8 BUS OPERATION BUSINESS IMPROVEMENT PLAN

8.1 Policy Directions for the Improvement of the Administrative System

8.1.1 Current Administrative System

Cities in China are under almost the same administrative system. The Public Utilities Bureau (PUB) is in charge of city transportation, while the Traffic Bureau handles suburban transportation. Chengdu has the same system, under which the PUB and Traffic Bureau share the work of increasing the routes and improving the facilities including bus stations. They however work independently because of different budget sources.

In recent years, with the expansion of the urbanized area, transportation services have gradually been provided on the outskirts. However, under the current traffic administrative system, management of transportation services on the city outskirts is unclear. Hence, a new area-wide traffic administrative organization in relation to traffic and transport systems must be established.

8.1.2 City Size in 2010

According to the General Plan of Chengdu City (1995 - 2020), the city size will expand to 598 sq km within the Outer Ring Road in 2010. Transportation within the 3rd Ring Road will be under the PUB, and that between the Third and Outer Ring Roads will be administered by the Traffic Bureau. It is predicted that the number of passengers generated in the area between the Third and Outer Ring Roads will increase from 170,000 to 550,000 within 10 years after year 2000 (see Table 8.1.1).

Table 8.1.1 Predicted Number of Bus Passengers

(person)

	2000	2010	Increase (2000-2010)
within the 3rd Ring Road	354,430	1,223,960	673,760
3rd Ring Road - Outer Ring Road	170,800	550,200	183,630

8.1.3 Proposed Traffic Administrative Organization

It is proposed that a single administrative body be responsible for public transport management in Chengdu. This setup will integrate management of city traffic including public bus (inter-city and intra-city), taxi and subway systems.

8.1.4 Shanghai (An Example of the Proposed Organization)

Until April 2000, Shanghai had a similar system with Chengdu. Traffic inside and outside the city was governed by the PUB and Traffic Bureau, respectively, while the Subway Group was in charge of planning, building and running the subway. Each of

these three administrative bodies planned, managed and carried out their respective mandates independently.

In May 2000, the PUB, Traffic Bureau and Subway Group of Shanghai were merged to form the Shanghai Urban Transport Administrative Office tasked to formulate and implement traffic plans. At present, all traffic and transport issues are handled by this single organization and the planning to implementation process has significantly improved.

8.2 Policy Directions for the Improvement of Bus Operation Business

8.2.1 Deregulation and Privatization

(1) Financial Problem of Existing Bus Transport Service and Privatization as the Measure to Solve It

At present, there is no major problem being experienced with the services provided by the public transport sector of Chengdu. However, due to the foreseen increase of vehicle traffic in the near future, travel speed of vehicles including that of buses will become lower, vehicles will use narrow urban streets to avoid traffic congestion on major roads, bicycle traffic will be seriously affected, and the traffic accidents will further increase. Under these circumstances, the PUB, responsible for implementing countermeasures to these problems, has difficulty in securing and allocating funds for necessary investments since it is also providing an annual subsidy to the current bus operation.

The subsidy has reached RMB 68 million in 1999. Roughly speaking, the subsidy will reach RMB 136 million in 2010, assuming that the number of bus units doubles and that the subsidy increases in proportion to the number of bus fleet. This subsidy will be a huge financial burden on the budgetary system of Chengdu since the proposed subway also requires a huge public investment.

By the establishment of new joint companies of the Chengdu Public Transportation Company and private investors, it is expected to introduce a new money source into the public transport industry.

(2) Deregulation in Bus Operation

To achieve privatization, restrictions should be lightened, with deregulation cultivating a competitive environment that is more efficient and providing demand-oriented services. However, based on the experience of other advanced cities, a phased deregulation is more viable.

If the direction of privatization is clear in Chengdu, the implementation will be much more smoother. As a guide for deregulation, the Japanese Road Transportation

Law submitted by the Japanese Government (Bus Traffic Bureau of the Transportation Department, Ministry of Transport) to the Diet in February 2000 may be useful. This was passed into law in May 2000, and following are the main points:

Objectives: In order to provide convenient and safe services and to boost the bus operation business, the demand adjustment rules are abolished to promote competition. However, the guidelines to ensure passenger safety and convenience are redefined.

Enterprises participation: The system used is changed from a licensing system based on the demands adjustment rules by route to approval system by company qualifications focusing on the requirements.

Business Plan: An enterprise's plan to increase its routes should be examined. As for plans to change the operating system and frequency, applications should be filed not unless it inconveniences relevant bus users.

Fare: It becomes free under the ceiling imposed in advance.

Suspension or abolition of enterprises: Any enterprise willing to suspend or abolish its routes should signify its intention six months in advance.

Before the revision came into effect, the public traffic administration (bus, taxi) in Japan used the demand adjusting system, which basically refers to the process of approving the applications of transport enterprises by the traffic administrative body when these meet a demand-supply balance. Such system can now be found in Shanghai, Guangzhou and Nanjing.

8.2.2 Experience in the Privatization of Major Chinese Cities

(1) Shanghai

Only one company monopolized the market since 1949. The appearance of minibuses in the 1980s signaled the beginning of private-owned mass transport service. But real privatization started in 1996 as a result of the city government's initiative to address the problem of increasing subsidy to mass transport system that the government could no longer support. In addition, low quality of service due to lack of competition was already causing irritation and impatience on the people. Below are the details of the privatization process.

(a) Reforming of the headquarter

- **Reform in the business system:** The mother company was closed and the new stock holding company was established as an independent state-owned holding company with 16 independent affiliated companies. The affiliated

companies gradually became private-owned by absorbing private funds. At present, the total number of bus companies is 63. Buses owned by the 20 major companies cover 80% of the total. Most of these companies are offshoots of the original affiliated companies where the state-owned holding company still maintains more than 51% ownership.

- **Reforms in the fare system:** The monthly ticket system which used to be accepted for all routes ceased to be effective because one bus company split into several companies. Some companies introduced the now widely-used ticket system which does not offer discounts but solves the problem of giving change in self-service buses. Now a certain IC card used in many transport facilities has been developed. A discount on this prepaid card is being considered. This card will take the place of monthly tickets for all bus routes which is more economical.
- **Abolition of the subsidy:** The Shanghai government allotted a subsidy of 800 million RMB to the Shanghai Public Traffic Company in 1995, while the requirement in 1996 was 1,000 million RMB. Since the government could no longer bear this burden, the 1995 and 1996 subsidy allotted to the company was reduced by 200 million and 84 million RMB, respectively. It also decided to push through with privatization. In 1998, the notice of abolishing the subsidy was sent out as well as the government's requirements to reorganize the company and make it independent.
- **Government reform**: The government's duty was to supervise privatization. The government reorganized the administration and established a Passenger's Transportation Administration which has the following tasks:
- **Participate in the examination:** Examine applications according to specified regulations.
- **Examine the route plan:** Reevaluate entire main routes each year. The same company principally runs the original main routes and its extensions. In case of new routes service, the Experts Committee will evaluate the qualifications of enterprises willing to establish new routes. When the proposed regulations on passenger transportation are passed in the 11 sections of the permanent committee of Shanghai People's Representative Convention, the right to operate the routes will become clearer and will thus affect the examination.
- **Regulate fare:** The fare in an air-conditioned and non-air-conditioned bus is 2 RMB and 1 RMB within the city, respectively. In the outskirts, the fare is 1 RMB within 12 km. Beyond 12 km, the fare is computed by multiplying the distance by 0.15 RMB per kilometer. This ensures profit for companies operating in the city's outskirts.
- **Ensure service quality:** Since private-owned companies now provide

transport service, there is apprehension that this may lead to higher profits but lower service quality. To prevent this, service in each route will be monitored. The number of air-conditioned buses will also not be allowed to be more than that of non-air-conditioned buses.

(b) Stimulating the merger of enterprises

There were 152 private-owned enterprises during the start of the privatization process in 1996. The Government required the merged enterprises to have a minimum bus fleet of 30 buses per enterprise and to merge within a limited time period. Weak enterprises took one of the following options:

- Sold the enterprise.
- Became stock companies when merged with other enterprises and gained shares according to the number of owned buses.
- Merged under one name but continued their businesses separately (these enterprises were eventually made to choose any of the first two options. At present the number of individual proprietors belonging in this category is controlled, at less than 1/4 of the former number).

Experience showed that one company running the business is not good. Nor are too many companies. Hence the current number of transport companies should still be scaled down to five or six.

(c) Instituting preferential policies

Since it will be hard to ensure the survival of the new companies without providing them subsidies, the following preferential policies should be adopted:

- Protect the right of a company to operate a certain route (do not permit competition on routes)
- Provide preferential policies on taxes (for example, the road maintenance tax is fixed at the 1995 level, which is 1/4 of the official taxes).

(d) Following the experience of the Shanghai Shengxing Bus Limited Corporation:

- In 1998 the China General Company, the second top Bus Company in Shanghai (old affiliated company), formed a joint venture together with a Singaporean company and is now known as the Shanghai Shengxing Bus Company. This company now administers the 14 bus routes owned by the former. The joint venture has funds of 100 million RMB. Its top management is comprised of 51% Chinese and 49% Singaporean: four Chinese nationals including the chairman and three Singaporean nationals including the

manager. The venture has a 25-years term. The Chinese partners have the option to buy the shares of the Singaporean partners if the latter will be willing to sell their shares.

- The Chinese valuated their building and the rights to operate the Routes (valued at 18.7 million RMB), which then became their counterpart share. The Singaporeans on the other hand, aside from purchasing new buses, infuse fresh capital in the amount of 49 million RMB. Since the total funds infused by the Chinese are over 51 million RMB, the Singaporeans had to pay the China General Company the difference.
- The number of workers was reduced from 2,460 to 2,268, but the Singaporeans plan to cut it further to 1,800. The present workers are composed of 900 drivers, 700 conductors, and 650 people for other jobs.
- The number of buses increased gradually from an initial of 489 buses. It is forecasted that there would be 600 buses by the end of 2000. Renovation, repair and oil supply are entrusted to the No.2 Bus Company.
- In 1999, gross income was placed at 140 million RMB. The profits including taxes were 0.6 million RMB. The running distance covered was 60,000 km on weekdays and 50,000 km on weekends. The running distance in one year totaled to about 20.9 million km. The number of passengers decreased from 370,000 to 300,000 a day because the Shanghai Shangxing Bus Company operates only in the city and demands are shifting to the outskirts.
- The bus company has identified the following business issues, as follows: a) difficulties in extending the route to the outskirts; b) fixed time schedule not responsive to the decrease of passengers; and c) the tax rate increases because of privatization. Table 8.2.1 predicts the business quotas.

Table 8.2.1 Management Quotas of the Shanghai Shangxing Bus Limited Corporation (year)

Management Quota	Value	Notes
Rate to capital profit	0.060	Profits before deducting taxes
Rate to turnover	0.043	Turnover before deducting taxes
Turnover per km each bus (unit: RMB per km)	6.715	Turnover before deducting taxes
Turnover per bus (unit: RMB per bus)	233,333	600 buses at yearend (excluding repairs)
Passengers per bus (unit: person per bus)	182,500	600 buses at yearend (excluding repairs)
Drivers per bus (unit: person per bus)	1.5	
Turnover per passenger (unit: RMB per person)	1.279	
Passengers per driver (unit: person)	121,667	
Workers per bus (unit: person per bus)	3.78	

Source: Based on data provided by the Shanghai Shangxing Limited Corporation

(2) Guangzhou

(a) Background: In 1992, 2,000 buses and 1.7 million passengers a day were shared by No. 1 Bus Company (services in the city), No. 2 Bus Company (services in the outskirts) and Guangzhou Trolley Bus Company. At that time, commuters tend to choose bicycles instead of the bus because of low quality service by the latter. The World Bank, with the assistance of the Guangdong Government and the Central Government of China, conducted a seminar to draw a plan for the establishment of a new public transport system that is appropriate with the development of Guangzhou. Among the agreements reached during the seminar was that public transport has priority over individual traffic in Guangzhou and private funds would be infused because of insufficient public funds.

(b) Participating enterprises: In 1993, Guangzhou Trolley Bus Company, together with a Macao-based company, founded the private bus company Guangzhou Xingfuli Bus Limited Company. No. 1 Bus Company, on the other hand, took advantage of funds provided by Hongkong and founded No. 3 Bus Company. After its establishment, No.3 Bus Company entered into partnership with Hongkong and established two companies, and another company with domestic capitalization. The Guangzhou Tourist Bureau founded two private companies. As a result of these ventures, the number of private companies increased to seven. Later, however, one company founded by Guangzhou Tourist Bureau merged with No. 2 Bus Company. Thus, there are at present six private companies and three state companies. These companies are in charge of public transportation in the whole of Guangzhou. The routes owned by the three state companies account for 79% of the total routes with a passenger share of 82%.

(c) Passengers: Daily passenger population increases from 0.2 to 0.3 million people each year, reaching 3.9 million a day in 1999.

(d) Adjustment in future demand and supply: In spite of the daily passengers reaching 3.9 million people in 1999, competition should be controlled based on demand-supply adjustment. The transfer rate is 1.27 at present with a possible increase of up to 1.50. It can therefore be concluded that the number of routes is excessive. To improve its public transport system, the Guangzhou Government allocated 7 million RMB for the preparation of a new transport plan. A Hongkong-based Consultant Group conducted a joint study with a university in Shanghai for this purpose. The output, which is the transport plan, will be carried out as soon as the Government passes the resolution adopting the implementation of said transport plan.

(e) Subsidy: No.1 Bus Company and Guangzhou Trolley Bus Company will receive

subsidies amounting to 42 million RMB this year due to increased fuel expenses. In 1999, the subsidy was 40 million. However, the deficit of these two companies exceeded the subsidy. It is also predicted that deficit will increase from 80 million in 1999 to 100 million this year.

(f) Guangzhou Xingfuli Bus Company: This joint venture was founded by Guangzhou Trolley Bus Company, which provided 3,000 hectares of land evaluated at 6.6 million RMB, and Macao which provided 15.4 million RMB. The former owns 30% of the company and the latter 70%. At present, total capitalization has reached 130 million RMB. The original two routes and 30 buses have increased to 26 routes and 424 buses including 73 air-conditioned buses. Routes operated are mainly connecting the city with the outskirts. Table 8.2.2 predicts the management quotas.

Table 8.2.2 Management Quotas of Guangzhou Xingfuli Bus Company (in 1999)

Management Quotas	Value	Notes
Turnover per km per bus (unit: RMB per km per bus)	4.337	
Turnover per bus (unit: RMB per bus)	309,906	Excluding repairs
Passenger population per bus (unit: person per bus)	299,036	Excluding repairs
Drivers per bus (unit: driver per bus)	2.4	Excluding repairs
Turnover per passenger (unit: RMB per person)	1.059	
Passenger per driver (unit: person per bus)	124,100	
Workers per bus (unit: person per bus)	3.78	

Source: Based on data provided by Guangzhou Xingfuli Company

(3) Nanjing

(a) Background: Minibus services began in 1982. Except for minibus services, there was one state-owned bus company that monopolized the transportation business until 1996. That year also, the company received 60 million RMB from the Nanjing Government. However, despite this regular subsidy, it was not feasible anymore to improve the company's business situation. This was why privatization was introduced.

(b) Reorganization of the state-owned company: The state-owned bus company was divided into three companies. Zhangbei Limited Company established Zhengbei Bus Company (referred to as Company A). Company B together with a Hongkong-based company founded a joint venture wherein the Hongkong-based company and the city has 60% - 40% paid-up capital sharing, respectively. Company C, on the other hand, was established as a new city-owned company using the rest of the bus routes and workers. This reorganization was completed in 1997.

(c) Market coverage rates and company focus: Among the three companies,

Company C had the highest market coverage rate because it bought the profitable routes and carried out privatization. Table 8.2.3 reflects the coverage rate of each company.

Table 8.2.3 Coverage Rate by Company

Company	Number of Owned Routes*	Coverage Rate (%)
A	28	19
B	12	8
C	110	73

Note: * The number of owned Routes was speculated based on Route coverage rate.

- Company A (Zhengbei Bus Company): A deficit would occur when the 28 profitable routes are transferred to Zhangbei Limited Company only. The burden of shouldering the stipends will fall on Company C. Company A enjoys special tax privileges as a state-owned company.
- Company B: Hongkong capitals introduced new management technologies. The Company is prominent in efficiency and annual updating system of contracts of workers.
- Company C (newly formed state-owned company): The situation of this company will worsen because of the burden of stipends transferred by Company A. It is also not enough to reduce the number of workers from 12.6 per bus to 4.8. To increase the turnover of profit, the company has to make full use of the real property taken over from the old company and to try to develop relevant business undertakings. Redundant workers were employed in restaurants and other service professions.
- Opposition to privatization: One problem encountered was the opposition to the initial plan to transfer the profitable routes and leave the non-profitable ones with Company C. Another problem was the demoralization felt by workers assigned to Company A and B for having been transferred to a small company.
- Responsibilities of the Passenger Transportation Administration:
  - → Examination of participating companies: Although many companies including poorly managed ones want to enter the business, the number of companies allowed to participate is controlled thus disallowing the growth of competition.
  - → Adjustment and assignment of routes: For the original routes, original proprietors' rights were respected. However, the right to run on such routes is limited to three years, which, according to the results of examination, can be renewed. New routes would be modified according to

each company's plan. This would be carried out through bidding.

→ Administration of routes: The operating routes would be supervised.

(4) Lessons

The driving force towards privatization, which was commonly identified among the cities discussed in this section, was mainly the pressure brought about by the increase in subsidy. Privatization doubtlessly lessened subsidy although there are differences in magnitude per city. A common problem, with the exception of Shanghai, is the existence of non- profitable routes remaining after selling profitable routes selectively. It is therefore important for Chengdu to improve profitability prior to privatization and to promote privatization by company.

Three cities provide some protective measures to the privatized companies given their vulnerable features. From the viewpoint of achieving better service under free competition, three cities are still in transitional stage. This is acceptable as a realistic measure as long as the cities still keep its goal and provide a very clear policy direction to the companies that they should strive for improving their operations and structures.

8.2.3 Rules of Operation

Public transport services of Chengdu are monopolized by the Chengdu Public Transportation Company. As such its system and rules become the norm. However, in order to promote competition and encourage the entry and growth of other companies, the situation should be changed.

The traffic regulations of Shanghai, Guangzhou and Nanjing and the traffic transportation law of Japan are compared in Table 8.2.4 for reference. As for the entry to the transport business of companies in the three Chinese cities, any individual or unit that can meet relevant conditions on transport safety can participate in the transport business. However, the departments concerned will approve applications only when these suit the yearly plan of the City Government.

Based on the foregoing sections, it is very clear that each city is still adjusting transport demand and supply and not yet actively pursuing privatization to remove state protection and sell parts of the state’s management rights to private transport companies. It can be said, however, that of all the cities Shanghai leads the others as to what stage it is now in the process of privatization.

Table 8.2.4 Privatization Rules in Chinese Cities and Japan's Transportation Law

Item	Japan	Shanghai		Guangzhou	Nanjing
		Current	Amendment Carried Out in 2001		
Participating Company	Examination of the qualification of the company to ensure transport safety	No written regulation	No written regulation	No written regulation	No written regulation
Applications for Routes	1. Applications for increase of Routes will be ratified when the approved company satisfies relevant conditions. 2. Applications for change of service should be made in advance and will be approved on a case-to-case basis. 3. To ensure passenger convenience, performance improvement advices are given when necessary.	1. Municipal Public Utilities Administration lays out the yearly Route plan and publishes this regularly. 2. Applications for Route change and extension are approved when they are in accordance with the yearly plan. 3. Applications for change of service should be made in advance and will be approved when the condition calls for it. Items to consider are fleet, parking lot size, transport plan, and number of drivers, etc. 4. When a violation occurs, the company should be ordered to improve its operation or be fined.	1. Municipal Traffic Administration (reformed) regulates the yearly Route plan. 2. Applications for Route change and extension are approved when they are in accordance with the yearly plan. 3. Applications for change of service should be made in advance and will be approved when the condition calls for it. 4. Management rights will be bid out. The term is 8 years, during which the rights cannot be transferred or sold. Six months before expiration, the company can apply for an extension. The Municipal Traffic Administration will publicize results 3 months before expiration. An examination will be done on the company's fleet, parking lot size, transport plan, number of drivers, etc. 5. The Municipal Traffic Administration will organize a committee to carry out annual evaluation. When violations occurs, the company will be ordered to improve its operation, be fined or its management rights revoked.	1. Municipal Public Utilities Administration lays out the Route plan. 2. Applications for Route change and adjustment are approved when they are in accordance with the yearly plan. 3. Management rights will be bid out. The rights cannot be transferred without the municipal government's approval. An examination will be done on the company's fleet, parking lot size, transport plan, number of drivers. etc. 4. When violation occurs, the company will be ordered to improve its operation, be fined or its management rights revoked.	1. Applications for route change and adjustment are approved when they are in accordance with the yearly plan. 2. Applications for change of service should be made in advance and will be approved when the condition calls for it. 3. Management rights will be bid out. The term is 3-5 years. In case of transfer of rights, the supervising administration's approval is required. An examination will be done on the company's fleet, parking lot size, transport plan, number of drivers, etc. 4. Evaluation will be carried out yearly. If problems occur, the company will be ordered to improve its operation, be fined, its management rights revoked, or its privilege to update its management rights canceled.

Cont. Table8.2.4

Fares	The upper limit is regulated. 1. Any adjustment of the upper limit should be applied for in advance. 2. When any unjust competition occurs, it should be corrected through regulations.	Regulated by the Municipal Prices Administration	Regulated by the Municipal Government	Regulated by the Municipal Prices Administration	Regulated by the Municipal Prices Administration
Termination of Management Rights	Application for extension should be made 6 months before termination of management rights.	Application for extension should be made 90 days before termination of management rights.	Application for extension should be made 3 months before termination of management rights.	Application for extension should be made 30 days before termination of management rights.	Application for extension should be made in advance.

8.2.4 Direction of Privatization in Chengdu

As is mentioned in section 8.2.1, introduction of a new money source into the public transport industry by the establishment of new joint companies of the Chengdu Public Transportation Company and private investors is expected. Following this scenario, the privatization direction for Chengdu is clear:

(1) Reorganize the Chengdu Public Transportation Company and create a Stock Holding Company.

(2) Privatize affiliated transport companies.

(3) Reorganize affiliated companies into joint stock companies of the said stock holding company and private funds.

(4) Pay more attention in strengthening the companies earlier mentioned as the first stage of privatization. In the second stage, Chengdu city government should create the competitive environment to encourage the growth of these private companies.

8.2.5 Chengdu City Government and Privatization

(1) Converting from Government Control System to Approval System

It is evident that Chengdu is late in introducing the principles of market economy in managing its public transport. This is so probably because it is deeply rooted in the people's mind that publicly-owned transport operation should always be beneficial to the public, and it is not appropriate to profit from it. However, many cities in various countries are relaxing restrictions to entry to the business. Studies also show that privatized public transport, when appropriately and efficiently managed, can provide the public with more longer-term benefits.

In a competitive world, success can be achieved by providing preferential prices and better services. The primary condition for sound competition is to publicize information and promote competition, an atmosphere that the government must

ensure. The result will be decreased price and improved service. Companies that cannot provide these will not survive the competition, while those that can will serve the public better.

Under the Government control system, the original company's interests are opt to be protected, but this system cannot protect the passengers' interests nor provide sufficient transport supply. The Government control system can only acts as a transitional measure in the transformation from a monopolistic, centrally planned economy to market economy.

(2) Ensuring Continued Service

The principles of market economy contradict the public benefit in some aspects. For example, bus owners who expect to earn profit will not transport a few passengers. Hence it is the responsibility of the supervising administrative body to ensure that public service is not sacrificed in favor of profit.

(3) Regulating Fare Ceiling

Although different routes make different profits, it is important to create a generally competitive environment for most transport operators, in which they can regulate the fare by themselves thus profiting from the operation while providing reasonably priced transport services. However, the Government will determine the fare's upper limit.

(4) Amending Laws Prior to the Reorganization of Chengdu Public Transportation Company

Amendments of regulations should be approved before the reorganization of Chengdu Public Transportation Company in reference to those of other cities.

(5) Preparation to Ensure Smooth Privatization

Prior to privatization, the following preparation should be done to ensure a smooth privatization on the basis of sound business environment:

- Air-conditioning buses: Half of the buses should be equipped with an air-conditioner, prioritizing the newer buses, while newly purchased ones should be equipped with this.
- Self-service system: A self-service system should be implemented in buses 8 years old and below.
- CNG: Conversion of Diesel/Gasoline engines boarded on less than 8 years old buses to Compressed Natural Gas (CNG) should be pursued.
- Fare: The fare should be changed according to the policies mentioned earlier.

- Monthly ticket: The monthly ticket for all routes should be abolished and a prepaid card should instead be used in all routes. Discount rate starts from the level at present but will be decreased up to 10%.

8.2.6 Chengdu Public Transportation Company and Privatization

The aim of privatization is to promote efficiency through competition. If Chengdu Public Transportation Company were privatized without any change in form a private-owned monopoly will take its place. It is thus necessary to break up the company into smaller firms first before privatizing it.

Characteristics of No.1 to No.6 Companies are calculated and summarized in Table 8.2.5. Sales per bus-km are scattered in the range of 3.0 and 3.5. No.2 and No.3 Companies show good figures (3.5), followed by No.1 (3.3) and No.4 (3.2), and No. 5 ended as 3.0. The reason of low figure of No.5 is due to existence of long distance routes, 9 routes with average length of 90km and sales per bus-km scatter from 1.0 till 1.6. Buses allocated are 373 buses for No.1 Company, 219 buses for No.3, 183 buses for No.2 and around 150 buses for other companies. Numbers of routes served are 27 for No.1 Company, 16 for No.5 and around 10 for others. Annual sales are 50 million RMB for No.1, 41 million for No.3, 34 million for No.2, 26 million for No.6 and around 20 million for each of others.

It is difficult to say these companies are located on the same route in characteristics but also difficult to say it is necessary to shuffle for the new start. The minimum adjustment of routes is required.

Table 8.2.5 Figures on the Affiliated Companies

Item	Total	Affiliated Company					
		1	2	3	4	5	6
Total turnover (unit: 1000 RMB)	19,286	4,954	3,435	4,097	1,962	2,218	2,620
Bus fleet as of Sep. 2000	1,232	373	183	219	147	151	159
Turnover per year per bus	156,545	132,821	187,706	187,092	133,446	146,886	164,794
Number of Routes	81	27	9	12	7	16	10
Route distance (km)							
Average Route distance	22.3	15.3	12.9	11.7	10.6	56.9	15.4
Longest Route	120.0	25.3	22.2	14.6	13.0	120.0	34.3
Shortest Route	5.0	5.2	8.0	6.8	8.3	5.0	9.5
Turnover per km per bus per year (unit: RMB/km/bus/yr)							
Average turnover per km per bus per year (unit: RMB/km/bus/year)	3.3	3.3	3.5	3.5	3.2	3.0	3.4
Highest turnover per km per bus per Route	6.4	4.9	6.4	4.8	4.3	4.8	4.6
Lowest turnover per bus per km per Route	0.9	0.9	1.5	2.1	2.0	1.0	1.7

Source: Chengdu Public Transportation Company

8.3 Financial Analysis on the Privatization of the Bus Industry

8.3.1 Income and Expenses of the Chengdu Public Transportation Company

The total income and expenses of Chengdu Public Transportation Company in 1998 are presented in Table 8.3.1. It reveals that total income can only cover 71% of the expenses. It is not even enough to cover business expenses. The deficit is made up for by subsidies. With the expansion of transport enterprises, the deficit becomes larger. This illustrates the essence of the deficit system. Given the fact that the deficit is proportionate with bus·running km, and subsidies make up for the deficit, the amount of deficit in the next 10 years is projected as shown in Table 8.3.2.

Table 8.3.1 Financial Condition of the Chengdu Public Transportation Company for 1998

(million RMB)

Item	1998	Remarks/Notes
Total Revenue	180.60	1,350 buses owned and number of dilapidated buses at the end of 1998
Recorded revenue	170.60	
Company deficit subsidy	10.00	
Total Outlay	242.16	
Recorded outlay: except the bus purchase expenses	199.23	
Expenses for bus purchase	12.00	In accordance with the subsidies used to buy new buses
Bus repair expenditures	25.13	At 18,615 RMB per year for each of the 1,350 buses
Taxes (Sales Taxes)	5.80	
Net Revenue without Subsidy	-61.56	
Total subsidy	68.00	
Recorded subsidy used to buy new buses	12.00	
Subsidy for CNG transformation	4.00	
House subsidy	2.00	
Business Performance	25.00	Distances covered of 59.37million km per year (using 1999 figures) × 0.3 RMB
Subsidy for repairing bus stations	25.00	
Subsidized Income less Expenses	6.44	
Revenue/ Outlay	0.705	The subsidy for the company's deficit is deducted from the total turnover

Source: Chengdu Public Transportation Company

Table 8.3.2 Projected Increase in Subsidies for Public Transport (Bus), 2000 – 2010

Year	Person-kilometer	Bus-kilometer	Ratio to 2000 (Bus- km)	Amount of Subsidy (million RMB)
2000	4,441,380	167,932	1.00	68.00
2010	10,404,580	440,700	2.62	178.16

8.3.2 Management Improvements to Make Privatization Possible

As discussed in the preceding section, the deficit occurs in the management of the whole bus transport industry. Thus even if privatization were carried out, it would fail. In this section, the following management improvement strategies will be presented in detail. If implemented properly, privatization could be possible.

(1) Prerequisites

- Accept the total 1,493 buses (as of May 2000) owned by Chengdu Public Transportation Company and keep them running.
- Increase the preserved buses according to the demands in the future.
- Retire the buses in operation for more than 10 years.

(2) Bus Fleet Plan

- Purchase price of buses—Assume that the purchased buses are the same as the existing buses of the Chengdu Public Transportation Company. Prices are the same: RMB 150,000 (non-air-conditioned CNG bus) and RMB 350,000 (air-conditioned CNG bus).
- Method of purchase—Assume that buses are bought through loans. In accordance with the depreciation period, the time limit for payment of the loan is 10 years at an annual interest rate of 10%. It is noted that according to the Chinese Statistical Yearbook (1999), the annual interest rate of loans (5 years or longer) was 10.35% in March 1988. The interest of the same loan was 12.42% in August 1996. This was reduced to 7.56% in December 1998. Thus, the average interest rate during the last 10 years is assumed to be 10%.
- Rate of operation—Use the actual performance level as the Shanghai Guangzhou private-owned bus company, that is 0.95.
- Number of buses—The number of dilapidated buses, which have been used for over 11 years, and the number of new buses that will be purchased are listed in Table 8.3.3. These estimates are under the assumption that privatization will be carried out in 2002. The dilapidated buses are too many in 2002 since those that have been used for at least 10 years will be cleared out at one time.

Table 8.3.3 Required Number of Vehicles

Year	Required No. of Buses	No. of Dilapidated Buses	No. of Possible Rental Buses	Required No. of Reserved Buses	No. of Purchased Buses (for rent)	No. of Purchased Buses (for reserve)
2002	1,715	312	1,332	86	383	86
2003	1,838	172	1,009	92	446	6
2004	1,970	91	918	99	223	7
2005	2,111	94	824	106	235	7
2006	2,263	124	700	114	276	8
2007	2,425	189	511	122	351	8
2008	2,599	168	343	130	342	8
2009	2,786	243	100	140	430	10
2010	2,986	100	0	150	300	10

- Other assumptions on expenditures concerning buses:
  (a) Repair expenditures: The Chengdu Public Transport Management Company spends 18,615 RMB per bus per year on repairs; this figure is also assumed here.
  (b) Insurance expenditures: The figures provided by the China-Japan Taxi Company will be used, that is, bus insurance of 12,000 RMB per bus per year and passenger insurance of 20,000 RMB per bus per year.
  (c) The buses will be scrapped after 10 year's use; the price of the scrapped bus is 6,000 RMB.
  (d) Renovation expenses of bus stations: The maintenance expenditures for bus stops and expenses of affiliated facilities are limited to the profits and will not be included in the relevant bus expenses.

(3) Personnel Plan

- Relevant matters concerning retired workers have been transferred to the Chengdu Social Security Bureau, the expenses of which are not taken into account. In China, there are many forms of additional economic benefits on top of the salaries such as workers' house subsidies. To make it simple, we adopt a multiplier of 2.25 times the salary to impute these additional income benefits from personal interview results. The difference between these figures and the actual salaries accounts for promotion expenses owing to privatization, pension expenses, and other personnel expenses on top of basic salaries. It is very evident that direct personnel expenses cover most of the total personnel expenses, so self-service system should be adopted. The direct personnel expenses for drivers are just salaries (now at 1,000 RMB per month). The salaries are 2.25 times as much as the current salaries for two shift works. Annual expenses are obtained by multiplying these figures by 12. The self-service system should be carried out before privatization. The foregoing assumptions, therefore, do not include the expenses for redundant conductors.
- Reduction of the indirect expenses (except various taxes) is assumed to be the

same as private-owned enterprise. Here we adopt the unit price of the China-Japan Transport Company (pertaining to bus operations). It is expected that the restructuring of the company structures by imitating the structure of the China-Japan Transport Company.

(4) Plan on Increasing Revenue

- Change the fare structure—The current fare is RMB 1 (RMB 2 for air-conditioned buses) regardless of the distance within the city. According to the fare policies of Shanghai, the fare is RMB 1 within 12 km plus RMB 0.15 per km. Applying these regulations, 51 of the 81 routes in Chengdu are within the 12 km distance limit. Owing to the still substantial number of routes over 12 km, the rule of charging fare by distance should be canceled and the quota fare system should be adopted. This system determines the additional fare by multiplying the incremental distance beyond 12 km by RMB 0.15 per km. This will add to the cost burden of short-distance passengers using long-distance routes. Thus, the bus travelling only part of its normal route should be introduced when changing fares (The bus traveling with a 12 km distance charge one RMB only).
- Increase the number of air-conditioned buses—As of May 2000, the Chengdu Public Transportation Company has 190 air-conditioned buses among its total 1,493 buses. Air-conditioned and non-air-conditioned buses are fielded in shifts, on the premise that they are equal in number. This means that different fare structures will be regulated according to the service. This also leads to an increment of turnover. To rationalize the different fare systems, the differences of type of service (air-conditioned or non-air-conditioned),air-conditioned buses should provide more comfortable to ride in. This work ought to be done during the preparatory period before privatization.
- Other strategies to increase income are extending the operation hours, operating diners and snack counters, increasing advertisements within buses, etc. These increases do not count in this section.

(5) Plan on Cutting Down Expenses

- The cost of CNG is half that of diesel oil or gasoline (diesel/gasoline expenses are a little bit higher than or similar to 1 RMB per km and the CNG costs only 0.46 RMB per km). Equipping buses with CNG engines is reasonable not only in the cutting cost points of view but also from the perspective of environmental preservation. This work should also be done during the preparatory period of privatization.
- The self-service system in the whole bus operation should be adopted, as earlier discussed. Two drivers are assigned to one bus. By doing so, direct personnel expenses can be reduced from 7,200 to 4,500 RMB a month.

8.3.3 Cash Flow after the Planned Improvements

Table 8.3.4 has incorporated some improvement methods to increase the turnover. These include fare amendment, increasing air-conditioned buses, reduction of expenses such as equipping buses with CNG and adopting the self-service system.

Table 8.3.4 Cash Balance of the Changdu Public Transportation Company after the Improvement Measures (using 1999 figures)

(unit: million RMB)

Number of reserved buses and allocated buses			
Allocated buses	1,232		
Total buses including reserved	1,493		
Cash Inflow			Notes
Turnover	Ticket	369.90	Half of the total bus fleet should be air-conditioned; Change in fare of buses covering routes beyond 12km distance
	Monthly ticket	40.80	Sales of monthly ticket is calculated using the figure before the improvement
Total		410.70	
Cash Outflow			Notes
Loan payments		60.74	Assumes that all buses are purchased according to the loan conditions stated above and the expenses will be 40,686RMB per year per bus
Insurance premium		47.78	Use the figure 32,000RMB per year per bus
Repair expenses		27.79	Use the figure 18,615RMB per year per bus
Oil and fuel costs		30.80	Reduce half of the CNG expenses according to the actual performance of No.1 branch company
Direct personnel expenses		55.44	2 drivers are assigned after the implementation of self-service system. The salary is 4,500 RMB a month.
Indirect personnel expenses except taxes		22.18	Use the standard of China-Japan Transportation Company
Business taxes		13.96	3.4% of the turnover amount
City building and planning taxes		0.75	500RMB per bus x no. of buses
City additional costs		10.75	7,200RMB per bus x no. of buses
Membership dues of association		0.18	120RMB per bus x no. of buses
Other taxes		5.91	4,800RMB per bus x no. of allocated buses
Total		276.28	
Net Inflow		134.42	

Table 8.3.4 shows that privatization becomes a financially feasible option, when carrying out the necessary measures stated earlier.

8.4 Analysis on Malfunctions

8.4.1 Operation at the Route No. 4 (No. 3 Bus Company)

A survey was made on the route No.4 in terms of bus service efficiency. On 19 September 2000, the operation performance of the buses at the West Gate Terminal was examined. The route No.4 starts the first service at 6 a.m. and the last service at 10 p.m. During the 16-hour operation, there were altogether 165 buses with the 30 buses including reserves. Table 8.4.1 shows the actual bus service per day. Taking into consideration the traffic congestion and bus failure on the road, the operation can be considered in order.

Table 8.4.2 presents a list of the buses that broke down on that day. It shows that 16 buses failed on the road, with 17 counts of malfunction (because one bus broke down twice). Four buses, after repair, got back in operation during the day and another four completed their repairs within the day. By the end of the day, 9 buses were still malfunctioning.

Based on the hearing at the survey site, most of the breakdown problems were due to flat tires, brake failure, clutch problems, and malfunction of the fuel pump. The minor problems could be solved on the spot but the others must be checked out in the shops of the branch companies.

Table 8.4.1 Driving Efficiency of the Route No.4 Buses

Time	No. of Buses Due to Set Out	No. of Buses That Actually Set Out
6 a.m.	10	11
7a.m.	12	13
8a.m.	11	11
9a.m.	10	8
10a.m.	10	10
11a.m.	11	10
Total in the morning	**64**	**63**
12 noon	12	9
1 p.m.	11	12
2 p.m.	12	10
3 p.m.	10	10
4 p.m.	10	10
5 p.m.	12	9
6 p.m.	11	9
7 p.m.	10	9
8 p.m.	7	6
9 p.m.	5	4
10 p.m.	1	2
Total in the afternoon	**101**	**90**
Total for the day	**330**	**306**

The dispatcher said that the level/frequency of malfunctions during the investigation day was normal. The repair shops of the branch companies will implement the working time schedule of 7:00 a.m. to 4:00 p.m. and 4:00 p.m. to 10:00 p.m.

Table 8.4.2 Malfunction Situation of the Route No.4 Buses

Bus No. of Buses That Broke Down	Kind of Bus	Setting-out Time at the West Gate Station	Notes
37044	Double-Decker	7:26	
37047	Double-Decker	7:35	Finished repairs after 4 hours
33011	Air-Conditioned	7:53	
33009	Air-Conditioned	9:45	Emergency repairs done and was back in operation again
37043	Double-Decker	13:28	
36087	Ordinary Type	13:34	Failure when setting out, was back in operation in the afternoon
33008	Air-Conditioned	13:57	
33014	Air-Conditioned	14:23	Failure when setting out, back in operation in the afternoon
36087	Ordinary Type	14:47	Failure when setting out, back in operation in the afternoon
36086	Ordinary Type	15:03	
37050	Double-Decker	15:27	
36087	Ordinary Type	15:33	Malfunctioned again after the first repairs
33015	Air-Conditioned	15:38	Emergency repairs done and was back in operation again
36090	Ordinary Type	15:51	Emergency repairs done and was back in operation again
37033	Double-Decker	17:15	Emergency repairs done and was back in operation again
33011	Air-Conditioned	18:21	
37040	Double-Decker	18:55	

8.4.2 Malfunction Analysis of the No.1 Company Buses

It becomes clear from the survey abovementioned that the high percentage of the malfunction requires more buses for reserve. The problem is not true only for this the Route No.4 buses and it has been one of the main factor that hinders bus service efficiency. To get a clearer picture, an analysis in a repair shop of a No.1 Bus Company repair records was carried out.

The No.1 Bus Company has a total of 468 buses at the end of October 2000 including the buses for reserve. There are repair services available at the bus terminal, which makes repair work on the spot possible. As the Study Team collected repair service records from the repair shop, certain repair works at the spot of bus malfunction are excluded. Usually, one mechanical problem but, in certain cases, several problems exist in a malfunction complaint, reaching as many as six.

Of the company's total buses before the end of October 2000, the most common ones are the ordinary type buses totaling 393 (including air-conditioned ones). In terms of the type of engine, there were 268 buses equipped with CNG engines, accounting for 57 percent of the total bus fleet (see Table 8.4.3).

Table 8.4.3 Buses Owned by the No.1 Bus Company, by Bus Type and Engine Type

Bus Type	Gasoline	Diesel	CNG	Total
Standard (w/o AC)	64	0	266	330
Mini (w/o AC)	44	0	1	45
Air-conditioned (All Type)	18	44	1	63
Double-decker (w/o AC)	0	30	0	30
Total	126	74	268	468

Source:No.1 Bus Company

The mini buses were mostly purchased about the year 1993. The air-conditioned buses were started to install from 1995, and 60 percent of the total installed is in 2000. The number of buses purchased in 2000 is rather high, 30% of the total bus fleet. The buses using gasoline were bought around 1993 as well diesel buses were introduced in 1995. The buses with CNG engines appeared around 1990, with a substantial increase after 1998. Table 8.4.4 presents the historical increase in buses purchased, categorized according to bus types.

Table 8.4.4 Number of Buses, by Type and Year Purchased

Year	Standard	Mini Sized	Air-con-ditioned	Double-decker	Gas Fuel	Diesel	CNG	Total
1986	1	0	0	0	1	0	0	1
1987	0	0	0	0	0	0	0	0
1988	4	0	0	0	4	0	0	4
1989	6	0	0	0	6	0	0	6
1990	10	0	0	0	5	0	5	10
1991	2	0	0	0	0	0	2	2
1992	12	3	0	0	13	0	2	15
1993	38	41	0	0	73	0	6	79
1994	14	1	0	0	4	0	11	15
1995	15	0	6	0	1	5	15	21
1996	9	0	0	0	1	0	8	9
1997	7	0	15	30	0	45	7	52
1998	40	0	1	0	1	0	40	41
1999	76	0	3	0	1	2	76	79
2000	96	0	38	0	16	22	96	134
Total	330	45	63	30	126	74	268	468

Source:No.1 Bus Company

In the following table, relation of malfunction and bus type will be analyzed. At first, number of buses sent into the repair shops in an average day are tabulated in Table 8.4.5.

Table 8.4.5 Average Number of Buses Breaking Down

Average No. of malfunctions per day	99.2
Average No. of buses sent to the repair shops per day	75.4
Average No. of malfunction points per bus	1.3

Source: based on the data provided by the No.1 Bus Company

Table 8.4.6 presents the frequency of bus malfunctions by type of engine. It indicates that the diesel double-deckers break down most often and other types go in for repair at

an average of 5 to 6 times a month (counting the several malfunction case as individual malfunction cases, so the real percentage is slightly below the data shown in the table).

Table 8.4.6 Frequency of Bus Malfunctions, by Engine Type

(times/month/bus)

Type of Engine	Gas	Diesel	CNG	Average
Standard	7.08	-	5.63	5.91
Mini	3.73	-	3.00	3.71
Airconditioned	3.00	6.11	10.00	5.29
Double-decker	-	17.50	-	17.50
Average	5.33	10.73	5.63	6.36

Source: based on the data provided by the No.1 Bus Company

Table 8.4.7 shows the frequency of bus malfunctions by type of bus and year purchased. Mainly due to the different ways of operating and maintaining buses, it is difficult to get any conclusions from the statistics. At least one thing seems to be clear, however. That is, there is no justifying evidence of a correlation between bus age and the frequency of its malfunction.

Table 8.4.7 Frequency of Malfunction of Buses, by Year of Purchase and by Type of Engine

(times/month/bus)

Year	Standard	Mini-sized	Aircondi-tioned	Double-decker	Average of All	Gasoline	Diesel	CNG
1986	6.00	-	-	-	6.00	6.00	-	-
1987	-	-	-	-	-	-	-	-
1988	13.00	-	-	-	13.00	13.00	-	-
1989	7.17	-	-	-	7.17	7.17	-	-
1990	11.30	-	-	-	11.30	13.00	-	9.60
1991	5.50	-	-	-	5.50	-	-	5.50
1992	5.50	1.67	-	-	4.73	4.31	-	7.50
1993	6.58	3.78	-	-	5.13	4.96	-	7.17
1994	7.50	7.00	-	-	7.47	4.00	-	8.73
1995	10.07	-	12.17	-	10.67	17.00	12.60	9.60
1996	10.56	-	-	-	10.56	0.00	-	11.88
1997	7.71	-	6.80	17.50	13.10	-	13.93	7.71
1998	9.68	-	10.00	-	9.68	10.00	-	9.68
1999	5.64	-	2.00	-	5.51	6.00	0.00	5.64
2000	1.96	-	3.74	-	2.46	2.38	4.73	1.96
Total	5.91	3.71	5.29	17.50	6.36	5.33	10.73	5.63

Source: based on the data provided by the No.1 Bus Company

Buses used for the route No.4 operation on the day of survey were 10 air-conditioned buses, 14 double-decker buses and 3 articulated buses. Probability of malfunction is 5.29/30 times/day for an air-conditioned bus and 17.50/30 times/day for a double-decker from Table 8.4.7. Assume probability of articulated is same as double-decker, expected times of malfunction of the route No.4 services becomes 11.7 times/day ((5.29x10+17.50x17)/30). Actual malfunctions were 17 but repairs at the workshop were 13 because 4 troubles were fixed at the site. It shows the survey result of the route No.4 was not peculiar.

As to type of bus malfunctions, we see that more than 20 percent of the breakdowns involved the electrical system, followed by the brakes (18%), wheel/tire (16%), propulsive axis, and engine (see Table 8.4.8). In terms of duration of repair work, more than 50% of malfunctioning buses go back in operation after fixing the electrical, CNG, wheel/tire and coin-thrown box problems. As for other problems, the same percentage requires about an hour of fixing.

Table 8.4.8 Percentage of Breakdown Among Different Bus Parts and Duration of Repair Work

Parts for Repair	In 30 Minutes	In 40 Minutes	In 50 Minutes	In 60 Minutes	In 90 Minutes	In 120 Minutes	Breakdown Percentage
Propulsion Axis	0.17	0.33	0.45	0.53	0.71	0.81	0.12
Electrical System	0.38	0.56	0.68	0.72	0.85	0.90	0.22
Engine	0.19	0.31	0.45	0.50	0.67	0.76	0.10
CNG- Connected	0.60	0.60	0.60	0.60	0.60	0.60	0.00
Rear Axis	0.12	0.30	0.42	0.48	0.71	0.80	0.08
Steering Gear	0.17	0.29	0.42	0.53	0.69	0.80	0.06
Main Body of the Bus	0.23	0.41	0.53	0.61	0.80	0.88	0.08
Coin-thrown Box	0.50	0.63	0.63	0.75	1.00	1.00	0.00
Wheel, Tire	0.49	0.63	0.82	0.87	0.95	0.97	0.16
Brake	0.25	0.42	0.57	0.64	0.83	0.90	0.18
Total	0.28	0.44	0.58	0.64	0.80	0.87	1.00

Source: based on the data provided by the No.1 Bus Company

The major mechanical malfunctions resulting in bus breakdowns are flat tires, brake problems, broken bulbs, and compressor malfunction. If necessary repair work has been done before dispatching the bus, the time wasted in fixing malfunctions in the garage during the trip may be avoided. Up to 90% of the buses of the No.1 Bus Company stop by the roadside after a day's driving due to shortage of parking space in the garage. It results in a lower bus operational efficiency (Table 8.4.9).

Table 8.4.9 Frequency and Type of Repair Works

Type of Repair	Total No. of Buses
Flat or broken tire	456
Brake trouble	268
Clutch trouble	161
Broken bulb	136
Leak of compressed air (from pump)	132
Leak of compressed air (from pipe)	114
Gear trouble	109
Dynamo trouble	105
Compressor trouble	99
Wiper trouble	88
Starter trouble	71
Short-circuit	64
Instrument trouble	61
Water leaking	57
Switch trouble	56
Horn trouble	54

Source: based on the data provided by the No.1 Bus Company

8.5 Promoting Use of CNG

8.5.1 Rationale for Promoting the Use of CNG Engine

(1) Cost Savings

According to the introduction of the No.1 company, the fuel price of diesel engine is a little higher by one RMB per kilometer while the price of CNG engine is only 0.46 RMB per kilometer or less than half of that of the diesel engine. Of vehicles equipped with gasoline engine, minibuses account for the large number (44 in 126). In spite of a lower fuel cost, gasoline-fed vehicles spend an average of 0.86 RMB per kilometer. This cost savings of CNG engines is one of the important factors to support financial viability of privatization of bus operation.

(2) Environmental Protection

From the viewpoint of environmental protection, the use of CNG is significant for two reasons. One, the main composition of CNG is methane. Thus waste gas emission is much less as shown in Table 8.5.1.

Table 8.5.1 Decrease Rate of Exhaust Gas Emission by CNG (in comparison with Diesel)

Waste Gas Emission	Decrease Rate
NO_X	60-70%
CO	40-50%
CO_2	2-3%
SO_X	100%
Black smoke	100%

Source: Journal of Bus Association in Japan, 1994

Two, CNG is not poisonous resulting in better air quality. In addition that it is lighter than air and seldom catches fire compared to gasoline and diesel. Table 8.5.2 below lists the specific properties of various kinds of fuel.

The CNG engine is sometimes said the power is insufficient for heavy vehicles including buses. However, the Transportation Bureau of Tokyo City compared the diesel engine (Isuzu 8PEI) with an improved CNG engine of the same. The result showed that although both have the same power, the latter has a stronger torque. The reason for this is that the burning speed of natural gas is faster than that of diesel (Table 8.5.3).

Table 8.5.2 Properties of Fuels

Property	Methane	Propane	Gasoline	Diesel	Property of Methane
Specific gravity to air (15℃)	0.555	1.548	3.4	>4.0	Lighter than air
Self-burn temperature （℃）	540	457	228	260	Difficult to self-burn
% of possible burning (volume %)	5.3-15.0	2.4-9.5	1.0-7.6	0.5-4.1	Difficult to catch fire
Total calorific capacity (kcal/l)	2,000	6,110	8,400	9,200	
Octane value	about 130	125	90-98	-	

Source: Natural Gas Association in Japan, " Popularization of Buses with Natural Gas", 1999

Table 8.5.3 Comparative Analysis between CNG and Diesel Engines

Engine Model	8PEI CNG	8PEI
Total gas emission	15, 201	15, 201
Maximum horsepower	240/2100	240/2300
Maximum twisting force	110/1000	85/1400
Compression ratio	12.0	18.0
Form of fuel ignition	form of spark ignition	compression form
Catalyst installation	cubic catalyst	not used
Fuel vessel	95. 5Nm^3	170 liter
Running distance per fuel fill-up	about 170km	about 340 km

Source: Environmental Report of The Transportation Bureau Tokyo City

8.5.2 Issues of CNG Conversion

(1) Distribution Density of CNG Stations

The biggest problem in CNG conversion is the inadequate distribution density of CNG stations, posing a serious problem for vehicles that have uncertain running distances especially those with uncertain destinations. This does not affect buses because they have standard running distance and scheduled destination. Their possible running distance is usually 300 km per fill up (up to 50–60 m^3) and there are only nine routes under the Chengdu Public Transportation Company with a daily average running distance of over 200 km. From this point of view, buses can perform very well when converted to CNG even in the inadequate distribution density of CNG stations (Table 8.5.4).

Table 8.5.4 Routes with a Daily Average Running Distance of over 200 Km

Route No.	Route Name (origin and destination)	Company	Route Length (km)	Distributed Vehicles	Running Frequency (one way/ day)	Average Daily Running Distance (km,)
34	North Station - North Station (1stRing Road)	No.2	22.20	29	211	323
27	Jiuyanqiao - Jiuyanqiao (1st Ring Road)	No.1	22.40	39	207	238
44	North Station – Huangzhongxiaoqu	No.2	11.30	8	82	232
83	Qinglongchang Central Terminal – Huangzhongxiaoqu	No.2	13.00	10	84	218
20	Niushikou – Kuangjichang	No.1	12.90	7	58	214
23	Ximen Bus station - Sichuan Industry College	No.3	14.60	11	80	212
10	Wuhouci – Jinhuacun	No.6	12.00	10	87	209
72	Youleyuan - Jiaodaguangshaxiaoqu	No.1	16.20	12	76	205
2	North Station - Wuguiqiao	No.2	12.75	22	176	204

Source: Chengdu Public Transportation Company

Assuming the number of buses with over 200 km running distance which needs refilling in a day is about 148 or 11.6% of 1,272. It is therefore rather easy to advance CNG conversion of public buses.

Buses using gasoline or diesel need 12,000 and 20,000 RMB, respectively, to convert to CNG. Once converted, they can save on fuel costs at about 0.5 RMB per kilometer. At a daily average running distance of 151 km, this translates to an average of about 27,556 RMB each year in fuel savings. Hence, conversion expenses will be recovered in less than a year. In fact, CNG conversion of buses of Chengdu Public Transportation Company has been ongoing. As of May 2000, CNG buses would have accounted for 24% of its bus fleet.

8.5.3 Malfunction Rate of CNG Engines

In Chengdu, the fitting of CNG engine is done at designated factories. In the city of Chengdu, buses using gasoline are the main targets for conversion. The conversion does not require much technical skills and mechanical troubles do not increase due to conversion. At the end of October 2000, the number of buses in the No.1 Bus Company was 126 gasoline-fed (including 44 minibuses), 74 diesel-fed buses and 258 CNG (including converted) or a total of 468 (Table 8.5.5, reshown of Table 8.4.3).

Table 8.5.5 Buses Owned by the No.1 Bus Company

	Gasoline	Diesel	CNG	Total
Standard size	64	0	266	330
Mini size	44	0	1	45
Air-conditioned	18	44	1	63
Double-decker	0	30	0	30
Total	126	74	268	468

Source: No. 1 Bus company

Table 8.5.6 (reshown of Table 8.4.6) lists the malfunction rate of vehicles by type of engine and by type of vehicle. Apparently, double-decker diesel buses have the highest malfunction rate at 17.50%. Rate of malfunctions of Gasoline Engine to CNG: 0.95. Rate of malfunctions of Diesel Engine to CNG : 0.96. The malfunction rate of CNG vehicles is higher than other vehicles by 5% including double-decker buses.

Table 8.5.6 Frequency of Bus Malfunctions by Engine Type

(times/month/bus)

Vehicle	Gasoline	Diesel	CNG	Average
Standard size	7.08	-	5.63	5.91
Mini size	3.73	-	3.00	3.71
Air-conditioned	3.00	6.11	10.00	5.29
Double-decker	-	17.50	-	17.50
Average	5.33	10.73	5.63	6.36

8.5.4 Proposed Plan for CNG Conversion

(1) Background

The Industry Department of the Chengdu Planning Committee is in charge of promoting CNG conversion. Following is a brief update on the program:

- At present, there are no laws that promote and popularize the use of CNG.
- Demand for CNG will increase owing to execution of strict emission control.
- In view of the insufficient horsepower of a CNG engine, installing bi-fuel (CNG and gasoline) engine is advised.
- The target of CNG conversion in 2000 is 10,000 vehicles. It will be achieved conversion of buses belonging to Chengdu Public Transportation Company and all vehicles operating under the jurisdiction of the City Government.
- Natural gas is widely used by households, 93% of families especially in the urban area of Chengdu uses this gas. This means a dense piping network is already in place and it would be easy to build CNG stations.Natural gas pipes are laid not only in Chengdu, but all over the province except for thinly populated areas As for supply, there are large-scale gas fields in North and South Sichuan as well as small fields in Longquan and Qinglong in the city of Chengdu.

(2) Bottlenecks

CNG engine is greatly attractive to vehicle owners due to the following reasons:

- It is more economical than diesel or gasoline even taking conversion cost into account.
- It is at par with other engines in terms of repair costs.
- Horsepower and torque are equal to diesel engine.

However, the major users of CNG are limited to buses so far. The few and uneven distribution of CNG stations is the major hindrance to its popularization.

(3) Plan on CNG Station

Background on CNG station plan

- The Public Department with the help of the Fire Bureau, a unit of Public Security Bureau, shall enforce safety regulations in CNG stations.
- Every bus company and bus-terminal company are encouraged to build new CNG stations.
- There are three existing CNG stations of the Chengdu Public Transportation Company for its affiliated firms. It likewise planned to increase the number of CNG stations by 25 at the end of 2000.
- Required investments are as follows: imported equipment - RMB 5 million, locally made equipment – RMB 3-4 million, land and building construction – average of RMB 4 million.
- Buying and selling price: CNG stations buy piped gas from 0.8 to 0.9 RMB per cu m and sell it from 1.5 to 1.7 RMB per cu m.
- The city stipulates that CNG stations and gasoline stations should be set up separately. At present there are about 170 gasoline stations in the city of Chengdu.

Plan on CNG Station

Over 2,000 buses including minibuses are assumed to be converted to CNG. According to the study by The Transportation Bureau Tokyo City, the average time of filling is 2 minutes 49 seconds and the average amount of filling is 47.7 cu m. Samples of this study, 224 fillings shows good fit to a straight regression. The formula obtained is as follows:

$$y = 2.67x + 36.3 \cdots\cdots (1)$$

where, y = time of filling (second)
x = amount of filling(m^3)
36.3 seconds = operation time needed before and after

The present situation in Chengdu is not like this. At the visited CNG station, drivers complained of long filling time, often one hour, due to low pressure, although that station adopts a quick-filling system of the cascade type using a high-pressure tank.

The Transportation Bureau Tokyo City lists the maximum loading capacity of bus fuel at 69 to 75 m^3 and average amount of filling is 47.7 m^3. Therefore, it can be considered that the average absorption rate has reached from 64% to 69% of possible loading capacity.

Based on the above discussions, the number of filling stations needed was estimated assuming the present loading capacity of bus. Average filling amount was assumed at its 65%. Average filling time can be calculated using the formula above. Gas consumption rate and average running distance were used to estimate the average daily frequency of filling, which leads to the number of buses that require filling.

In order to predict the demand and supply of CNG, the rate of service time in filling posts at four gasoline stations in the city of Chengdu was studied. It was found out that the rate of service time is 26% for 8.5 filling posts in an average gasoline station. Efficiency will be increased to 100% in each CNG station if there are four filling posts with a service rate of 25%.

In addition, the frequency of filling for buses whose mileage is over 200 km daily is twice a day, while that for buses running from 100 to 200 km and less than 100 km daily are once a day and once every two days, respectively.

Table 8.5.7 Number of Vehicles Requiring Daily Filling

Daily Mileage	No. of Units	Route Number	Number of Buses for Filling
Over 200 km	148	7	296
From 100 to 200 km	869	48	869
Under 100 km	196	7	98
Total	1213	62	1263

According to Table 8.5.8, the total number of CNG stations for 2,000 buses which need daily filling is 3. This is comparable to the existing number of CNG stations.

Table 8.5.8 Number of Required Gas Stations

Volume of gas bottles(m^3)	50
Average quantity of gas supply (m^3) [1]	32.5
Average time of gas fillup (seconds)[2]	123.1
Average running distance (km)	151
Consumption rate of gas (km/m^3)	6
Frequency of gas supply (time or day)	—
Number of served vehicles	2000
Number of served vehicles daily	1263
Average amount of filling post	4
Operating rate of filling post	25%
Operating rate of gas station	100%
Daily working hours of a gas station	16
Average number of served vehicles per day	467.91
Required number of CNG stations	3

Notes: [1] Presumes filling is required when 65% of gas is consumed.
[2] Data is from The Transportation Bureau Tokyo city.

8.6 Bus Fare System

(1) Background

The bus fare system of Chengdu cannot offset the total loss incurred by bus operation. That is why the municipal government still subsidizes the Chengdu Public Transportation Company. The 1999 subsidy reached RMB 68 million (including 12 million RMB for the purchase of new buses) to support company expansion and it is even expected to. This costs must be kept to a minimum, passing the financial burden to users, and the fare system must be reviewed. In principle, the passenger should shoulder the transportcost. Otherwise, it will be sourced from the tax revenue. It is not fair to compensate the loss by tax because bus users is minority, only 0.45 million of city population of 2.87 million (6 years old and above).

(2) Direction for Improvement

Based on the discussion above, the directions for improving bus fare system is to ensure sound bus business operation on the basis of beneficiaries-pay principle. Prior to requesting users to shoulder the cost, the business should curtail its expense to the minimum extent. This section discusses the fare system that produces a reasonable profit assuming the maximum effort of bus operators to reduce the cost of operation.

(3) Fare Structure

As discussed earlier, Chengdu is advised to adopt a fixed fare system based on the calculation of charging 0.15 RMB per km after the first 12 km. This will add to the cost burden of short-distance passengers using long-distance routes. Thus, the bus traveling only part of its normal route should be introduced when changing fares. (The buses traveling within a 12km distance charge one RMB only).

(4) Air-conditioned Bus

As discussed earlier, it is advisable to assign the same number of air-conditioned and non-air-conditioned buses on the same route, and the fare at present shall be maintained.

(5) Monthly Ticket

If the number of trips is 2.7 times a day which is assumed by Chengdu Public Transportation Company, the average trip frequency is 81 a month or 81 RMB worth of income for non-air-conditioned buses. In contrast, the monthly ticket price is 40 RMB with a discount rate of roughly 50% as of the end of October 2000. This discount rate seems to be too high.

In the future, the monthly ticket will be limited to certain routes and operating companies shall decrease discount rate gradually to prepare for the future reform.

(6) Prepaid Card and Bulk-paid Ticket

The major problem in self-service buses is the need to respond to the passengers' request for change. One way of addressing this is to install a vending machine that can give change. Another is to introduce prepaid cards and refluxing tickets. It is general to give 10% discount for prepaid card and bulk-paid ticket users. If we follow this, 11 bulk-paid tickets equal to the cost of 10 cards can be issued or a prepaid card worth 50 RMB can be used 55 times.

8.7 Bus Unit Improvement

8.7.1 Current Situation of Bus Units

(1) Type

The buses in Chengdu are generally divided into four categories: standard buses, minibuses, double-deckers, and articulated buses. Standard buses account for 75.3% of the total number of buses as of May 2000. Other buses are scheduled to be retired in the future. Buses can be further categorized according to the type of their engine: gasoline, diesel or CNG. For standard buses, gasoline engines account for 55%, CNG 31% and diesel 14%. The height of the bus floor from the ground is normal, the stairs are a little higher and not appropriate for elderly and disabled passengers.

(2) Self-service System

Self-service bus system began in 1993. A third of the buses of No. 1 company are self-service vehicles. That is, a cash box is installed near the front door where passengers can drop their fare after getting on the bus. This does not allow giving change, exchanging money and checking out card.

8.7.2 Direction of Vehicle Improvement

The purpose in improving buses is to cut down costs on manpower, fuel and repair, reduce time in getting on and off, ease crowding while fully considering the needs of the elderly and disabled, protect the environment; and make bus trips more comfortable.

Measures to be taken in improving buses are as follows: adopting self-service and card system; converting to CNG; integrating bus model (scrapping double-deckers or articulated buses); widening bus door; decreasing bus height; installing long seats, slanting door, priority seats, fixed fittings for wheelchairs, buzzers to indicate getting off; improving air-conditioning and information system inside buses; and bus location system (see Table 8.7.1).

(1) Cutting Down Costs

The importance of improving vehicles to cut down costs cannot be overemphasized. To do this, cutting down personnel expenses, adopting a self-service system and installing a machine that can give change, exchange money and accept card are necessary. It also covers installing buzzers to indicate getting off and improving the information system inside the bus to indicate the next bus stop and, probably in the future, to allow an automatic indication system using a GPS system.

Cutting down fuel costs can be done through CNG conversion. Fitting existing vehicles with CNG engine should be continued, while buying new vehicles should be limited to buses with CNG-engines. At present, gasoline buses are the targets of conversion. Diesel buses will soon be included.

(2) Increasing Transportation Capacity

Running speed often depends on three factors, time to get on/off, time to accelerate and decelerate and running speed. For city buses, their speed in accelerating and decelerating and running speed are mainly affected by external conditions. However, buses can control the time for passengers to get on/off. This can be shortened by using long seats, reducing bus floor height and widening the door to accommodate more passengers at a time.

The passageway will be spacious if long seats are used. Though these seats are less comfortable, city trips take a short time anyway. As a compromise, double seats can be used at the back where few passengers move about. Reducing the height of the bus floor from the carriageway shortens the time of boarding and alighting, but is not practical because of the engine placement of existing buses. It would be easier to widen the bus door to accommodate more people at a time.

(3) Improving Passenger Comfort and Convenience

To ensure passenger comfort and convenience, a clean vehicle and kind service, comfortable seats and adequate air-conditioning are important. In Chengdu, there is a big discrepancy in the fare of air-conditioned and non-air-conditioned buses. The aim now is to improve the services of air-conditioned buses to compensate for the high price they charge passengers. The next step is to improve the services of non-air-conditioned ones.

To ensure the convenience of the aged and disabled, priority seats can be assigned and fixed fittings for wheelchairs installed. The former measure is simple and does not cost much. It had good results in Shanghai. The latter measure however will be useless at present because it is not easy to bring a wheelchair into the vehicle. The latter shall be installed in coordinate to introduction of a wider door – lower floor type bus.

Table 8.7.1 Direction of Bus Improvement

Measure	Cut Down Man-power Costs	Cut Down Fuel Costs	Cut Down Repair Costs	Protect Environ-ment	Reduce Time in Getting On/Off	Ease Crowd-ing	Meet Demands of the Elderly and Disabled	Make Trips More Comfort-able
Adopt self-service system	◎							
Adopt card system	○							○
Convert to CNG		◎		◎				
Integrate bus type			◎	○	○	○	○	○
Widen door					◎	◎	○	○
Decrease bus height					◎	◎	◎	◎
Install long seats					◎	◎		
Install slanting door							◎	○
Install priority seats							◎	
Install buzzers to indicate getting off	○						◎	○
Install information system inside bus	○				○		○	○
Install fixed wheelchair							◎	
Improve seats							○	◎
Improve air-conditioning							○	◎
Bus Location System	○						○	○

8.7.3 Immediate Implementable Measures

From the discussion above, the improvement of the moment limit as follows.

- Adoption of a self service system
- CNG conversion
- Widening of bus doors
- Improvement of seats including long seat and priority seat
- Air-conditioning of buses
- Installation of information system inside the bus including buzzers for passengers to indicate getting off

8.8 Implementation Schedule

Implementation schedule shall be discussed in Chapter 11, in the Feasibility Study of Privatization of Chengdu Public Transportation Company.