Bicycle Use in Urban Areas in China

TOSHIKAZU SHIMAZAKI AND DONGYUAN YANG

The bicycle is the most important personal mode of transportation in the urban areas of China. Currently, the domestic production of bicycles is not only extensive but also increasing very rapidly. In 1988 more than 310 million bicycles were in use. The causes of the intensive use of bicycles and their effects on urban transportation are identified, and measures to overcome these problems are analyzed on the basis of data from various sources. Several reasons for such intensive use of bicycles include (a) poor public transit service, (b) the relative cost of private modes of transportation, (c) adequate size and shape of cities, and (d) the bicycle's standing as a major industry in China. Hence, the importance of bicycles as an urban transportation mode is expected to increase. With the intensive use of bicycles, several related problems were noted: one is the high rate of traffic accidents involving bicycles, and another is the traffic congestion due to heavy bicycle traffic. Several measures to overcome these problems are being studied in China, such as reducing bicycle usage through the intensive construction of subways and properly managing bicycle traffic on the basis of basic studies related to the characteristics of bicycle flow.

The major modes of transportation in the urban areas of China are buses and bicycles. Bicycles, in particular, are the most important personal mode of transportation in China. However, the overabundance of bicycles has caused various adverse impacts to urban transportation. To mitigate these impacts, several countermeasures are being undertaken. This paper first briefly reviews the status of the bicycle traffic in China and then introduces the major countermeasures being considered.

OUTLINE OF BICYCLE TRAFFIC IN CHINA

Currently, there are more than 300 million bicycles in China (*1*). Since 1980 the annual rate of increase of bicycle ownership has been more than 10 percent. The number of bicycles in Tianjin is more than 7 million, which is 33 times the number of cars. In 1987 the ratio of passenger transport by bicycle reached 81 percent of the total daily trips in Tianjin; public transit accounted for the remaining 19 percent (*2*). In 1989, 37 percent of the total trips in Shanghai were made by walking, 35 percent by public transit, and the remaining 25 percent by bicycle. In Beijing, the ratio of trip by public transit is only 57 percent. These are the three largest cities in China; they have relatively higher levels of service of public transit than other cities. Hence, it follows that the bicycle is the most important mode of transportation in China.

The modal choice ratio of the bicycle is greatly related to the trip distance and physical condition of users. From the origin and destination survey conducted in the city of Nanjing, the relationship between trip time distance and modal choice ratio is as shown in Table 1 (*3*). In Nanjing, with a trip distance within 10 to 30 min, the ratio of the bicycle is the highest of all modes, which exceeds 50 percent. It is said that the average modal choice ratio of bicycle is about 35 percent in Japan (*4*). The ratio is even lower in European countries. Judging from these ratios bicycle usage is very intensive in China. Table 2 shows the relationship between modal choice ratio and ages of users (*3*). In Nanjing, which is a typical large city in China, almost half of the people between 15 and 49 years old use bicycles very often, but most people younger than 14 and older than 59 make trips by foot.

There are both merits and demerits in the wide usage of bicycles. Saving energy and reducing exhaust gas are examples of benefits, but increasing traffic accidents is one of the demerits. The ratio of bicycle-involved accidents reached 30 to 50 percent of the traffic accidents in urban areas and 40 to 70 percent of the fatal traffic accidents in China. In 1989, for example, bicycles in Shanghai were somewhat responsible for about 32 percent of the traffic accidents and 37 percent of the fatal traffic accidents out of the total of 7,527 traffic accidents. Moreover, the number of car-bicycle collisions in Shanghai was 2,254, which was more than the number of car-pedestrian collisions (1,272) in 1988. The latest figure shows that the number of car-bicycle collisions was 1,087 and the number of bicycle-pedestrian collisions was 686 from January to September in 1989 (*5*).

TABLE 1 Relation Between Trip Time Distance and Transportation Mode in Nanjing

Distance (Min)	Walk %	Bicycle %	Public Transport %
≤10	52.6	44.0	2.0
11-15	39.0	55.7	3.7
16-20	35.5	52.8	9.2
21-25	27.5	52.5	17.3
26-30	21.9	50.9	23.7
31-35	13.6	36.0	43.7
36-40	11.6	35.6	45.4
41-45	8.0	32.7	50.6
46-50	8.2	24.9	58.2
51-55	6.0	19.9	64.4
56-60	7.0	6.2	62.9
>60	7.6	14.4	15.0

T. Shimazaki, Division of Geotechnical and Transportation Engineering, Asian Institute of Technology, G.P.O. Box 2754, Bangkok 10501, Thailand. D. Yang, Department of Road and Traffic Engineering, Tongji University, Shanghai, People's Republic of China.

TABLE 2 Relation Between Age of User and Transportation Mode in Nanjing

Age	Walk %	Bicycle %	Public Transport %
6-14	84.2	8.1	6.0
15-19	35.8	43.6	19.0
20-24	16.5	54.2	25.8
25-29	13.0	58.0	24.6
30-39	15.0	58.5	21.1
40-49	28.7	47.4	20.1
50-59	42.9	36.5	17.0
>59	61.3	20.7	15.7

REASONS FOR POPULARITY OF BICYCLE USE

Low Level of Service of Public Transit

In 1988 about 48,000 buses and trolley buses were used for the public transit service in more than 322 of 431 cities in China (*6,7*). The number of buses increased 14 percent a year from 42,000 in 1987. Buses, the major mode of public passenger transportation, carried 26.8 billion people in 1988. The ridership increased by about 2.8 billion in 1987. Although ridership looks very large, it is small in comparison with its population of 1.1 billion people. The low level of service of public transit is characterized by its average passenger density of 10 to 13 people per square meter in peak hours. Accordingly, the average ridership of public transit is very small; it was about 20 percent in Tianjin in 1987.

Subway systems serve in Beijing and Tianjin only. The total number of subway coaches is 274, and the passenger volume is about 31.9 million a year (*6,7*).

The number of taxis is very small—only 13,223. This is much lower per capita considering that there are only 0.93 taxis per 1,000 people in Shanghai, 1.18 in Beijing, and 2.56 in Guangzhou (*8*,p.12). In addition, taxis are used mainly for foreigners and tourists, not for daily transportation.

Economic and Financial Background

Because bicycle production is a major industry in China, the increase of bicycle production is highly encouraged by the government. Bicycle production accounted for about 5 billion yuan in 1984, which is approximately 0.5 percent of China's gross national product (*9*). The number of bicycles produced was 13 million in 1980, 28.6 million in 1984, and 41.2 million in 1988 (*1*).

During the oil crisis from 1949 to 1965, the Chinese government encouraged walking and riding bicycles because of the shortage and high price of petroleum. Since the accident rate of motorcycles is high, the Chinese government now restricts the use of motorcycles in urban areas. The average prices of personal modes of transportation in China are as follows:

Mode	*Price (yuan)*
Bicycle	200–400
Motorcycle	3,000–15,000
Car	80,000–200,000

The typical price of an ordinary bicycle is about 200 to 400 yuan (4.6 yuan = $1.00 U.S.) The average monthly wage of workers is about 150 to 200 yuan, which makes the bicycle affordable. In addition to this, the Chinese government subsidizes $20 (U.S. dollars) a year to the bicycle commuter, although the amount depends on the city. Consequently, it is normal for bicycles to be the major mode of personal transportation in the urban areas of China.

Size and Shape of Cities

The typical trip length by bicycle is about 6 km, or a ½-hr ride in China (*10*). The area of a circle with a 6-km diameter is about 30 km^2, and the area of most Chinese cities is less than this. This is one of the reasons that bicycles can be useful for personal transportation. Likewise, bicycles are also important in large cities, considering that most of the large Chinese cities have only one central business district, in which almost all the commuters gather. The commuting pattern looks like the diagram shown in Figure 1. The area for this case is about 113 km^2, but the area of most of large cities is less than 100 km^2. This is the reason that bicycles are useful even in large cities. Accordingly, a bicycle trip can easily cover the commuting areas in most Chinese cities.

Easiness of Bicycle Use

From Table 2, more than one-third of people between ages 13 and 59 use bicycles. Moreover, more than 20 percent of people—even those older than 60—use bicycles. This is partly because bicycles are very easy to handle. It is said that people between 13 and 70 years old can ride a bicycle after a week of practice.

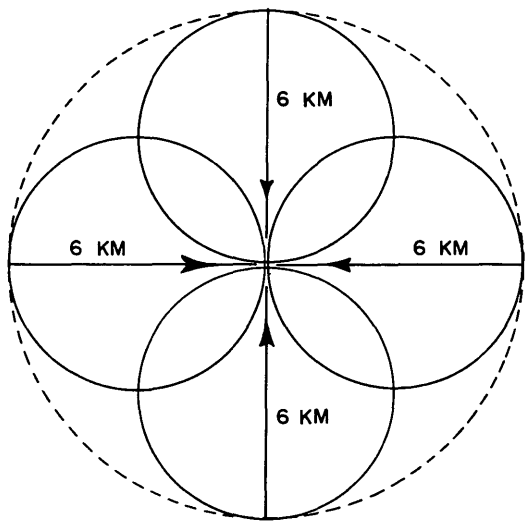

FIGURE 1 Schematic diagram of bicycle trip pattern in large Chinese cities.

EFFECTS OF BICYCLE TRAFFIC ON URBAN TRAFFIC CONDITION

The heavy bicycle traffic has caused various problems for urban traffic. Traffic accidents involving bicycles are the issue for which the influencing extent is the smallest but the most serious. Inefficiency of road usage is the issue for which the influencing extent is the largest. There are many issues between these two; major ones follow.

Traffic Accidents Caused by Heavy Bicycle Traffic

Figure 2 shows a schematic diagram of traffic flow at a crossing when the traffic signal is green. As bicycles mingle with cars, the chances of collision become great. When lanes for cars and bicycles are not properly separated, serious traffic accidents sometimes occur because bicycles suddenly turn left to cross a road. The ratio of accidents of this type is about 30 percent in Shanghai (*5*).

Reduction of Vehicle Speed

At Drum Building Square in Nanjing, the average vehicle speed decreased from 18.14 km/hr in 1983 to 11.17 km/hr in 1989, which corresponds to the increase of volume of bicycle traffic from 163,142 bicycles in 1983 to 277,469 in 1989 (*11*). Similarly, at Sanjie Street crossing, the average car speed decreased to 8.78 km/hr in 1989 from 15.59 km/hr in 1983, which also corresponds to the increase of bicycle traffic volume in 8 years from 114,410 bicycles to 203,528.

Inefficiency of Road Use

Compared with buses, bicycles do not fully use road capacity. The 1988 data obtained by authors in Guangzhou give the following facts. During peak hours, the average speed of bicycle is 5 to 8 km/hr with a required road area of 3.8 to 5.1 m^2/bicycle. During off-peak hours, the speed is 13.8 km/hr with a required area of 8.1 m^2. This means that eight bicycles are equivalent to one large bus in terms of required road area. Because the number of bicycles in Guangzhou was 1 million in 1988, bicycles require the same area as 125,000 buses. As for the traffic capacity, a large bus in China can accommodate 160 passengers. A million passengers can be transported by only 6,250 buses. Although these are rough estimates, we can deduce that bicycles are very inefficient in terms of road usage. This fact could possibly lead to more investments in road construction in urban areas.

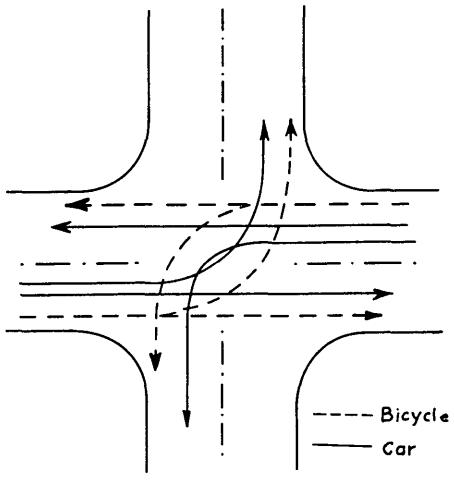

FIGURE 2 Schematic diagram of traffic flow at crossing when traffic signal is green.

EFFORTS TO MITIGATE ADVERSE EFFECTS OF BICYCLE TRAFFIC IN CHINA

China is one of the world's leading bicycle users. The development of mitigation measures that influence bicycle traffic is one of the most crucial issues in China.

Separation of Car and Bicycle Flows

Figure 3 shows a typical cross section of a road in an urban area. It is considered that physically separating cars and bicycles is the best way to reduce accidents between them. Separation is tried even at a flyover in China. Figure 4 shows the plan of the flyover, at which lanes exclusive for bicycles are installed in Beijing (*12*).

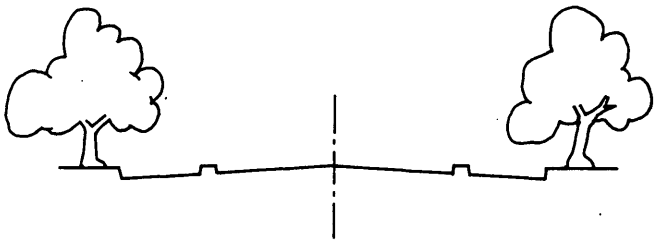

FIGURE 3 Standard cross section of road in urban area.

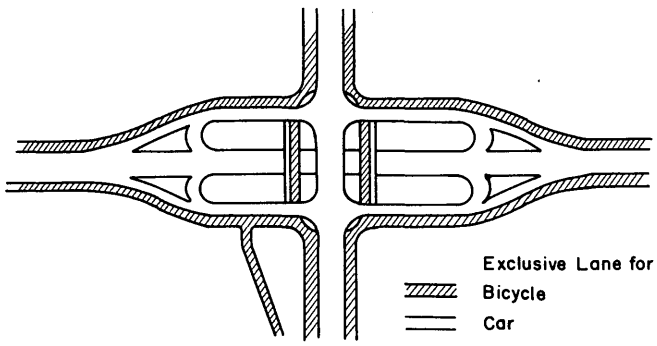

FIGURE 4 Plan for flyover with exclusive lane for bicycles in Beijing.

Level of Service of Public Transit

There is an adequate mix of transportation modes depending on the scale of cities, population density, available mode of transportation, and so on. Generally speaking, the ratio of bicycle use in urban areas in China exceeds this adequate level. Chinese engineers and planners consider the importance of diverting bicycle users to public transit by raising the level of service of the public transit system. The severe shortcomings of the public transit in China are its slow speed and congestion. However, efforts to raise the level of service of public transit are being undertaken. The first concern is to increase the average speed of buses on trunk roads. The low road density in urban areas makes it difficult to build exclusive lanes for buses in China. Hence, measures based on transportation system management are considered for the major policies.

In the central district of Shanghai, bicycles are prohibited in some roads; they are also prohibited from turning left at some crossings during peak hours. The traffic congestion problem on arterial roads is solved to some extent because bicycles do not necessarily suffer from these restrictions, because they can use the secondary roads near the main road. However, this may inconvenience bicycles and increase the danger to pedestrians on secondary roads. Since the bus service is the only public transit in Shanghai now, full use of bus is the only possible measure to solve the transportation congestion problem. Substantial improvements, such as construction of new roads, are almost impossible, although the subways are now being constructed. To improve the total performance of road usage, restriction of bicycles on arterial roads is almost the only measure. As for the increase of danger to pedestrian, we can only expect a level of danger that is less with the bicycles than with the vehicles. With this restriction, the average speed of vehicles on the main roads has improved.

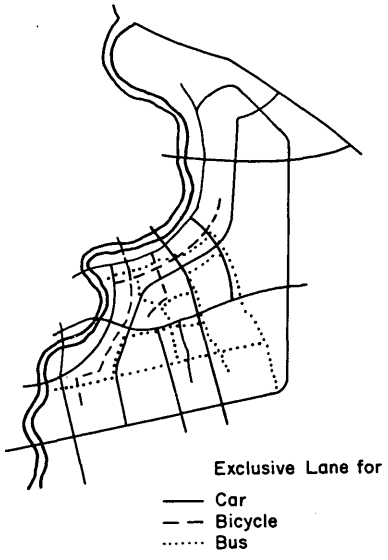

FIGURE 5 Road network system in new economic development district near Shanghai.

An increase of bus speed by 0.5 km/hr and 1.5 km/hr increases the transportation volume by 9.5 percent and the transportation capacity by 14.5 percent, respectively (*13*).

In long-range planning, construction of public mass transit systems, such as subways, is required and is now under consideration.

Improvement of Road System in Urban Area

Taking the side of long-range planning of roads, the improvement of the road system in urban areas should be considered. One major point is to consider bicycle traffic in the planning stage. Figure 5 is an example of this that shows the road network system in the new economic development district on the east side of Huanpu River near Shanghai (*14*). It is noted that an exclusive road for bicycles was planned from the beginning.

CONCLUSIONS

From the foregoing discussion, we can conclude the following:

- Overintensive use of bicycles causes urban transportation problems in China. Considering the importance of the bicycle because of the lack of sufficient public transportation, the solution to this problem is not to eliminate bicycles but to find adequate measures of coordination of bicycle and other mode of transportation.
- Overuse of bicycle in urban areas may harm the urban transportation system. The level of bicycle usage should then be kept within an adequate level in accordance with the urban development.
- In long-range planning, exclusive roads for bicycles should be considered.

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