Benchmarking Efficiency of Urban Transport Systems in China

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Short bio:
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Summary of paper:
In this paper, the main benchmarks of urban transport system in China were presented by selecting the various performance indicators and comparing with different nations and international cities. The 6 proposals may serve as a strategic framework of promoting sustainable urban transport in China are: 1) Speed up infrastructure construction and improve transport supply capacity; 2) Reinforce public transport capacity and service, while instilling greater competition; 3) Extension of the TDM polices for movements from home to school and work; 4) Ensure pedestrian, cyclist, and other disadvantaged groups' access and security; 5) Encourage energy-efficient urban transport systems using a vehicle fleet of clean, efficient fuel; 6) Reduce the number of deaths and injuries from road accidents, as well as improve safety for all users by improving emergency response capacity. Thus, a reference for decision makers, planners, and operators of urban transport in the national and local level is established.

1. Introduction

With the rapid urban transport development in China, the level of urban transport development and the priority for future urban transport have to be clarified. “Benchmarking” was designed as a tool to provide an important reference for decision makers, planners, and operators, to monitor and evaluate sustainability of urban transport on its quality and efficiency, to improve sustainable transport systems at local, regional, and national levels. This topic is one of the five research themes of China Urban Sustainable Transport Research Centre (CUSTReC) funded by Volvo Research and Educational Foundations (VREF).

2. Main Benchmarks

Initially 35 performance indicators were identified to benchmark the level of urban transport development in Chinese Central Cities. Among them, some of the key indicators were compared to equivalent international cities, such as Tokyo, Seoul, Paris, London, Marseilles, Chicago, Toronto, Amsterdam, etc. These indicators cover safety, accessibility, affordability, energy consumption, and social equality. Later on the studies revealed 10 main benchmarks around the ten aspects including economy, urbanization, motorization, public transport, rail transit, modal split, travel behavior, affordability, energy consumption, and traffic safety.

2.1. Economy

Figure 1 shows respective GDP per capita economic growth among developed and developing nations. From 1985 to 2008, GDP per capita of China increased from $294 to $2520. The GDP per capita growth of China is the highest (see Chart 1), while the overall GDP per capita in china is much less than that of developed countries. If China wants to catch up with these developed nations at current 9.8% growth rates, it will take 22, 15, 30, and 31years respectively to meet South Korea, Poland, Japan, and America’s 2008 Levels. But if we estimate that China’s GDP per capita growth will decrease to approximately 7% only in the following years. 31, 20, 41and 43years respectively will be required to meet South Korea, Poland, Japan, and America’s 2008 Levels.

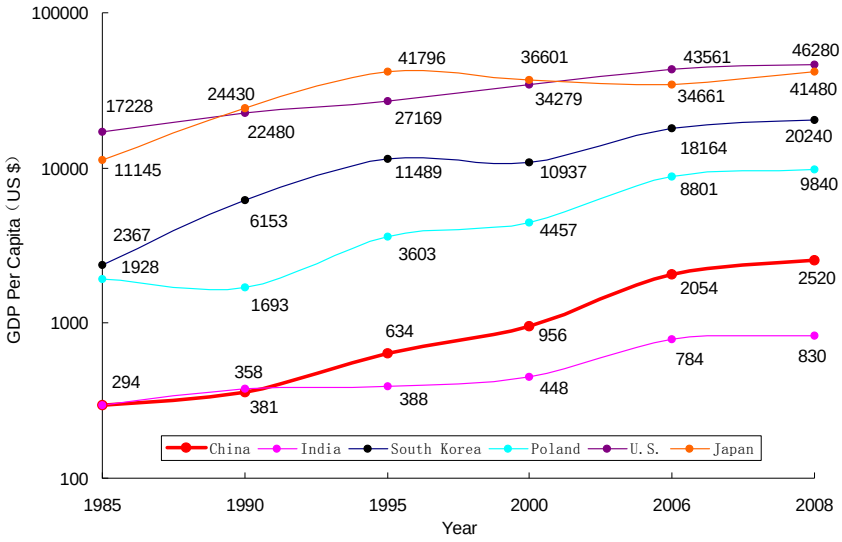

Figure 1. GDP per capita economic growth among developed and developing nations

Chart 1. Comparison of increasing rate in GDP per capita

Country	China	South Korea	Poland	Japan	U.S.
Increasing Rate of GDP per Capita from 1985-2008（%）	9.8	9.8	7.3	5.9	4.4
Number of the years to reach the level of the related country in 2008 by the 9.8% increase rate (year)	–	22	15	30	31
Number of the years to reach the level of the related country in 2008 by the 7% increase rate (year)	–	31	20	41	43

Conclusion:

Benchmark 1: While the GDP per capita growth of China is very high, the overall GDP per capita is much less than that of developed countries, 20-40 years are needed to catch up these countries with the continually growth rate by 9.8% or 7%.

2.2. Urbanization

Figure 2 details the increasing trends towards urbanization in countries around the world. As you can see from this figure, China has experienced a rapid urbanization in just a decade and a half, (nearly doubling in this time period, from 26.4 to 43.9% of the population living in urbanized areas). If we compare china with other countries, the doubling of the urbanization rate from the 20% to 40% took a mere 22 years. In contrast to Britain, France, Germany, America, Russia, and Japan, the doubling period of urbanization took 120, 100, 80, 40, 30, 30 years respectively (see Chart 2). If this trend continues in China, we will expect 57% urbanization rate in 2020 and 70% in 2050 (see Chart 3).Which means that the 2008 level of urbanization in these developed countries will be reached in 2050.

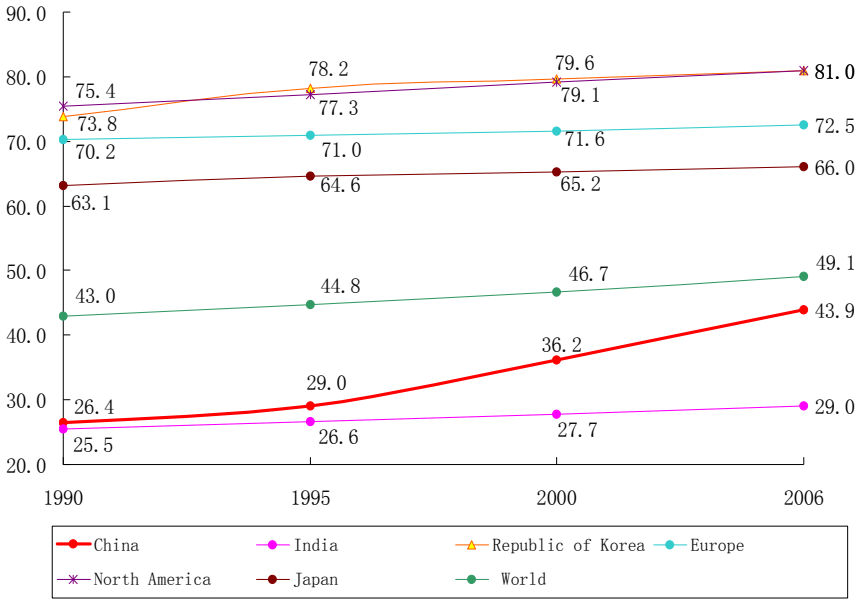

Figure 2. Increasing historic trends of urbanization in different countries

Chart 2. Urbanization rate from the 20% rate to 40% in different countries

Country	Britain	France	Germany	U.S.A.	Former U.S.S.R	Japan	China
Year	1720-1840	1800-1900	1785-1865	1860-1900	1920-1950	1925-1955	1981-2003
Period	120 Years	100 Years	80 Years	40 Years	30 Years	30 Years	22 Years

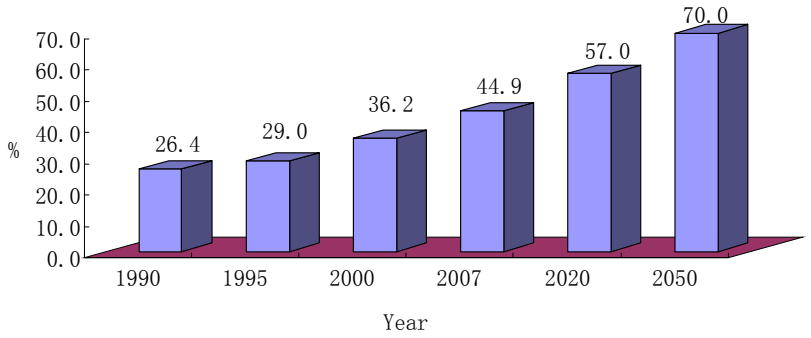

Figure 3. Future urbanization trends in China

Conclusion:

> Benchmark 2: China has experienced rapidest urbanization in just a decade and a half. If this trend continues, we will expect 70% in 2050, which will reach the 2008 level of urbanization in developed countries

2.3. Motorization

Figure 4 monitors respective motorization growth among developed and developing nations. From Chart 3, we will notice the increasing rate of motorization growth from 1985-2006 of different countries. In order to compare these countries with one another, the unit of measurement, number of automobile per thousand people, was established. As you can see, the overall number of automobile per thousand people in China is much less than that of developed countries such as America, France, and Japan. South Korea, however, is an interesting case as it has the highest growth rate of automobiles per thousand people from 1985 to 2000 worldwide. If China wants to catch up with these developed nations at current 10.2% growth rates for automobiles, it will take 27, 29, 33, and 37 years respectively to meet South Korea, Poland, Japan, America, and France's 2006 Levels. However, we estimate that China's annual increasing rate will increase and even follow that of South Korea from 1995 to 2000, as we can see on the graph that China's rate of automobile ownership will continue to follow this increasing trend. If this is the case, then the catch-up period may even be shorter.

Conclusion:

> Benchmark 3: The overall number of automobiles per thousand people in China is still much lower than in developed countries. However, with the continuation of rapid economic development of the past, China will reach these countries within 20 to 30 years.

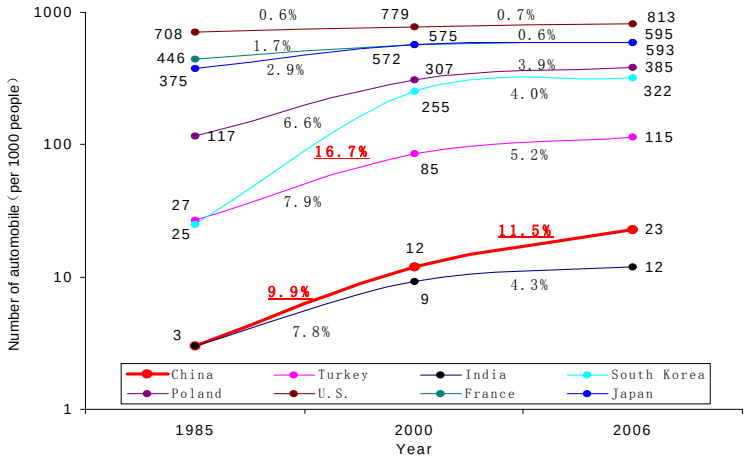

Figure 4. China and the historic trends of motorization in other countries

Chart 3. Comparison of growth rates in motorization

Country	China	South Korea	Poland	Japan	U.S.
Annual Increasing Rate of Number of automobile（per 1000 people）from 1985-2006（%）	10.2	12.9	6.8	2.2	0.7
Number of the years to reach the level of the related country in 2006 by 10.2% increase per year. (year)	–	27	29	33	37
Number of the years to reach the level of the related country in 2006 by 15% increase per year. (year)	–	19	20	23	26

2.4. Public Transport in Cities

Figure 5 shows the share of public transport as a percentage of the total of overall commuter transport. All Chinese central cities with the exception of Beijing fall under 30% target, which is the objective of the government.

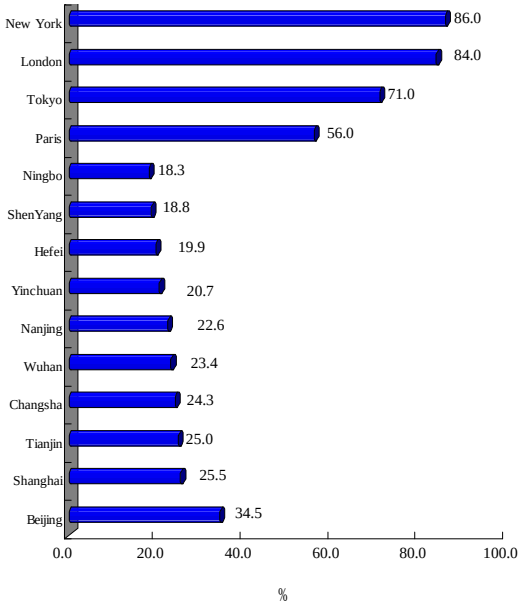

Figure 5. Share of public transport as a total of overall commuting

Conclusion:

> Benchmark 4: Most of the Chinese central cities fall under the 30% share of public transport as the targeted objective by the government. Even 30% objective benchmarks is low in comparison to overall share of public transport in other international cities, such as New York 86%, London 84%, Tokyo 71%, Paris 56%.

2.5. Rail Transit Share

An interested finding is that most of the selected international cities have a high share of rail transit. All have 60% or greater share of rail transit in public transport, see figure 6. One of the main reasons for such a low percentage of rail transit in public transit is due to the fact that central cities in China have much fewer rail kilometers per cities. But the main issue has less to do with actual distance of railway and instead is due to fewer kilometers per one million people in these Chinese cities.

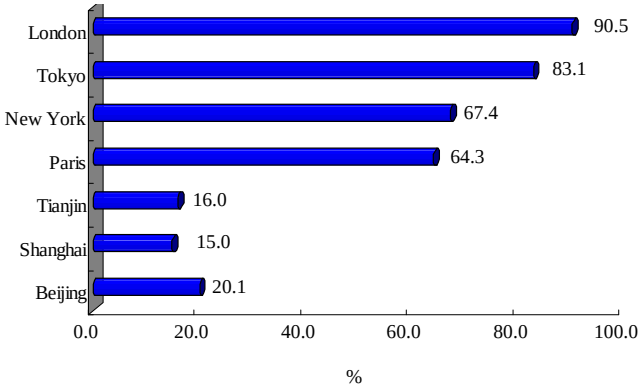

Figure 6. Percentage of Rail Transit in public transport

Conclusion:

> Benchmark 5: The length of metro lines in the central cities of China has to increase four times if the level of Singapore or Tokyo is to be reached and may need 27 years of investment if the present economic growth remains 7% per year.

2.6. Modal Split for Bicycles and Private Cars

The next benchmark we will look at is the modal split for bicycles. As we can see from Figure 7, most Chinese cities rely at a rate of 30% or more on bicycle usage for commuting. Compared to developed countries, which have a bicycle usage, even in best case scenarios, of not much greater than 30%. So we assume that Chinese central cities should at least keep bicycle usage around 30% in the following decades.

Figure 8 illustrates the share of private cars. In most of Chinese cities, the car use is much less than that of international cities, such as Paris, Tokyo, New York, London, However, in Beijing, the share of private car is drastically greater than in all other Chinese cities and reaches almost other typical international cities. We think Beijing is already in the dangerous area, and don't want other Chinese cities to follow suit.

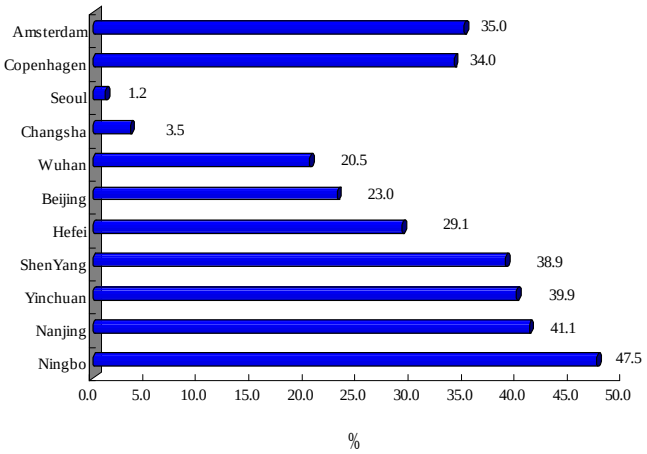

Figure 7. Share of Bicycles

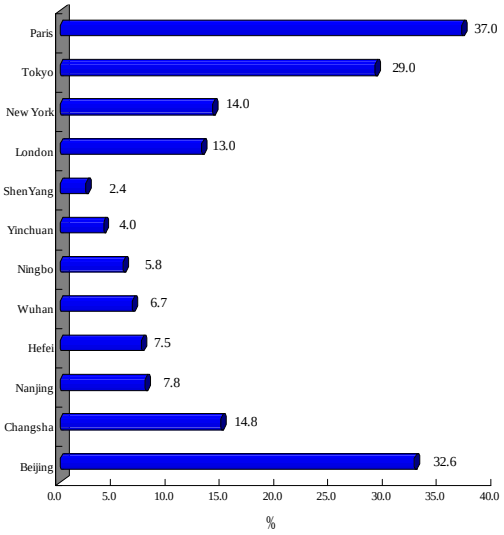

Figure 8. Share of private cars

Conclusion:

Benchmark 6: Chinese citizens prefer to sustainable transport modes (such as walk, use a bicycle, or public transport). However, there are growing challenges to keep these trends, and priority is given to the proposed modal split (Public transport 30%, Bicycle 30%, and walk 30%), although the use of private cars is increasing.

2.7. Changes in Travel Behavior

Figure 9 illustrates the modal split in Changsha cities, the overall shift from use of bicycle to greater use of public transport and private cars. This shows the increasing reliance upon private automobiles for transport over the use of public transport and bicycle usage. Overall, sustainable modes of transport (bicycle, public transit and walking) have decreased over the last decade while the use of motorized modes of transport has increased over time.

This trend is even more apparent in a city like Beijing (see figure 10), where an increase in quality of living and wealth has caused many residents to prefer motorized transport to bicycles. The share of private cars is steadily increasing although a series of integrated

measures on public transport development was implemented in Beijing during the recent three years. Therefore, we think the motorized travel has become the inevitable trend. However, I would suggest that as people's living standards, wages and incomes increase, they turn to public transportation over private automobiles.

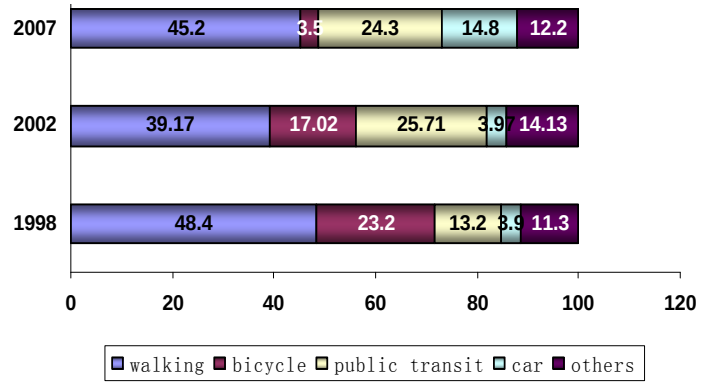

Figure 9. Modal split in Changsha

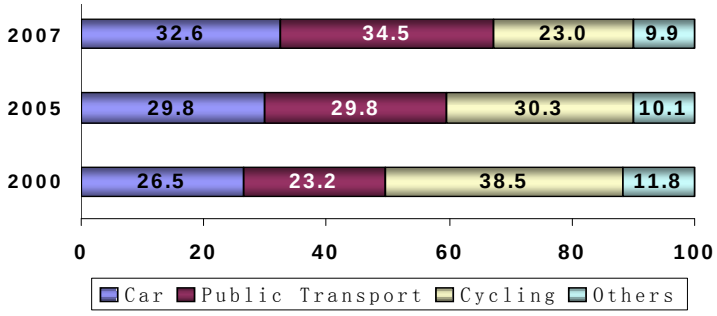

Figure 10. Modal split in Beijing

Figure 11 shows the factors of "door to door" speed, cost per km and accepted distances traveled by each mode of transport as conducted by our survey in the ten typical central cities from 2006 to 2007. While costs and distances traveled are greater with car, taxi and rail transit, the average travel distance of a Chinese citizen in these cities is between 3.5 and 9.3 km.

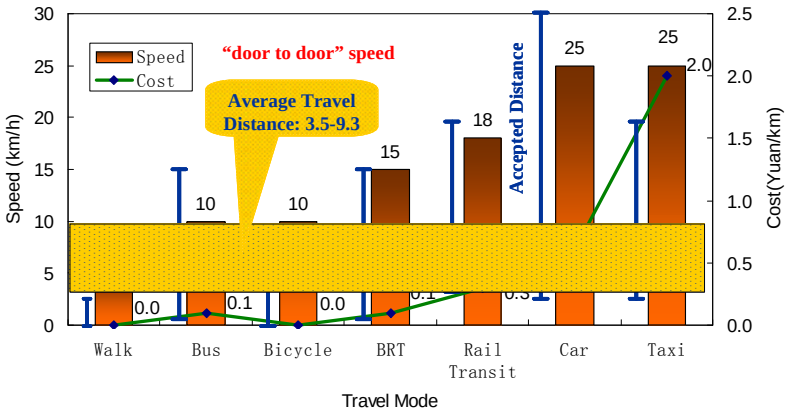

Figure 11. Cost, Speed, and travel distance in different travel mode
Source: Survey from 10 Central cities during 2006-2007

Conclusion:

> Benchmark 7: Although people's living standards, wages and incomes increase, we should encourage them, to use the most cost effective, environmentally friendly and ideal method of travel bus transit or bicycle, not private car.

2.8. Affordability

The 8th aspect is affordability to pay for transport. In Chart 4, we can see the monthly expenditures for a Chinese citizen commuter in both urban and rural areas in China. The cost of different travel modes is weighed as a percentage of disposable income, and is for the rural resident much higher than for the urban resident, all the motorized travel mode is over the international standard 8%.

Conclusion:

> Benchmark 8: As affordability to pay is a key factor in choosing modes of transport, the government should balance all factors to meet the various needs of all transport users (include urban and rural resident).

Chart 4. The monthly expenditures for a Chinese citizen commuter in both Urban and rural areas

Mode	Commuter Expenditure per Month (Yuan)	Percentage of Commuter Expenditure in disposable income (for urban resident)	Percentage of Commuter Expenditure in total income (for rural resident)
Walk	**0**	**0%**	**0%**
Bicycle	**0**	**0%**	**0%**
Bus	**66**	**5%**	**14%**
BRT	**66**	**5%**	**14%**
Rail Transit	**132-264**	**8-17%**	**28-56%**
Car	**138-368**	**9-23%**	**29-77%**
Taxi	**462-1228**	**29%-78%**	**97%-258%**

2.9. Energy Consumption

Figure 12 shows the average increasing rates of gasoline consumption (TOE/1000 people) in Beijing, Shanghai and China as a whole from 2000-2005. It also shows the same rates for Tokyo, Japan, Seoul and Korea. While both Korea and Japan consume more gasoline per 1000 people than China does, the rates of increase are very low (2.6 and 1.6% for South Korea and Japan respectively). In contrast, Beijing and China as a whole average 14.9 and 12.5% respectively. Thus, after 3 and 8 years, Beijing will reach the current level of Korea and Japan, and for China as a whole, it would just take 12, and 18 years to reach this level. Such a large increase in gasoline consumption would be nearly impossible to meet at current standards. If the trend is true in the future one and a half decade, China will consume the present total gasoline output of the world.

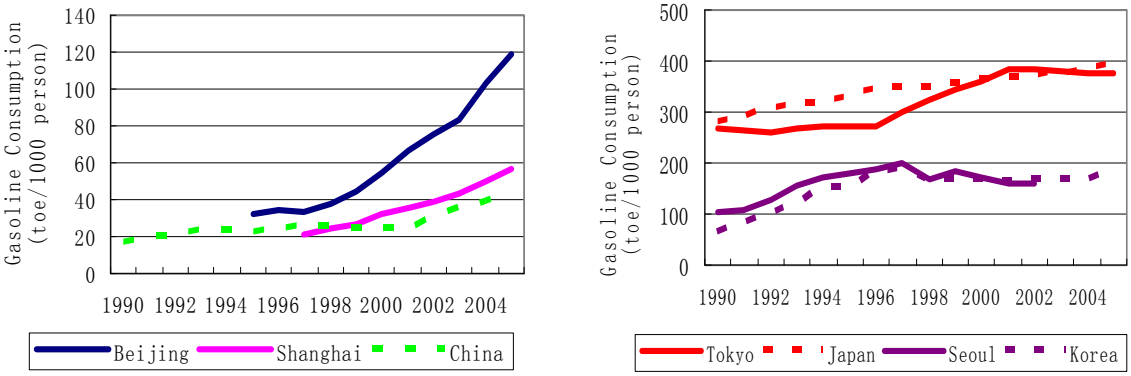

Figure 12. The historic trends of gasoline consumption in China, Japan and South Korea

Chart 5 Comparison of gasoline consumption increase

	Beijing	China	South Korea	Japan
Average Increasing rate from 2000-2005	14.9%	12.5%	2.6%	1.6%
Beijing: Number of years to reach the current level with 14.9% increase per year. (year)	–	–	3	8
China: Number of years to reach the current level with 12.5% increase per year. (year)	–	–	12	18

Conclusion:

Benchmark 9: Gasoline consumption per capita has entered into a high increasing stage in Chinese cities. However, Limited energy supply requires us to encourage the development of high energy-efficient transport systems.

2.10. Traffic Safety

The last benchmark is traffic safety. In the selected central cities, the average mortality rate is 8.1 deaths per 10,000 automobiles (see figure 13). However, when comparing the average traffic mortality rate of these selected central Chinese cities with other countries (see figure 14).

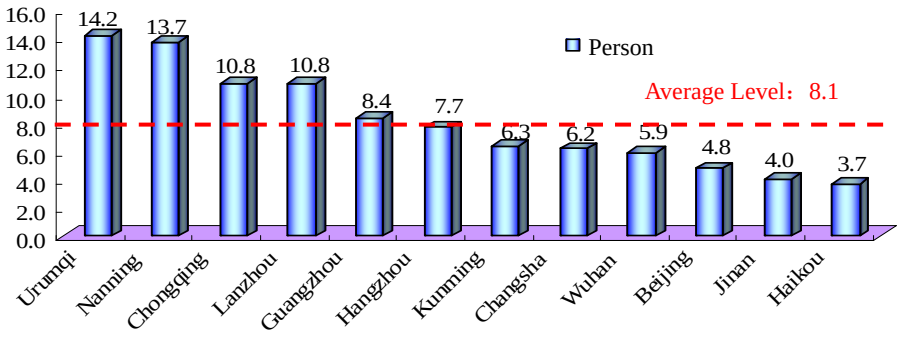

Figure 13. Number of deaths per 10,000 automobiles in different cities of China

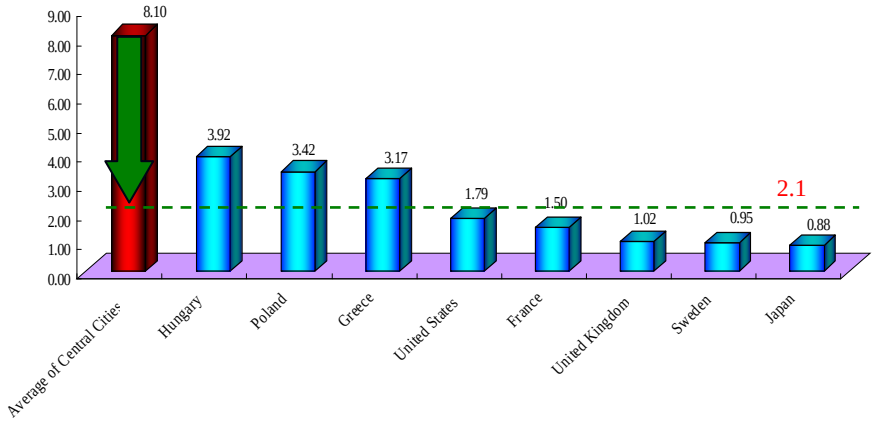

Figure 14. The average mortality rate of Chinese central cities with other countries

Conclusion:

Benchmark 10: High traffic accidents require strengthening of traffic safety management to diminish mortality rates from 8.1 to 2.1.

3. Summary: the Strategic framework

Based upon these 10 previously mentioned benchmarks, we finally present 6 strategic priorities of promoting sustainable urban transport in China for Chinese government as follows:

1) Speed up infrastructure construction and improve transport supply capacity;
2) Reinforce public transport capacity and service, while initiating greater competition;
3) Extend the TDM polices for movements from home to school and work;
4) Ensure access and security for pedestrian, cyclist, and other disadvantaged groups;
5) Encourage energy-efficient urban transport systems using a vehicle fleet of clean, and efficient fuel; and
6) Reduce the number of deaths and injuries from road accidents, by securing safety measures for all users while improving emergency response capacity.

Although there are many restraints to realize a sustainable future, we must find out a methodical, middle of the road approach for building a sustainable transport system in China. Too slow and too fast planning should be avoided.

This may be the best way to preserve the inherited identity of China.