Urban Transportation in China: Trends and Issues

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China's population was 1.1 billion in 1990; it is expected to reach 1.3 billion by 2000. Its urban population was 33 percent in 1990 and is expected to grow to 47 percent by 2000. This enormous urban growth poses tremendous challenges to urban transportation planners. The five megacities—Beijing, Shanghai, Shenyang, Tianjin, and Wuhan—are planning for light rail transit/subway (LRT/MRT) systems that will cost $10 billion to $15 billion (U.S. dollars). However, China does not have the money and will depend on foreign aid and borrowing. Concurrently, planners disagree about the appropriate role of motorized and nonmotorized transportation, especially the bicycle: some wish to abolish, restrict, or redirect it, and others wish to expand its systems role. The global LRT/MRT experience suggests that such systems are expensive and take a long time to build. Forecasting systems for cost and ridership are unreliable: actual costs are more than two or three times the forecast. The urban transportation trends and issues in China are discussed on the basis of a very diverse array of data research sources. The analysis includes mode splits, costs, and reliability functions, and their applicability to Chinese cities. It proposes a strategic planning framework for Chinese urban areas, focusing on optimum modal mixes, investment and regulatory policies, and transportation system management. Although the framework has been developed particularly for China, it is generally applicable to other low-income countries in Asia.

China's population was 1.1 billion in 1990, and it is expected to become 1.3 billion by 2000. In 1990 its gross national product (GNP) was $330 per person (U.S. dollars). Table 1 shows that China had 39 cities with more than 1 million people in 1990; by the year 2000, there will be 46 of them. Of these, 23 will have between 1 million and 2 million people, 18 will have between 2 million and 5 million, and 5—the megacities—will have between 5 million and 17 million (*1*).

TABLE 1 Chinese Agglomerations, 1990–2000 (*1*)

Population	1990			2000		
1-2 Million	23 Metro Cities			23 Metro Cities		
2-5 Million	13 Agglomerations			18 Agglomerations		
	1.	Shenyang	(4.8 m)*	1.	Guangzhou	(4.8 m)
	2.	Wuhan	(3.9 m)	2.	Chongqing	(4.2 m)
	3.	Guangzhou	(3.7 m)	3.	Dalian	(4.1 m)
	4.	Chongqing	(3.2 m)	4.	Chengdu	(4.1 m)
	5.	Chengdu	(3.0 m)	5.	Jinan	(4.0 m)
	6.	Harbin	(3.0 m)	6.	Xian	(4.0 m)
	7.	Xian	(2.9 m)	7.	Harbin	(3.9 m)
	8.	Nanjing	(2.6 m)	8.	Nanjing	(3.6 m)
	9.	Dalian	(2.5 m)	9.	Changchun	(3.1 m)
	10.	Zi Bo	(2.5 m)	10.	Taiyuan	(3.0 m)
	11.	Jinan	(2.4 m)	11.	Zi Bo	(2.7 m)
	12.	Changchun	(2.2 m)	12.	Zhengzhou	(2.4 m)
	13.	Taiyuan	(2.2 m)	13.	Kunming	(2.3 m)
				14.	Guiyang	(2.2 m)
				15.	Urumqi	(2.1 m)
				16.	Tangshan	(2.1 m)
				17.	Lanzhou	(2.0 m)
				18.	Nanchang	(2.0 m)
>5 Million	3 Mega Cities			5 Mega Cities		
	1.	Shanghai	(13.4 m)	1.	Shanghai	(17.0 m)
	2.	Beijing	(10.8 m)	2.	Beijing	(14.0 m)
	3.	Tianjin	(9.4 m)	3.	Tianjin	(12.8 m)
				4.	Shenyang	(6.3 m)
				5.	Wuhan	(5.3 m)

NOTE: m = million

URBAN QUALITY OF LIVING

Population Crisis Committee has measured the quality of living in the world's 100 largest metropolitan cities, whose populations range from 2 million to 29 million; 35 of these cities were in Asia (*2*). The livability index consists of the following components, each category having equal weight:

- Public safety,
- Food costs,
- Living space,
- Housing standards,
- Communications,
- Education,
- Public health,
- Peace and quiet,
- Traffic flow, and
- Air quality and pollution.

There may be some disagreement as to the relative weight of each component of the index, but the methodology is reasonably scientific in assessing a very complex question. Three components are important to transportation planners: ambient noise levels, traffic flow (average peak-hour traffic speeds in kilometers per hour), and air quality (air pollution measured in levels of suspended particulate matter, sulphur dioxide, and nitrogen oxide exceeding health thresholds defined by the World Health Organization).

Chinese megacities fared well in this analysis, as shown in Table 2. Out of 100 points, Shanghai scored 56, Beijing scored 55, Harbin scored 52, and Tianjin and Wuhan scored 51.

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TABLE 2 Urban Living Standards in Large Metropolitan Cities in China, 1990 (1,2)

City	Shanghai	Beijing	Tianjin	Shenyang	Wuhan	Guangzhou	Chongqing	Harbin	Nanjing
1990 Population in Million	13.4	10.8	9.4	4.8	3.9	3.7	3.2	3.0	2.6
Urban Living Standards Score	56	55	51	42	51	42	48	52	49
Levels of Ambient Noise (1-10)	5	4	5	6	6	6	7	5	5
Peace & Quiet Score (1-10) *	6	7	6	5	5	5	5	6	3
Traffic flow: Km/h in Rush Hour	24	41	32	26	45	30	40	42	27
Score (1-10)	3	6	4	3	7	4	5	6	3
Clean Air: Alternate Pollution Measures	16 days SO_2	272 days SPM	1900 ppm O_3	146 days SO_2	-	123 days SPM	-	-	-
Score (1-10)	7	1	5	1	-	2	-	-	-

* The Best Condition Is Score 10

Following closely were Nanjing with 49, Chongquin with 48, and Guangzhou and Shenyang with 42 each. It appears that livability index is inversely proportional to motorized traffic. Shanghai, Beijing, Harbin, Tianjin, and Wuhan have less motorized traffic and higher livability indexes than Guangzhou and Shenyang, which have substantially higher proportions of motorized traffic.

The peak-hour traffic moved at 32 to 42 km/hr in Beijing, Chongquin, Harbin, Tianjin, and Wuhan, whereas it moved at 24 to 32 km/hr in Guangzhou, Nanjing, Shanghai, and Shenyang. Air quality was the worst in Beijing and Shenyang, followed by Guangzhou and Tianjin.

URBAN TRANSPORTATION IN SELECTED CITIES

Background

The principal urban transportation modes in China are buses, trolley buses, street cars, subways, bicycles, and walking. China is the "Bicycle Kingdom." There were 300 million bicycles in 1985 but only 1.2 million cars. In 1987 China produced 41 million bicycles; the global production of bicycles was about 99 million (*3*).

In 1985 the 225 big and medium-sized cities of China had 65 million bicycles. Bicycle ownership grew 7 percent in the 1960s, 9 percent in the 1970s, and 20 percent in the 1980s. This growth has occurred with government's inability to provide adequate public transport (buses). Low personal incomes and the desire for higher mobility have produced fairly high growth rates of bicycle ownership (*4*).

Ownership of private cars and motorcycles is far beyond the means of almost all people in China. Therefore, the desire for higher personal mobility leaves them with only two options: bicycle or bus. Bus fleets have not grown consistently with population growth. During the past 20 years, increases in discretionary incomes have been accompanied by substantial increases in bicycle ownership. For example, in 1987 there was 0.6 bicycle per person in Beijing (*4*).

There were 48,000 buses and trolley buses in 322 cities in China in 1988, compared with 42,000 in 1987. These bus systems carried 24.0 billion people in 1987 and 26.8 billion in 1987. This ridership is small compared with the population base of 1.1 billion people. However, Shimazaki and Yang show in another paper in this Record that the average passenger density was 10 to 13 people per square meter in peak hours, which indicates tremendous overloading.

Shanghai had 4,600 buses, Beijing 3,000, Tianjin 1,400, and Guangzhou 1,800. This is quite low in comparison to western countries and many Asian cities. For example, Shanghai had 3.4 buses per 10,000 people, Beijing 2.8, Tianjin 1.5, and Guangzhou 4.9 (*5*).

Bicycle production increased rapidly from 13 million in 1980 to 29 million in 1984 and to 41 million in 1988. It accounted for 5 billion yuan in 1984, about 0.5 percent of the GNP. According to Shimazaki and Yang, the average cost of private vehicles in 1990 was as follows:

Vehicle	*Cost (yuan)*
Bicycle	200 to 400
Motorcycle	3,000 to 15,000
Car	80,000 to 200,000

The easy availability of locally made bicycles combined with their reasonable cost makes them an attractive transport investment. For example, in Shanghai the average household income in 1989 was 397 yuan and the expected savings were 41 yuan per month. The cost of the cheapest bicycle is 200 yuan, or 5 months' household savings (X. Lu, unpublished data, 1991). Many households own more than one bicycle.

Because the public transit system was inadequate and the government did not wish to have any more citizens waiting for hours indefinitely, in 1978 it canceled the bicycle registration tax and introduced a subsidy of 2 to 4 yuan per month for those people who rode their bicycles to work. Therefore, workers who used bicycles could receive a yearly subsidy of 24 to 28 yuan (*4*). Assuming a bicycle can be used for at least 20 years, the subsidy amounts to 480 to 960 yuan. Even at current rates, this is equivalent to 1.5 to 3 bicycles. This has encouraged bicycle ownership. In Beijing in 1986, 84 percent of the households had at least one bicycle and 52 percent had two or more. Fifty-four percent of people in Beijing ride bicycles regularly, and 78 percent of the total daily person trips are by bicycle (*4*).

Many bicycle repair shops are scattered throughout the urban areas. Parts are manufactured locally, without any import content. It is very easy to replace parts and to repair and maintain bicycles. Renting bicycles in China is also easy. The rental shops lease bicycles by the hour, by the day, and by the month. The rental rates are 0.2 to 0.3 yuan per hour and 0.3 to 0.5 yuan per day (X. Lu, unpublished data, 1991).

All bicycles are required to be registered and carry license plates. It is nearly impossible to steal a bicycle or to sell a stolen bicycle. Because all citizens carry identification at all times, bicycle renting and parking is done with proper identification.

Bicycle travel speeds in major urban areas were reported to be 13 to 18 km/hr during the morning peak hour and 10 to 13 km/hr in the afternoon peak hour. Average bicycle trip length was 9 km for men and 5 km for women. Although bicycle parking space is scarce in some areas of larger cities, bicycle parking is not a serious problem in China (X. Lu, unpublished data, 1991). Waiting time has increased considerably during the past decade. If door-to-door travel times are considered (walking, waiting, and travel times), bicycle travel is often more efficient than bus transport (*6*).

Shanghai

Shanghai is the largest metropolis in China. It is also the administration center for the largest special economic zone, covering five provinces. In 1990 Shanghai had 13.4 million people, a number that is expected to grow to 17 million by 2000. Shanghai has more than 10,000 industrial enterprises and accounted for 6 percent of the national GNP. Heavy industry (cars, aircraft, petrochemicals, electronics, and power) accounts for 60 percent of its economic base. It has 200 scientific research institutions and 49 colleges and universities. Downtown Shanghai is the busiest shopping area in China (*6*).

Several researchers have reported on transportation modes and changes in Shanghai during 1981–1991, as shown in Table 3 (*4–10*). The share of public transit has decreased from 28 percent in 1982 to 24 percent in 1989. This is attributed to both the nonincrease in bus transport supply and the resultant increase in waiting times. Travel modes in 1989 were as follows (*7*):

Mode	*Percentage*
Walk	41
Bicycle	31
Bus	24
Other	4

According to Lam and Huang in another paper in this Record, buses and trolley buses carried 1.4 million passengers during the morning peak hour and 10 million on an average day in 1982. In 1987, they carried 10.9 million passengers a day (*6*). Bus operating speeds on major arterials have decreased slightly despite more signalization. The average operating speeds were 14 to 16 km/hr in 1980 and 11 to 14 km/hr in 1986 (*6*).

Before 1985 motorcycle ownership was frowned on. There were 2,900 motorcycles in 1978 and 16,000 in 1985. Even then, all motorized transportation (car, motorcycle, and taxi) carried only 1 percent of the total travel in 1982, growing to only 4 percent by 1989.

Bicycle population has grown considerably during the past two decades. For every 1,000 persons there were 105 bicycles in 1970 and 546 bicycles in 1990. During the same period, buses per 1,000 persons have decreased (*7,10*).

The average speed in 1985 for bicycles was 13 km/hr; for trolley buses, 15 km/hr; and for buses, 17 km/hr (X. Lu, unpublished data, 1991). In 1990 the peak-hour motorized traffic moved at 24 km/hr (*2*). There were 63 fatalities per 1,000 vehicles in Shanghai in 1985; the national average was 99 fatalities per 1,000 vehicles (Lam and Huang).

Part of Shanghai's first subway (MRT) line, estimated to cost $2 billion to $3 billion (U.S. dollars), is expected to open in 1995. To complete the entire system may take 20 years because of financial constraints (*6,7*).

TABLE 3 Travel Modes in Metropolitan Cities in China

City	Reference	Year	Share of Total Person Trips %				
			Walk	Bicycle	Bus	Others	Total
Shanghai	Shi, 1989	1982	58	13	28	1	100
	Midgley, 1991	1986	38	33	26	3	100
	Replogle, 1991	1986	38	33	26	3	100
	Powills, 1989	1986	41	31	24	4	100
	Shimazaki, 1991	1986	37	25	35	3	100
	Xuedong, 1991	1989	41	31	24	4	100
Beijing	Shi, 1989	1986	14	54	29	3	100
Tianjin	Zhao, 1987	1981	45	44	9	2	100
	Shi, 1989	1987	43	45	10	2	100
	Thornhill, 1990	1987	50	41	9	Negl.	100
Guangzhou	World Bank, 1991	1986	38	30	28	4	100

Beijing

Beijing had 10.8 million people in 1990 and is expected to reach 14 million by 2000. There are two underground railway lines in Beijing—the first, a 24-km line, was completed in 1969 and the other, a 16-km line, was completed in 1984. Together, they carried 500,000 passengers a day in 1991 (*11*). There were 3,000 buses and 600 trolleys in 1987 carrying 5.5 million passengers a day (*5*). Since then the bus fleet has shrunk because of aging and nonreplacement. In 1985, out of 280,000 motor vehicles, 260,000 were cars, jeeps, or trucks.

The bicycle is the dominant mode of transport in Beijing. In 1986, 54 percent of all trips were by bicycle, 29 percent by bus, 14 percent by walking, and 3 percent by motorized vehicle, as shown in Table 3. Fifty-seven percent of all trips were work trips, 27 percent were recreational, and 16 percent were cultural. Eighty-four percent of all households had at least one bicycle, 32 percent had two bicycles, 13 percent had three bicycles, and 6 percent had four or more bicycles (*4*).

The bicycle population grew rapidly in the 1980s. In 1978 there were 2.8 million bicycles, which increased to 3.0 million in 1980, 6.8 million in 1987, and 8.0 million in 1990 (*4*). In 1989 three of the busiest intersections were each handling more than 50,000 bicycles an hour (*4*). The average motor vehicle speeds on Changan Street, the widest street in Beijing, were 35 km/hr in 1959, 30 km/hr in 1979, and 24 km/hr in 1980 (X. Lu, unpublished data, 1991). This is the most congested condition in Beijing.

Lam and Huang report that there were 45 fatalities per 1,000 motor vehicles in Beijing. In 1987 there were 8,134 reported accidents in Beijing. Of these, 1,975 were caused by bicycle traffic, 24 percent of the total. The fatality rate of bicycle traffic accidents was 1.7 deaths per 10,000 people, or 2.5 deaths for every 100,000 bicycles.

Recently, an automatic traffic control (ATC) system covering 92 signalized intersections in the central business district (CBD) has been put into operation. This system is estimated to have increased the intersection capacity by 20 percent. By 1993 another 250 intersections will be connected to the ATC system (*11*).

Tianjin

Tianjin had 9.4 million people in 1990 and is expected to have 12.7 million by 2000 (*1*). During the past decade, Tianjin has experienced continuing explosive growth of its industrial output, housing stock, and bus fleet, all increasing by 70 percent between 1980 and 1988 (*12*). In 1982 there were only 73,000 motor vehicles, which grew to 90,000 by 1990. These are primarily government vehicles, because private motor vehicles are rarely allowed.

In 1950 Tianjin had 14,000 bicycles and 2.4 million people; by 1980 it had 2.7 million bicycles and 7.3 million people. By 1990 there were 4 million bicycles and 9.4 million people. Because of the compactness of the metropolitan area and the predominance of bicycle transportation, Tianjin devotes only 4.8 percent of its land area to its streets and roads (*9*). In contrast, large cities use 35 percent of North America's land area for streets and roads.

Tianjin's bus fleet had 1,400 buses/trolleys in 1990 and the system carried 1.6 million passengers a day. It also has a small underground railway system, which carries only 30,000 passengers a day. The public transit system is relatively small: there is only one bus per 6,714 persons (*6*).

In 1990 the average work trip was about 45 min (*9*). At Bell Square (CBD) in Tianjin, the average traffic speeds decreased from 18 km/hr in 1983 to 11 km/hr in 1989 (*5*).

Severe congestion often persists longer than 30 min, limiting traffic flow to less than 5 km/hr. Average motor vehicle speed is approximately 16 km/hr in the central city and less than 10 km/hr in the more-congested areas. Investment in public transportation has decreased in Tianjin, from 3.6 percent of total capital construction investment in the 1950s to 0.5 percent during the 1970s. There are indications that this trend continued during the 1980s (*13*).

The quality of Tianjin's public transit service is the lowest of all major Chinese cities (*13*). Because of very narrow streets, several areas are not served by the bus system. Although the waiting times at bus stops can be as high as 45 min, walking to bus stops takes only 8 min. Peak-hour bus speeds are very low, about 11 km/hr. Bicycles often form a "wall" in front of buses at many intersections, gaining efficiency and speed for themselves (X. Lu, unpublished data, 1991).

Table 3 shows that in 1987, 50 percent of all trips were by walking, 41 percent by bicycle, and only 9 percent by public transit (*12*). Car and motorcycle trips were negligible. Walking trips increased from 1981 to 1987.

Tianjin is an old city containing many narrow and winding roads. The average road has a paved width of less than 9 m. This historical city has many bottlenecks and dead ends. Traffic flow in the central area is further inhibited by street vendors. Severe congestion often persists in the CBD, reducing motorized traffic flow to less than 5 km/hr.

Guangzhou

Guangzhou is one of the 14 open cities of China. It is also the nation's gateway to foreign trade and international interaction, as well as a transport and administrative center of south China, with strong ties to Hong Kong. Its urban pattern is broadly a combination of three linear clusters: old city, Tianhe, and Huangpu. In 1990 Guangzhou had 3.7 million people; its population is forecast to reach 4.8 million by 2000 (*1*).

From 1980 to 1990, its population increased from 3.0 million to 3.7 million (23 percent) and the number of bicycles increased from 1.0 million to 2.2 million (112 percent). Reflecting high economic growth during the 1980s as well as the open door policy, motor vehicles increased from 21,000 to 115,000, a growth of 448 percent. Private cars also increased significantly from 6,000 to 53,000 (783 percent). Private cars will increase but not necessarily at the previous geometric rates. According to Thomas et al. in another paper in this Record, reliable forecasts indicate that there will be 109,000 private cars and 3.5 million bicycles by 2000. Because of this enormous growth, conflicts between motorized and nonmotorized transportation will also increase.

Public transit carries 1.1 million trips daily: 69 percent by bus, 10.8 percent by ferry, 10 percent by trolley bus, and 0.2 percent by taxi. There was a bus or trolley for every 2,623 persons and a taxi for every 460 persons. The capacity gap for the morning peak-hour bus system is 130,000 people; this leads to overcrowding of up to 12 persons per square meter aboard the buses (*14*).

Table 3 shows transportation modes in 1986 (*5*). Bicycle and walking together accounted for 68 percent.

In 1984, 64 percent of freight was moved by road, 28 percent by water, and 8 percent by rail. In passenger movement, road transportation was even more important, carrying 72 percent of a total of 50 million trips; rail carried 16 percent, water carried 10 percent, and domestic air carried 2 percent. In 1990 Guangzhou had 1.1 billion passenger trips a year (*14*).

Traffic accidents have increased substantially, parallel to the growth in vehicle population, conflict between motorized and nonmotorized vehicles, and congestion. The number of reported accidents increased from 650 in 1971 to 1,800 in 1980 and to 4,200 in 1990. Thomas et al. report that fatalities increased from 75 in 1971 to 120 in 1980 and to 300 in 1990.

URBAN TRANSPORTATION POLICY PERSPECTIVES

Policy System and Research Findings

For the short term of 1991–2000, common or universal private ownership of cars, as it is in North America and Europe, is probably beyond the means of almost all Chinese households (*4,6,7,9,10,13,15,16*). Cars will be owned mostly by governments and their enterprises, except in cities such as Guangzhou, Shenzhen, and Canton in southern Canton because of their special economic status and the open door policy. According to the paper by Thomas et al., in 1990 Guangzhou had the highest car ownership of all Chinese cities: 53,000 (one car per 70 people), which is expected to reach 109,000 by 2000 (one car per 44 people).

Because of the relatively low income of most people in China, bicycles are still the most popular alternative to walking and public transit (*15*). China's economic, energy, and living conditions will make it virtually impossible for individuals to own and operate private automobiles within the next 20 to 30 years (*13*). For most people, this means primarily three modes: riding the bus, bicycling, and walking.

Researchers disagree about why there is congestion now and what policies should be pursued. There is a dichotomy of conceptual and technical approaches to the current and future roles of the bicycle. As well, there are divergent views on what to do with public transit—bus and light rail transit (LRT)/MRT. By and large, Chinese authors would like to reduce, restrict, or remove the use of bicycles to general or specific areas or specific times. But others advocate accommodating the bicycle even more.

The policy analysis to date is somewhat confusing. All authors acknowledge that bicycles are very important: they are energy-efficient and pollute less, and they are universally available, economical, and versatile for all age groups (*3,4,6,7,9,13*). However, further policy extrapolation is riddled with inconsistencies and contradictions.

Zhao, while acknowledging the predominance of bicycles in Tianjin, states that the growth of bicycles has created many system-level transportation problems. He asserts that the transportation problems in Tianjin result from the inability of transportation planners to restrict the growth of bicycles. He suggests that if the bicycle transportation is allowed to develop unrestricted, the state of urban transportation will worsen (*11*).

Yang recognizes that bicycles are a very important means of urban transport in China, but he suggests that too many bicycles can cause problems. His main concern is that large bicycle volumes spill over to motor vehicle lanes, causing motor vehicle speeds to decrease and making motor vehicles wait longer at intersections (*13*).

Shimazaki suggests that too much bicycle use harms urban transit systems. He suggests heavy bicycle traffic causes inefficient use of road space and reduces motor vehicle speeds. At the same time, he acknowledges the importance of the bicycle within the system and suggests its incorporation with other modes.

Powills and Shen have documented clearly the ways in which Chinese professionals view bicycles. They state that some people argue that bicycles are ubiquitous and uncontrollable, that they are a nuisance cluttering the streets, that they are parked everywhere, and that their users tend not to obey the law and therefore their numbers ought to be diminished. Buses are more efficient, subways move more people faster, and bus/motor vehicle modes will better solve the problems of urban transit by serving longer trips. Furthermore, China must move into "more modern urban transport" (*7*).

Bicycles are considered by many in China to be archaic, inefficient symbols of backwardness—things that will give way to motor vehicles sooner or later (*16*). These are strongly held philosophical views of many Chinese professionals that lead them to extrapolate various conclusions. For example, Chen has reported that in Shanghai, the bicycle is considered to be the principal cause of the noticeable decline in public transit market share that has occurred in recent years and of the concurrent rise in the level of traffic congestion on many streets in Shanghai (*15*).

Many experts are concerned with the increasing use of bicycles. Lu has reported that the government recently published several policies to restrict the use of bicycles: to build bus-only roads and to forbid bicycles on such roads, to impose and increase bicycle registration (license) fees, and to charge an ownership tax (*6*). These policies are being slowly implemented selectively but without providing alternative transportation options to bicycle users. Some experts believe that if the bicycle is allowed to develop unrestricted, the state of urban transportation in China will worsen (*13*).

Other researchers have documented the positive aspects of bicycle use. Its energy-efficiency, total lack of dependency on foreign inputs (vehicles, parts, and repairs), economic and competitive pricing, availability within easy reach of low-income households, and versatility have all been very well documented (*3,6–10,12,16*). Lowe has advocated the adoption of the bicycle as "the vehicle for a small planet" (*3*). She has also prepared policy spectrums to reduce automobile dependence (*17*). Powills and Shen have gone further to suggest traffic control, channelization, and traffic segregation methodologies for accommodating bicycles in traffic engineering practice (*7*).

Some researchers have attributed traffic congestion, deteriorating bus systems, and decreased safety to the increasing number and use of bicycles (*12,13,15*). Only a few have pointed to the lack of required investment in public transportation systems (*7,10,17*). Extensive work by Midgley shows that the bus systems in China are inadequate and that new investment is not forthcoming (*9*). For example, if only 50 percent of the current bicycle users were to shift to the bus, Shanghai alone would require 800 to 1,200 more buses (*6*). Current policy appears to place the highest priority on increasing the bus system capacity and increasing its market share (*18*). However, this has not resulted in any significant urban bus system expansions (*14*). The availability of public transit is quite inadequate and service levels are very low; the lowest level among big cities is in Tianjin (*11*).

The sheer volume of people using the system during the peak hours is staggering. The systems are overcrowded and the service is poor. They have lagged behind for many years. As a result of severe overcrowding, many commuters avoid the buses and go by bicycle, even for long trips (*13*). Walking times are long because bus stops generally are spaced 1 km apart. Waiting time in Shanghai varies from 20 to 45 min, making walking and bicycling more efficient and economic (*7*). Commuters are optimizing their costs and benefits by walking and riding bicycles.

Private ownership of motorcycles and mopeds is restricted but possible. Motorcycles are becoming more common in large cities. Though restricted, the increasing number of motorcycles in Shanghai is attributed to the ingenuity of the local people to register them to a non-Shanghai address (*8*). However, motorcycles and cars together account for only 2 to 3 percent of all person trips.

Several studies have proposed LRT/MRT systems for megacities. Shanghai's new MRT system is to open for service in 1995. The entire system may take 20 years to complete (*6*). Guangzhou is hoping to start construction in 1993, subject only to the availability of $2 billion to $4 billion (U.S. dollars) from foreign sources, according to Thomas et al. in this Record. Plans are afoot to build LRT/MRT systems in all the megacities, but the funding must come from foreign sources. Even then, to complete these systems may take 15 to 30 years.

The urban transportation situation can be summarized as follows:

1. All cities want to build LRT/MRT systems, but there is no money;
2. The existing bus systems are inadequate and inefficient;
3. People use bicycles because they are efficient and economic;
4. Many people walk; and
5. The government wants to reduce, restrict, or abolish the use of bicycles in heavily traveled corridors.

Urban Transportation Policy Options

LRT/MRT systems are very large lump-sum investments requiring technology, equipment, parts, and training from the Organization for Economic Cooperation and Development (OECD) countries. None of the LRT/MRT systems in the low-income countries has been built without direct or indirect heavy subsidies from the western donor countries or lending and aid institutions (Manila, Calcutta, and Shanghai). For example, the proposed Lavalin LRT line in Bangkok, though justified as economically self-sustaining, will be indirectly subsidized with $400 million to $500 million (U.S. dollars) from the Canadian government and with $300 million to $400 million (U.S. dollars) from the Thai government through land use rights and tax holidays. Therefore, any question of rigorous benefit/cost analysis and user cost recovery analysis becomes irrelevant (*19*). China is no exception to these conditions or the political rules of the international aid game.

Most of the money and technology (both material and intellectual) required to build the LRT/MRT systems in Asia comes from the OECD countries. Pickrell's analysis of several LRT/MRT systems in North America indicates that LRT/MRT cost and passenger forecasts have been unreliable. Actual capital costs were 200 to 800 percent of the forecasts, operating expenses up to 200 percent higher, and passenger volumes only 15 to 72 percent of the forecasts (*20*). This is a dismal record. Thus, the same margins of error would apply to LRT/MRT systems to be built in China, because donor countries will insist that the feasibility studies be done by donor-country nationals or firms.

Kain's studies show clearly that, on the basis of cost per passenger capacity, exclusive grade-separated busways are substantially cheaper than LRT/MRT systems. For example, the Miami, Florida, busway system, which carries 200,000 passengers a day, cost $1.2 billion; the Ottawa, Canada, grade-separated exclusive busway system carries 200,000 passengers a day, and it cost only $190 million (*21*). In most cases, and until very heavy load factors are reached, busway/transitway systems are economically more efficient.

The generalized empiric reliability functions are shown in Figure 1. In general, in areas that require population, land use and economic base forecasting (trip generation, modal split, capital costs), the reliability functions are the low end. At the high end are maintenance costs, safety, traffic control,

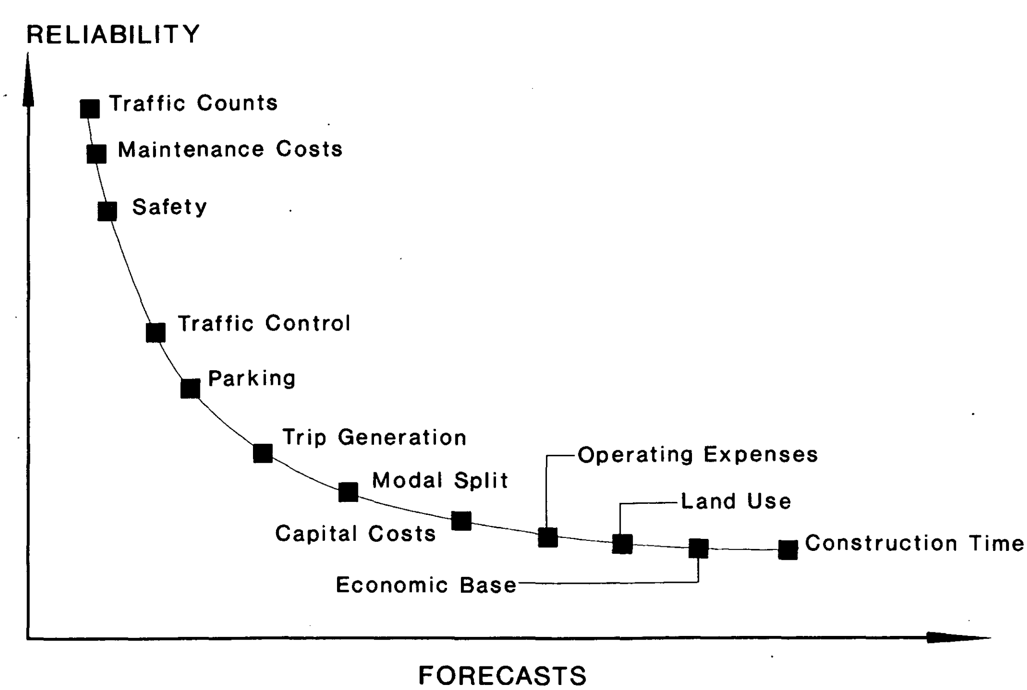

FIGURE 1 Reliability functions.

and parking. Land use and economic development are primarily government activities. Coordination should come easier. But the evidence is to the contrary.

Incomes in China are very low, and any effort at serious user cost recovery is quite complex. However, we can expect very large passenger volumes as long as the fares are kept low. Revenue prediction should be a little more reliable.

It appears, therefore, that

1. Unless there is a massive infusion of foreign aid, the LRT/MRT systems in China are unlikely to be built within 5 to 15 years.
2. Even if funded, the time required to complete the LRT/MRT systems will most likely be about 10 to 30 years.
3. Equal capacity exclusive busways are more cost-effective and may take only 10 to 15 years to complete.

So what do we do in the meantime?

Transportation planning strategies, for Chinese cities, will differ depending on city size, trip lengths, corridor volumes, economic base, and individual discretionary incomes. There is adequate evidence to show that motorization has much to do with discretionary incomes and government regulations on their availability and purchase. Furthermore, bicycle and walking trips are related to incomes, trip lengths, city size, and the level and cost of public transit service (*22,23*). These strategies will also differ from the short term to the long term. Barret's studies have shown that the long- and short-term strategies will be different in the developing and the developed countries (*24*).

LRT/MRT should be provided for, but the transportation system management strategies should dominate planning with appropriate choices of modal mix for various population groups and 5- to 15-year horizons. These should also include non-transport methods (urban planning) to reduce trips, trip lengths, and energy-efficiency and to retain environment-friendly transportation systems. A generalized model is shown in Figure 2. Even though this model has been developed specifically for China, it is generally applicable to low-income countries.

The large volume of bicycle and walking trips will remain for at least 5 to 15 years in China. The strategy should be to accommodate these modes efficiently while making new investments in bus fleets (over 5 to 10 years) to cater to unsatisfied pent-up demand and to growth in demand. It is likely that applying very simplistic draconian measures to restrict bicycle and pedestrian modes in China without sufficiently comfortable and cheap alternatives will fail in practice.

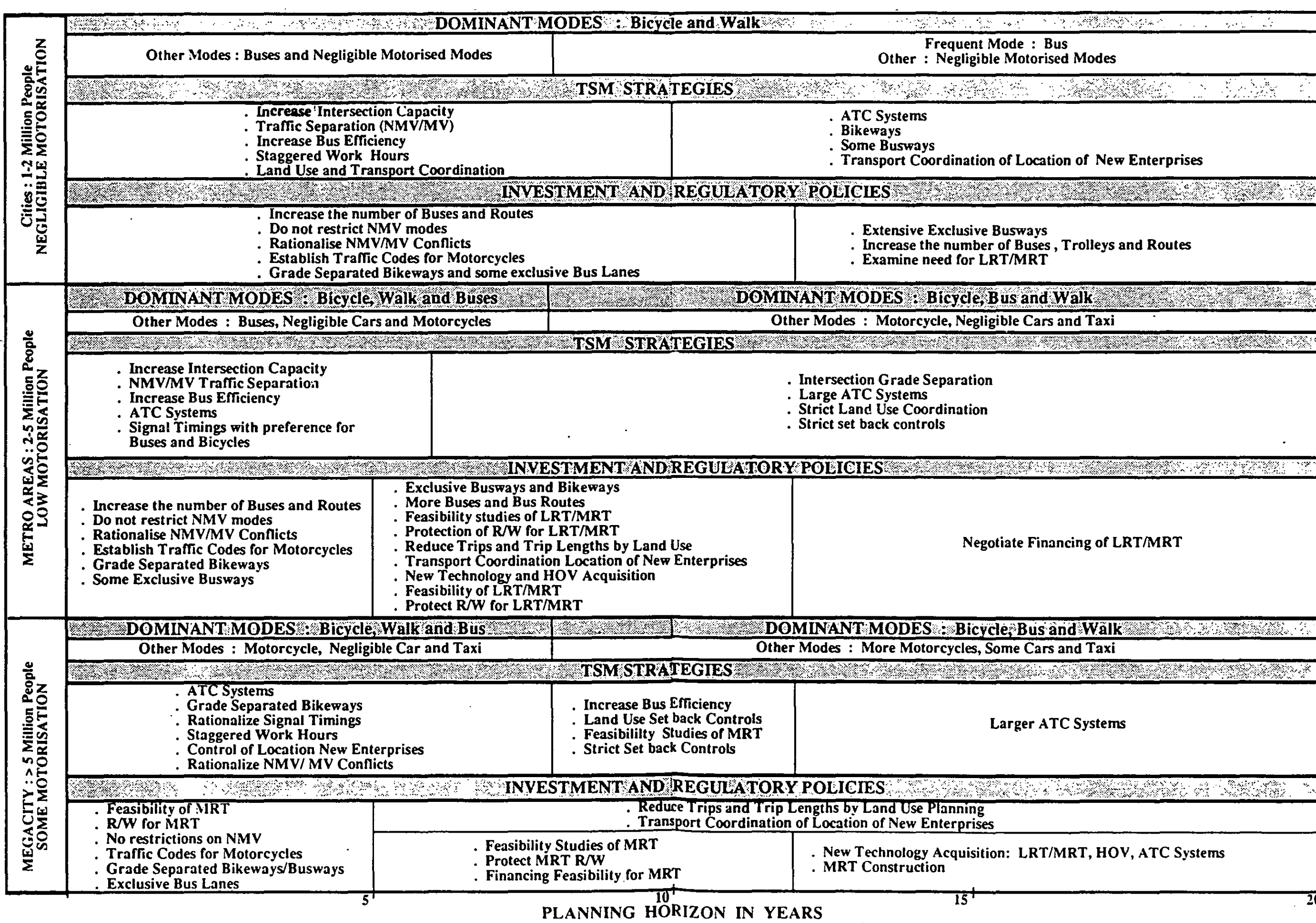

FIGURE 2 Urban transportation planning strategies in China.

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