". Some factors might seem that rapid increase of population, and affordable family bought extra private cars to avoid the influence of car number restriction.

In response to this, Beijing Municipal Government has introduced car purchase restriction measures, up to 20,000 new car licenses in one month since January 2011. Consequently, traffic congestion index significantly decreased. Average daily traffic congestion time has been reduced to 1 hour and 15 minutes from 2 hours 15 minutes in 2010. Before introducing the car purchase restriction measures, it was forecasted that car ownership in Beijing would reach 6 million units in 2011. However this car purchase restriction measures success to extend five years.

However, it is pointed out that as evil, depressed at least 1% GDP growth rate in the first half of 2011 in Beijing. In addition, car purchase restriction measures are carried out in other cities, it prevented the growth of the automobile industry, which accounts for 10 percent of China's GDP. Therefore, as a measure to prevent the development of the automobile industry, the abolition of the request from the automotive industry gets strong. In addition, illegal activities such as eligibility to resell a car purchase also occurred.

3.2 Detail Description of Car Number Regulation Measure

In order to ensure a good air and traffic condition, during the Beijing Olympics, based on two trial experiments of earlier, "Beijing transportation plan during the Olympic and Paralympic Games in Beijing in 2008", promulgated by Beijing Municipal Government on June 11 and announced the TDM measures on car use regulation, including odd/even car number restriction during the Olympics. Contributors to this regulation, the payment of three-month worth car related tax has been waived. On the other hand, CNY 100 worth fine was collected from offenders. With the success of TDM measures at Beijing Olympics, this measures were continued.

In September 2008, Beijing Municipal Government presented "Notice from Government of Beijing about implementation of travel management measures", it included restrictions of one day a week car use as temporary semi-annual implementation. Once a week restriction means all cars are assigned onto five groups considering the end of the license plate number, car owners in each group should not use once a each weekday. By this measure, average travel speed rose 14.7% comparing before introducing this measure, and traffic congestion index also improved to be “light”, which is 5.15, from “medium”, 7.24.

In the February 2009 survey of the Beijing Transportation Committee was conducted, 68.6% of the residents of Beijing supported the implementation of this Measure. However among mass media and residents, something doubt had spread on collecting CNY 100 fine from an uncooperative.

In April 2009, Beijing Municipal Government announced further extension of this temporal measures until April 10, 2010. But restricted area became smaller and restricted hours became shorter. Also there is no longer an incentive for cooperatives but penalty fine for offenders was continued. Some car user complained about this legitimacy for on that was a temporary measure has been further extended but incentive was abolished.

Additionally, Beijing Municipal government extend temporal measures again, until April 10, 2012. Service level of public transportation remained poor, many of car did not use public transportation. Moreover, the price of fine is cheaper than fare of taxi, many people think "paying fine is better than taking taxi", such car user were rapidly increased. Due to this situation, the fine regulation was changed, three hours in one unit to apply penalty. As the government announced that support rate for this measures was 90.4 percent, but according to internet research, the rate was only 14%.

In April 2012, the temporal Car Number Regulation was additionally extended until April 10, 2013, and new penalty that three points would be subtracted from the number of driving license has been introduced. Considering each driver has twelve points in one year, this new penalty is stringent for drivers.

Basically, the car number regulation measures have been implemented to suppress the use of motor vehicles and to encourage the improvement of traffic congestion. However, this car number regulation measure also an increase in the violation as described above, and also occurred the situation to buy the extra car at home with affordable economic capacity.

Why the government decided to extend the "temporal" measures? The reason is rapid increase of car ownership and worse situation of traffic congestion in Beijing. The government considered to abolish this measure when invested transportation infrastructures are sufficiently provided. However, the increase in car ownership was 800,000 in one year, and travel demand of cars would easily expected. If the measure was stopped in such a situation, it could be expected to become more stringent traffic situation in Beijing. Therefore, the government was not able to stop this car use regulation measures.

In Beijing, on September 17, 2010, travel demand still continues to increase, traffic congestion index leads to 9.68, that means severe condition, traffic congestion occurs on 143 points, and congestion duration was over 9 hours. Beijing came to be derided as occurs, the "moving parking lot".

3.3 Detail Description of Parking Charge Regulation Management Measure

Figure 8 shows car ownership and provided parking lots in Beijing. Balance between car ownership and capacity of parking is disproportionate, 3.4 times diverge in 2011. It can be seen that the parking supply in Beijing is very scarce. In addition, there is a considerable number of political, economic, tourist cars come into Beijing, it seems that lack of parking in the city of Beijing is found to be very harsh conditions.

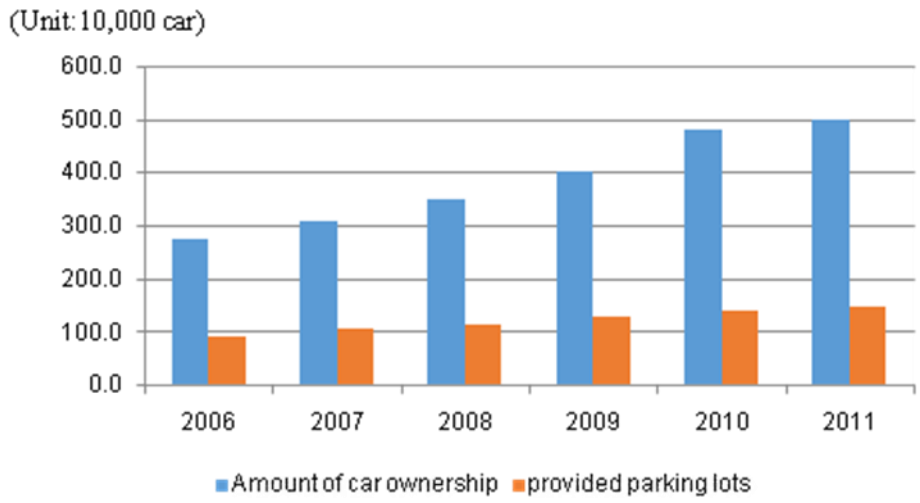

Figure 8. Car ownership and provided parking lots in Beijing

As a cause of severe shortage of parking supply in Beijing, not only the rapid increase in the amount of car ownership in Beijing, the Beijing Municipal Government did not focus on developing parking facilities well. While urbanization in the 1980s, development of parking was not included in the scope of the Beijing government's plan. Parking development within building had been prescribed in the downtown of Beijing, but supply of general parking is not emphasized. As a result, the land should be used as a parking initially, to be used for other purposes, and It began to gradually lose the ability to supply potential of the parking lot.

The number of vehicles owned surged further by policy "automobile industry promotion policy" in 1990s. Problems such as traffic congestion, traffic accidents and obstruction to the passage of emergency vehicles caused by illegal parking become obvious.

Many researchers have suggested for Beijing to face parking problems, to regulate vehicles flowing to the city center with the measures such as standardizing parking charge in downtown and introducing discriminatory parking fee measures. In response to this, Beijing Municipal Price Bureau announced the "Notification for the standardization of Beijing parking charge" in 2002. Its content was to standardize parking charge by area and size of vehicle (small, large).

Parking charge regulation management measure was not realized soon. In 2004, several political organization propose parking charge regulation management measure but not adopted. In January 2008, it was submitted again but failed. The main reason is due to increase of commodity price. At that time, commodity price had been increased continuously, it was afraid that this policy would fear citizens' economic burden worse.

In November 2008, the CPI (consumer price index) drops for the first time that has been rising steadily. In addition, the government announced "Petroleum tax expense reform act" in December 2008, it include to lower the price of gasoline. Moreover, road use fees have been waived.

Then, in April 2009, the Beijing Municipal Government has ratified the "Reduce traffic

congestion policy plan Stage 6 (2009)". In the policy plan, promoting measures of parking charge management to alleviate the traffic congestion problem in Beijing. However, this measure was not implemented again. The reason seemed strong against not only from car users but also from the relevant industries.

February 1, 2010, the Beijing Municipal Development and Reform Commission announced "Notice on changing the standard non-residential parking priority areas Beijing". In its announcement, the government expressed about Parking charge management measures can be introduced in Beijing from April 1, 2010. In this policy, parking charge was calculated in half-hour increments, and when people park more than an hour, and parking charge will be 50% premium.

By this measure, various problems have emerged. The first problem is illegal parking. on-street parking near Hutong (small alley that exist in the old castle Beijing) has increased. In addition, in order to occupy a place in the Hutong street parking, In addition, the situation also occurred to provide parking without permission on public roads, and collecting money. By such problems, a landscape of Hutong was disturbed, the congestion on narrow streets became worth, and hindrance of movement of emergency vehicles such as ambulances occurred frequently. Furthermore, the problems caused by competition for land in the Hutong area occurred many times. Because there was no clear provisions regarding the establishment illegal parking and illegal parking, the government could not crackdown against these illegal activities. And residents of Hutong was frustrated.

The end of 2010, Beijing's traffic situation began to deteriorate rapidly by proliferation of car ownership. In response, Beijing Municipal Government hold a press conference on December 23, 2010, and had announced measures in order to solve the problem of traffic congestion in Beijing. In it, the government announced that it would further adjusted for the parking charge. February 1, 2011, in the "Notice Concerning Change of standard parking fee settlements non-priority areas Beijing", Development and Reform Commission, Beijing has clearly defined target are, the adjustment range, standard parking charge and so on. In this notice, parking charge in downtown Beijing would be increased doubled and expand the price difference with other areas.

4. EFFECIVENESS AND IMPORTANT FACTORS OF TDM POLICYES IN BEIJING

4.1 Effectiveness of TDM Policies

First, as the result of TDM has been introduced in Beijing, brought to consider the effect of easing traffic congestion. Figure 9 shows the traffic congestion index and introduced TDM measures in Beijing. Since Beijing got qualification of 2008 Summer Olympics and Paralympic Games Beijing, TDM measures such as bicycle rental, promotion to use of public transportation have been introduced in 2001. In Olympics period, comprehensive TDM measures are implemented. Then after Olympics, packaged TDM Measures such as car number regulation measure, parking charge regulation management measure, car purchase regulation have introduced. As shown in the graph of Figure 9, especially after 2008, Olympics were hold, traffic congestion index became decrease tendency. On the other hand, as described so far, the number of automobiles is increasing. It can be interpreted that the effect of the TDM measures is being exerted Under this situation that the traffic situation is slightly

maintain even under such circumstances of increasing car ownership. Especially after Olympics period, the government intermittently introduced various kind of TDM measures and improved its details, such measures successfully moderated travel demand.

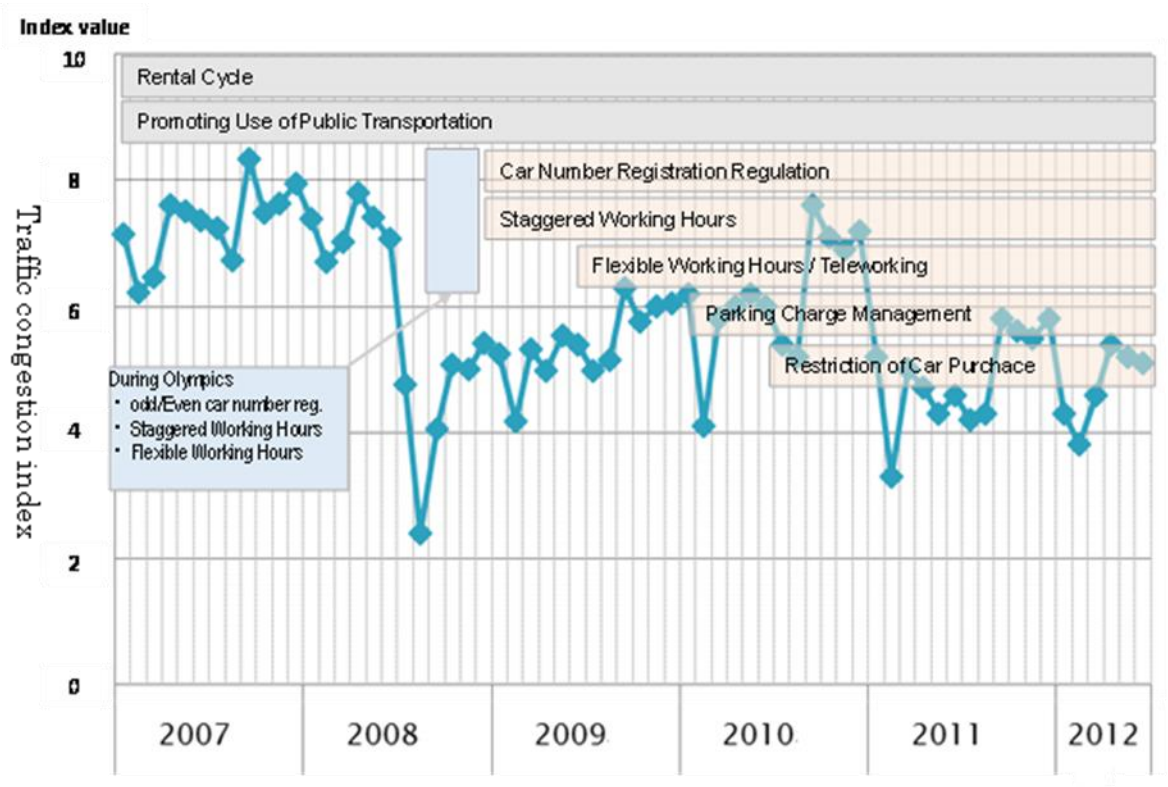

Figure 9. Traffic congestion index and introduced TDM Measures

4.2 Strength of Power of Government

One of the important factors to become success in Beijing is strength of execution of government. In other countries, there are many cases that TDM measures does not work well. As we can guess from there, it is not easy to get success of TDM measures in developing regions. However, it appears that the effects of TDM measures was added to demonstrate in Beijing, that it is because of the strength of the Chinese government's ability to execute is centralized. However, the reason why the TDM measures demonstrated in Beijing provide success, the authors guess it is because of the strength of the centralized Chinese government's execution. In Beijing, the speed of implementation of the government policy was very fast. For example, when congestion has worsened in September 2010, the government has expressed to suppress an increase in the amount of car ownership, and car purchase restriction policy was introduced after just four months later. The Chinese government has been able to implement measures with a significant burden on residents in a short period of time from the occurrence of the problem. As a result, traffic congestion index rose to 9.68 on 17 September 2010, the car purchase restriction policy has been initiated, it has been greatly improved in 2011. Of course, there are some opposition from citizens and mass media while introducing TDM measures, however, the government strongly pressed all the way they have reached an implementation of the measures in the short term. If the government did not have strong force, it seemed impossible to achieve. It should be true that quick and forced introduction of TDM measures as described above is effective to improve

traffic condition in developing regions. From these things, we can realize the importance of a large power of a centralized government.

4.3 Social Dilemma

As other success factors of TDM policy in Beijing, it seems that the indication from a viewpoint of social dilemma theory is important. In the problem involving traffic congestion, the structure of social dilemma lies. Social dilemma is the situation in which each individual must decide to choose the uncooperative act to contribute to improvement of a short-term private profit and however to reduce a long-term public profit, or the cooperative to reduce a short-term private profit and however to contribute to improvement of a long-term profit. Social dilemma is a classic example of the social circumstances seen on not only a traffic problem but also various social phenomenon. On the problem involving traffic congestion, the uncooperative action is considered to be automobile use, and the cooperative action is to be automobile non-use.

In order to escape from this social dilemma, Fujii (2008) pays attention to an external environmental factor and an internal psychological factor, and distinguishes in the following two strategies.

- Structural Strategy
  Structural strategy changes the social structure creating social dilemma. For example, the enactment of law prohibits the uncooperative act, reduce the private profit of the uncooperative act or increase the private profit of the cooperative act.

- Psychological Strategy
  Psychological strategy prompts the spontaneous cooperative act by working on the psychological factor which decides the individual's act. The psychological factors are belief, attitude, ascribed responsibility, trust, moral obligation, conscience etc.

Here the author try to interpret some of the important factors of success of TDM measures considering psychological viewpoint.

4.4 The Multiple Application of the Extensive and Large-scale TDM Policies

In Beijing, large-scale TDM measures which influence broadly was introduced in the Beijing 2008 summer Olympics and afterwards. Their TDM measures were effective in the improvement of traffic congestion, because a traffic congestion index declines sharply at least levels during the Olympics. Then after the Olympics, trending to increase, the index kept below eight.

In particular Parking charge management measure, car number registration regulation measure, car purchase restriction measure are considered to Structural strategy, and the packaged multiple implementation of their TDM measures has a highly effect on improvement of traffic congestion. Thus, Structural strategy solves social dilemma effectively. On the other hand, it is pointed out that it causes a lack of government resources, public non-acceptance and a disappearance of independent motive.

Actually, Structural strategy carried out in Beijing caused various worse influences. Parking charge management measure results in many illegal parking. Under car number registration

measure, some affordable people buy extra cars to reduce the disadvantage on individuals, and consequently, amount of car ownership is promoted. Car purchase restriction policy caused illegal car holdings. As this measures may hinder the development of the automotive industry, automotive industry is also increasingly demand the abolition of the measure. As described above, in this manner, various problems are exposed, the implementation of the TDM measures are considered structural strategy, involves great difficulties in its continuation. Various problems exposed to the implementation of TDM measures as Structural strategy, the great difficulty is accompanied by its continuation.

4.5 Psychological Strategies

However, focusing on during Olympics period, odd/even car number registration regulation measure as Structural strategy, 94.8% of people support the implementation of the measure. Actually people did not use cars as lower traffic congestion index showed.

Why the most of Beijing citizens support such inconvenient TDM measures? It is conceivable that during the Olympic period was just two months short. However it was “just two months”, Beijing citizens should be patient on a little inconvenience. It seems there is a psychological factors that accept TDM measures. Structural Strategies primarily encourage selfishness, on the other hand psychological strategies aims to induce cooperative behavior that encourage the public mind primarily. During the Olympics, there were some newspaper articles that considered the cooperative behavior of the citizens towards the improvement of the congestion. For example, in the People's Daily on July 18, 2008 quoted, "more than 70% of Beijing citizens answered that transportation will play an important role" and "60 percent of car owners answered that the best way to solve traffic congestion during the Olympics is the precise government policy and citizens’ wiser car use”, the newspaper articles reported the promotional activities aimed at improving traffic congestion and a variety of research has been done towards the Olympics and it called for that efforts to improve traffic congestion in Beijing citizens. It is conceivable that, it was able to reach out to take advantage of the public spirit of Olympic events, has led to the social acceptance of TDM measures.

In other words, the public mind here is, can also be thought of as nationalism. By psychological factors that nationalism triggered by the Beijing Olympics is a large event to raise the nation has been activated, Beijing citizens took a cooperative behavior refrain from the use of automobiles and use of public transportation. From the fact that traffic congestion index has been improved and 90% of the people supported the measures TDM, utilize the national class event of the Beijing Olympics, while activating public spirit, TDM measures can be very effective. In South Korea also, 94% of citizens cooperate odd/even car number registration regulation measures at the time of Seoul Olympics in 1998.

4.6 Temporal Structural Change Measures

Regardless after the Olympics, most of the TDM measures have been relaxed or even stopped, it is confirmed that traffic congestion index has remained lower than before the Olympics. Psychological strategies have worked here as well in this period. The effects might come by experience induction effects. Experience induction effects induce cooperative behavior of the non-cooperative person by temporal structural change, and then cognitive belief is corrected by the experience of cooperation behavior, and even after the temporal structural change is completed and environmental structure of behavior returns to its original, cooperative action

is executed continuously (fujii (2003)).

In Beijing, two months period of the Beijing Olympics, powerful TDM measures that combines various kind of TDM measures had been implemented temporary. This opportunity was considered temporal structural change to reduce car use. At this time people had experienced cooperative behavior refrain from car use and experienced to use public transportation, a negative perception towards public transport has been corrected and after the Olympic temporary structural change is completed, they continued to refrain from car use.

Public transportation service level was not sufficient in Beijing, and it might not comfortable to use it. Of course, it is possible to regard temporarily experience may also intensified negative recognition to the further use of public transport. But as traffic congestion index has keep lower value than before Olympics, it is not possible to deny the effects of temporal structural change. Considering the above, it can be seen that the resolution of traffic congestion, as one of social dilemma, it is necessary not only to implement strategies structural that measures TDM, considered enough to the side of the strategy psychological.

5. CONCLUSION

In an economic developing area, traffic congestion is a common and one of the most important issue. Beijing, the capital of China, has been plagued by traffic congestion for many years due to rapid population growth and motorization along economic growth. After 2001 Beijing got certification of Olympics, Beijing tried to relax traffic congestion with hard and soft measure approach and introducing TDM measures. During Olympics period, traffic congestion improved significantly and after Olympics, the situation has kept better. In this study, the authors reveal the effects and the problems associated with the introduction of TDM policy and identify the factors that led to success of TDM measures.

As a result, it is found that a large power of a centralized government, introducing packaged TDM measures, and combination of structural and psychological strategy is important. In this way, without enough consideration to the aspects of psychological strategy, and to implement TDM measures only with Structural Strategies, the problem of social acceptance for these measures is actualized. As shown in Beijing's experiment, combination of TDM measures, for example parking charge management measure, car registration number restriction measures and car purchase restriction measures, the effects on easing traffic congestion would be greater. However, such measures directly interfere freely car use of citizens, so there are much difficulty to implement and continue TDM measures.

Nevertheless such strong TDM measures are implemented for a long time in Beijing, this paper insist that strong power of implementation on the government in China. Notable point of this study is that the strength of the power of a centralized China government has played a very significant role in the success of TDM measures in Beijing.

The result of this study will be helpful for cities in developing countries to study why TDM measures made success in Beijing. Also issues and problems, reaction of the citizens are important information. In this study, we reveal the effects and the problems associated with the introduction of TDM policy. Further, the knowledge obtained in this study will be contributing to the implementation of TDM policy in other emerging cities. Further study is

expected to support the conclusion of this study, by interviewing citizens and drivers, and modeling the relationship among factors.

REFERENCES

Beijing Transportation Research Center (2011): Urban road traffic performance index, Beijing Municipal Administration of Quality and Technology Supervision.

Cleland, F. and Cooper, T. (2003):TDM In Europe: A Synthesis of Research Findings, *Center for Urban Transportation Research*, University of south Florida

Fujii, S. (2001), TDM and Social Dilemmas: The Role of Public Spirits in Solving Transport Problems. *Journal of Japan Society of Civil Engineering*, 667 (IV-50), 41-58. (in Japanese)

JSTE Workshop for Traffic Demand Management. (1999), Pearls of Wisdom for Easing Traffic Congestion. *Japan Society of Traffic Engineers*, Tokyo. (in Japanese)

Liu, K. (1985): On the way to solve traffic problems in Beijing, *Urban Issues*. (in Chinese)

Li Q. *et al* (2003): Behavior modification needs adjustment - oriented the Olympic traffic demand management research, *planning and construction.* (in Chinese)

Ministry of Public Security (2008) Beijing 2008 Olympic and Paralympic Games in Beijing during transport security programs. (in Chinese)

Quarter, J. (2009): Evaluation of the model with the spatial structure of the Beijing urban public traffic satisfaction of Geographical Science, *Acta Geographica Sinica.* (in Chinese)

Suyue, L. *et al* (2009): Beijing traffic demand management strategy based on odd and even number of measures to limit analysis, *traffic information and safety*, 2009 (in Chinese)

Suyue, L. et al (2009): The 2008 Summer Olympics in Beijing during transportation demand management strategy analysis, *The 2009 cross-strait intelligent transport system Symposium* (in Chinese)

Wen, H., Hu, Z. and Sun, J. (2010): Road Traffic Performance Monitoring in Beijing, The 6th Advanced Forum on Transportation of China.

Zhang X. and Wen Z. (2001): The role of transportation demand management solutions to urban transport problems, *Liaoning Police Academy*. (in Chinese)

Zhou H. and Xu J. (2003): Metropolitan transportation Demand Management Research, *Urban planning*, (in Chinese)