

APPENDIX 15
PUBLIC TRANSPORT PLAN

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APPENDIX A15 PUBLIC TRANSPORT PLAN

A15.1 PLANNING CONCEPT

A15.1.1 Problem Identification and Evaluation of Existing Public Transport

Identified problems and planning considerations for the public transport plan, based on the existing public transport situation in Phnom Penh, can be summarized below.

(1) Overall existing public transport features

- Public transport supply is inefficient due to lack of a mass public transport system, because the urban area in Phnom Penh is small and densely populated—a condition resulting from a limitation of topographical conditions.
- When the population and economic conditions in Phnom Penh are changed, the public transport system will also shift from para-transit-oriented system to a comprehensive public transport system, based on the analysis of other Asian cities.

The future public transport system is proposed based on the future urban size (population and area), income level, and public transport demand in Phnom Penh, and the existing public transport system in other Asian cities. It is considered that the bus system will be one of the most appropriate public transport systems for the Phnom Penh metropolitan area in the future.

(2) Bus Transport

- Only one intercity bus company has an off-road terminal, bus terminals operated by other small bus companies are on-road
- Problems encountered in and around the taxi-bus terminal because of taxi-bus traffic

A new city bus system is to be introduced, the intercity bus system is to be restructured and major bus terminals in the CBD will be improved.

(3) Taxi Transport

- There is no city taxis.
- Various types of vehicle, such as vans, pickups and sedans, comprise intercity taxi-bus.

Sedan type of intercity taxi-bus can be converted into city taxis for foreigners and passengers who have several pieces of luggage with them.

(4) Para-transit 1 (Motodop)

- Motodop is the major public transport system in the city, because of its high level of service in terms of cheaper fare, frequency and door-to-door trips. It is also the most important financial source for low-income people. In spite of its popularity, its service is insufficient and poses danger to drivers and passengers alike. The motodop is also a primary contributor to the traffic problems in the city.

There is a need to introduce a registration system and a designated operational area for motodop drivers. Furthermore, it is necessary to restructure the motodop as a feeder transport mode to buses. As this measure will reduce the number of motodop units in operation, it will be necessary to prepare measures for those motodop drivers who will lose their jobs.

(5) Para-transit 2 (Cyclo)

- Cyclo is historically a unique mode of transport in Phnom Penh. However, this mode is not

effective in an urban transport setting because of its low speed.

Because of its history and uniqueness, the cyclo should still be allowed to operate but in a designated area, e.g., a tourist zone.

(5) Para-transit 3 (Motorumok)

- Allowing the motorumok to continue plying along the narrow and heavily-trafficked trunk road in the suburban area is dangerous.

It is necessary to restructure the motorumok for use as a feeder mode to buses in the suburban area and to ban its operation along the narrow suburban trunk road.

(5) Railway Transport

- Utilization of the existing railway is extremely low.

It is necessary to improve the existing railway. This can be accomplished by strengthening passenger and freight transport systems, by assessing the probability of its conversion to an urban rail system and by improving the station plaza at Phnom Penh Central Station, among other things.

(6) River Transport

- While river transport, which is an environment-friendly mode of transport, is the most important mode of transport in areas not served by land transport, its facilities, such as ferryboats and jetties, are deteriorated.

It is important to improve not only these facilities but also the feeder transport system between the ferry and trunk public transport for convenient access to/from the riverside area and for the improvement of urban environment in Phnom Penh.

(6) Air Transport

- Access to/from Pochentong International Airport is only by airport taxi and private modes and it is necessary to assess the future air passenger demand.

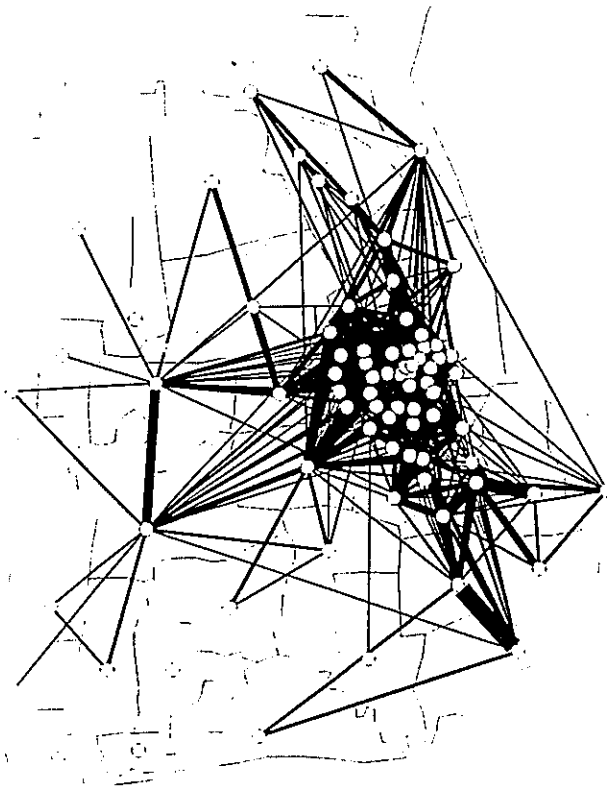
It is necessary to improve the landside access to/from Pochentong International Airport and to assess the development of a new international airport.

A15.1.2 Analysis of Existing and Future Transport Demand

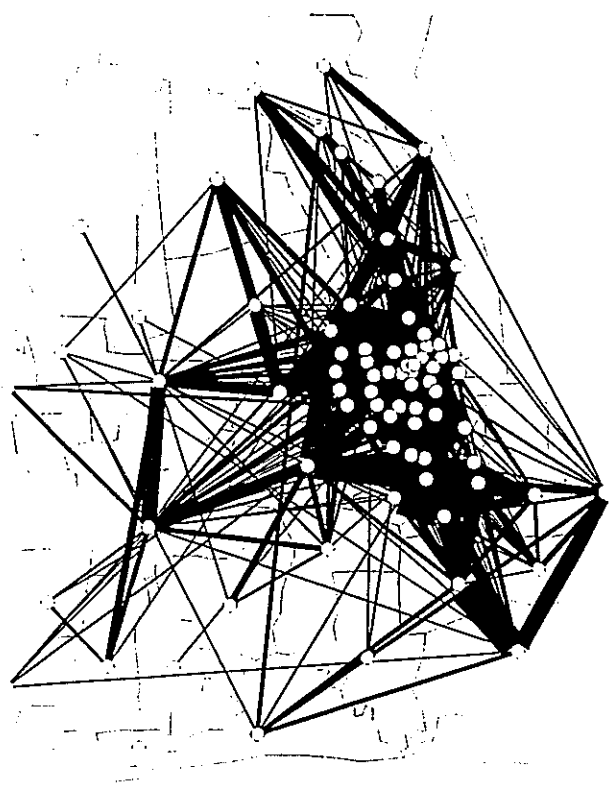
The following cases of transport demand will be analyzed:

- Existing transport demand: The objective of analysis is to assess the existing transport characteristics and the bus route of the public experiment on the introduction of city buses.

Future transport demand: The aim of this exercise is to assess the future transport corridor and to evaluate the future trunk public transport system and other public transport policies in Phnom Penh metropolitan area.



Total G/A trips, excluding walk = 2,442,000 trips/day
Year 2000



4,054,000 trips/day
Year 2015

It can be said that the trips between CBD and suburban area will increase in the year 2015, especially western part of the study area, due to the future urban expansion scenario.

Figure A15.1.1 Desire Line in the Year 2000 and 2015

A15.1.3 Planning Directions for Public Transport Plan

Based on the basic concept of the urban transport master plan, the planning directions for public transport planning in Phnom Penh metropolitan area in the year 2015 are summarized below. These planning directions have been drawn up within the basic concept of the urban transport master plan. This is, *'to establish the comprehensive urban transport system considering the urban environment and sustainable development of Phnom Penh metropolitan area.'*

- ① Considering the urban environment and future increase of public transport demand, the shift from para-transit to an appropriate transport mode as the main public transport mode should be carried out in as smooth a manner as possible. Furthermore, a harmonized comprehensive public transport system should be developed between the main public transport mode and the para-transit.
- ② Considering the urban character, population size and economic activities in Phnom Penh, the bus system will be introduced as a major public transport mode following a comparison between several public transport systems and other Asian countries
- ③ Considering the urban size and characteristics of existing transport facilities, the minibus shall be adopted as the main public transport mode in the city. At the same time, a new environment-friendly and distinctive public transport mode will be introduced as a trunk public transport system along the major public transport corridor.
- ④ Considering the transport characteristics of para-transit, the existing para-transit modes such as the motodop, cyclo and motorumok should be converted mainly into feeder modes to buses.
- ⑤ With improvement of the transport environment, it could pave the way for the possible shift from

motorcycle use, including motodop, to not only public transport but also non-motorized modes such as bicycles, or walking. This is the development of indirect countermeasures of public transport improvement

One of the most important issues for the development of the future public transport system is to utilize the existing transport facilities and modes, such as existing road network in the CBD and para-transit. It is necessary to develop an efficient traffic management plan to accompany the shift in public transport system to create a safe and comfortable urban living environment, especially in the CBD.

It is necessary to develop an appropriate public transport plan to cope with the staging of the urban transport master plan, and thus implement the master plan smoothly and soundly.

A15.1.4 Proposed Public Transportation System

Taking into serious account the above conditions and planning directions, the comprehensive public transport system in Phnom Penh metropolitan area in the year 2015 is outlined below and illustrated in Figure A15.1.2.

Introduction of the bus system as the major public transport mode considering the urban characteristics and road network conditions in Phnom Penh

Basic type of bus in both intra-city and inter-city is the minibus. Large air-conditioned buses are introduced for operation to/from major provincial cities, such as Sheap Lep and Sihanouk Ville

Introduction of a new, environment-friendly bus system, which will be one of the characters in the major public transport corridor in Phnom Penh metropolitan area in the year 2015

Introduction of a city taxi system

Introduction of a zone system for motodop, which will play the role of feeder mode to the bus system in the CBD

Restructuring of the cyclo as a historically unique mode for operation in a designated area, such as tourist zone

Restructuring of the motorumok as a feeder mode to the bus system in the suburban area

Strengthening of the railway transport

Improvement of the river transport to a more environment-friendly operation

Improvement of access to/from the airport and development of a new international airport

Improvement and development of mode interchange areas

- Bus stop (CBD and suburban area)
- Bus terminal (Transfer between city and intercity minibus, transfer between city bus and intercity bus)
- Railway (Improvement of Central Station Plaza)
- River transport (Transfer system between land transport)
- Air transport (Improvement of curbsaide of airport, etc.)

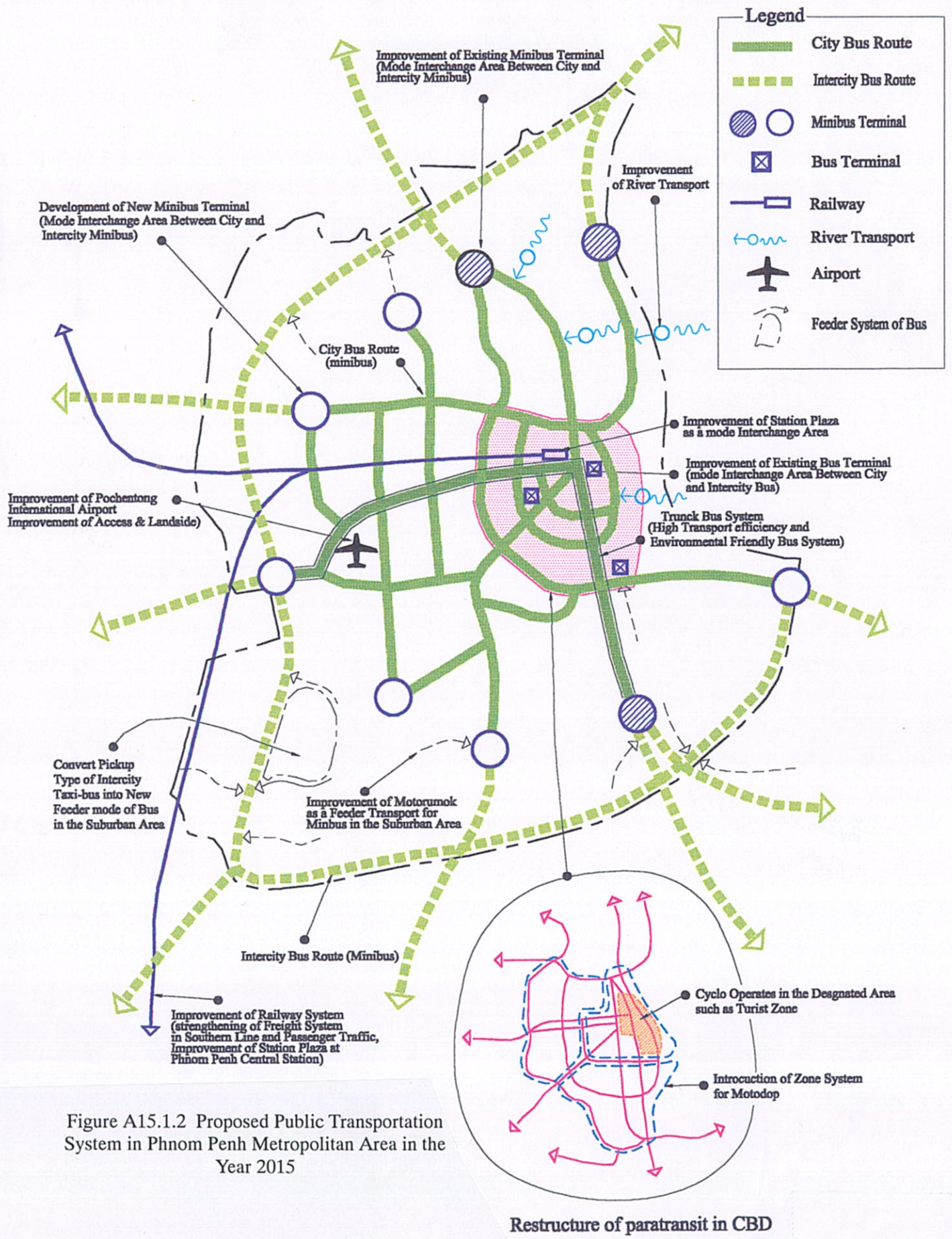


Figure A15.1.2 Proposed Public Transportation System in Phnom Penh Metropolitan Area in the Year 2015

A15.2 BUS TRANSPORT

A flow chart of the work explained in this section is summarized in Figure A15.2.1. The figures inside the box indicate the section of this report where the topic is found.

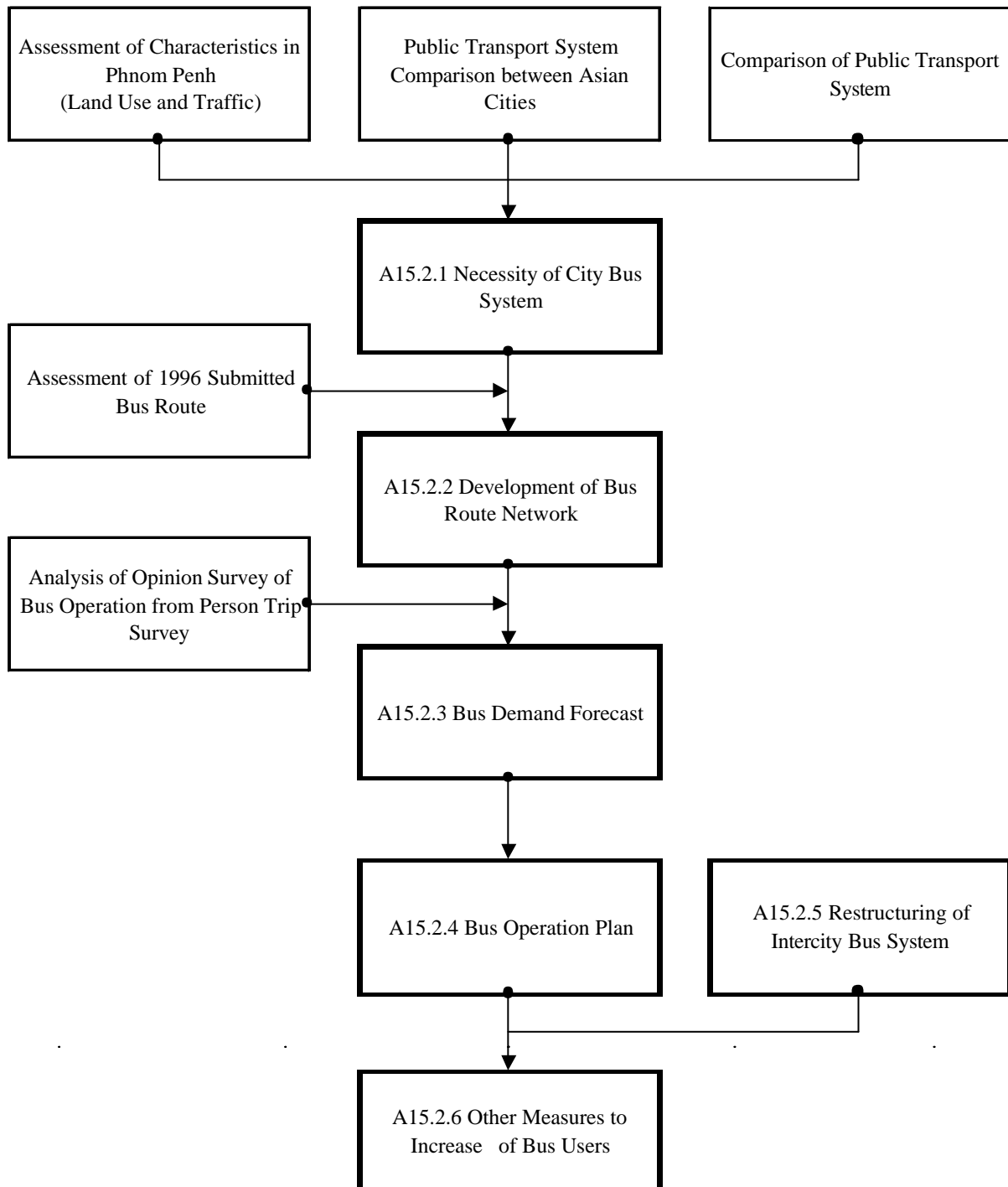


Figure A15.2.1 Procedural Flow Chart of the Work

A15.2.1 Necessity of City Bus System

Based on the following reasons, a bus system will be introduced as the trunk public transport system in Phnom Penh. Basic data and issues are discussed in the following pages.

- The existing main public transport system in Phnom Penh is the motodop, which has short trips due to the small urban area. It is necessary to introduce a transport system, which can cope with the future urban expansion.

The bus system is one of the most flexible and easiest development transport systems and it can even be introduced into a small scale urban area.

- It is necessary to introduce a transport system, which can operate in the existing road system of the densely populated CBD, a condition owing to the limits of expansion of road facilities.

The bus system can be easily introduced without any drastic change to the existing transport facilities, such as road system.

- It is necessary to introduce an appropriate transport system to connect the major urban facilities for the convenience of Phnom Penh citizens.

Major urban facilities locate along the thoroughfares in the city; therefore, they can be connected easily by the bus system.

- It is necessary to introduce the transport system in cooperation with trunk public transport mode and para-transit due to the characteristics of road configuration, which is composed of major roads with multi-lane and secondary roads with 2 lanes.

The combination of bus system and para-transit as the public transport system in Phnom Penh is the most suitable considering the road configuration in the city.

- It is necessary to introduce a public transport system with a small initial investment cost due to the financial limitation of the Municipality of Phnom Penh.

The bus system is a public transport system, which requires a small initial investment cost.

- It is necessary to consider an appropriate public transport system based on the increase of population and per capita GNP in the future

Considering the population size, level of economic activity and other Asian experience of urban transport systems, a public transport system belonging to the bus oriented system will be introduced into Phnom Penh.

- It is necessary to introduce an environmentally friendly transport system to sustain the urban environment in Phnom Penh.

There are some bus systems with environmentally friendly transport, which can be introduced as the trunk bus system in the future.

(1) Assessment of the Characteristics of Phnom Penh

a. Socio-economic and Land Use Characteristics

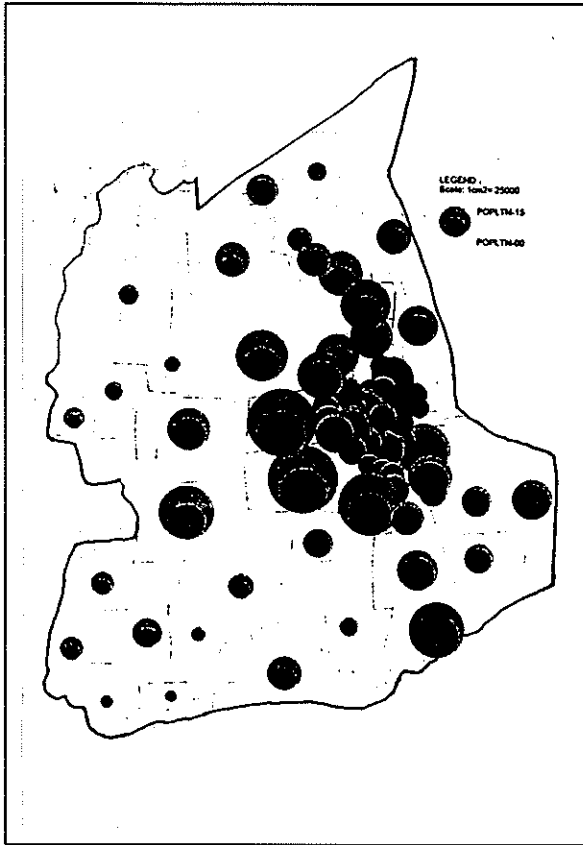
- **Population distribution**

Population distribution in the study area is shown in Figure A15.2.2.

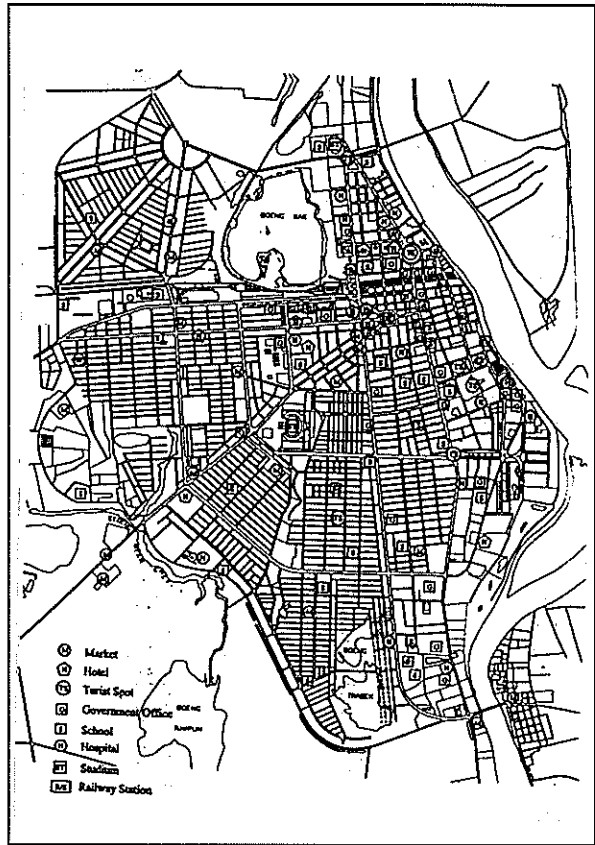
Phnom Penh is topographically limited. A population of 570,000 people out of approximately 1 million is concentrated in the CBD, which covers only 7% of Phnom Penh. The population in the suburban area is concentrated along major roads, which are the major transport corridors.

- **Distribution of major facilities (markets, government offices, schools, hospitals, tourist spots, etc.)**

Distribution of major facilities is shown in Figure 6.2.2. Major facilities, such as government offices and hotels, are concentrated in the northeastern area from Monivong Blvd. Markets and schools, which support the daily life of Phnom Penh citizens, are dispersed in the CBD. These are Orussey Market, Duam Kor Market, Olympic Market and Chav Ampav Market.



Population Distribution



Distribution of Major Facilities in CBD

Figure A15.2.2 Socio-economic Characteristics of Phnom Penh

b. Transport Characteristics

- Trip generation/attraction by mode and by purpose

Motorbikes accomplish approximately 60% of the total trips in Phnom Penh, and a third of them are made by public mode, such as motodop and motorumok, shown in Figure A15.2.3. The break down of total trips according to purpose is as follows: 'to home' (50%), 'to work' (15.2%), 'to shopping' (14.9%) and 'to school' (12.7%).

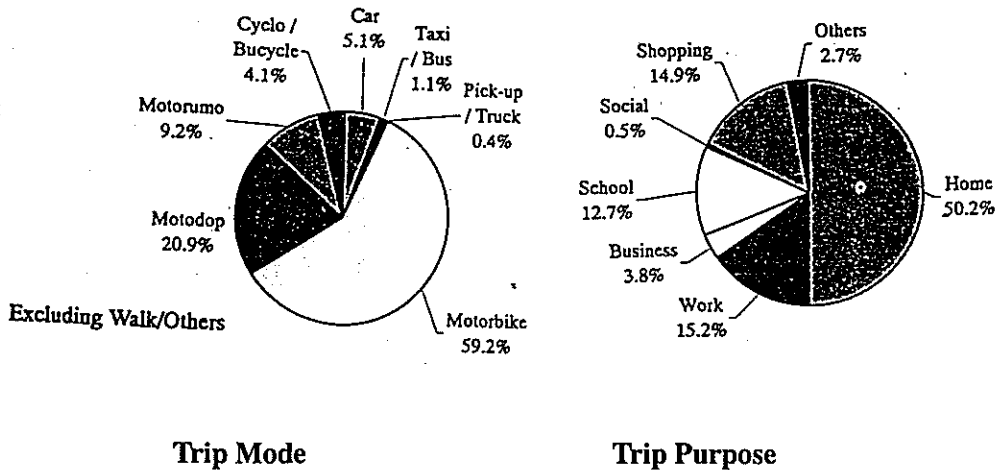


Figure A15.2.3 Trip Mode and Trip Purpose by Phnom Penh Citizens

- Desired lines by mode

Desired lines by motorcycle and motodop in the CBD are shown in Figure A15.2.4. It can be seen that the trip length by motodop is shorter, compared with motorcycle trips.

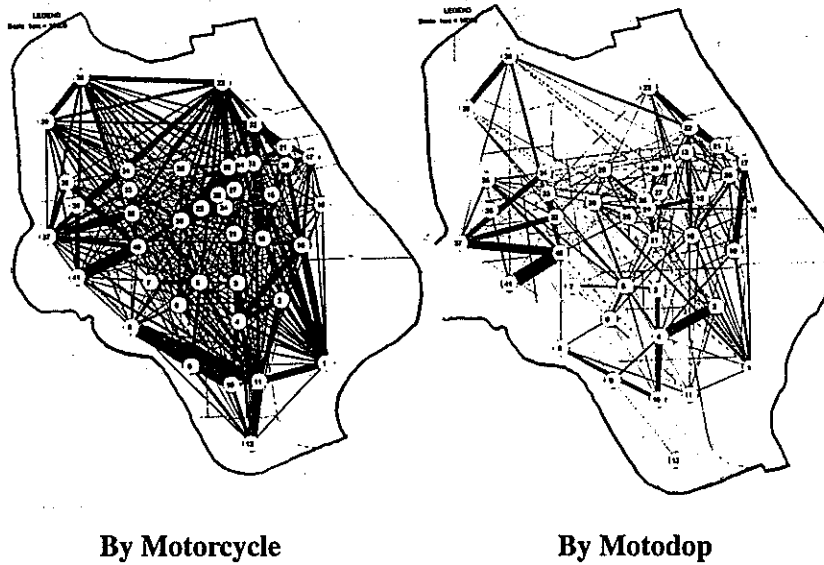


Figure A15.2.4 Desired Lines in CBD

- Road conditions and traffic volume at major roads

Number of lanes of major roads makes almost 4 lanes. There are no roads with more than 6 lanes. Road conditions of major roads in Phnom Penh can be considered fair except for some road sections, such as the southwestern section of Monireth Blvd. after Mao Tse Tong, and the Inner Ring Road. On the other hand, traffic volume along the major roads is shown in Figure A15.2.5. Daily traffic volume along most of the major road sections exceeds 50,000 vehicles and the largest traffic volume of 128,579 vehicles/day has been observed on Mao Tse Tong between Monivong Blvd. and Street 63.

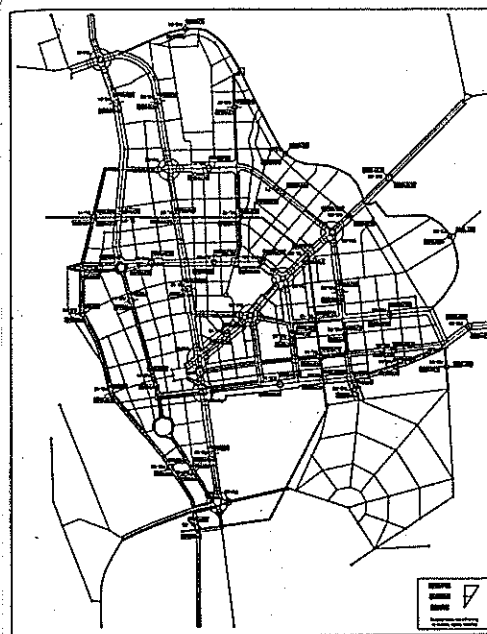


Figure A15.2.5 Road Conditions and Traffic Volume along Major Roads in CBD

- Traffic characteristics at major intercity public transport terminals

Intercity taxi-bus terminals, which are located near major commercial markets, ferry jetties, railway station and airport compose major public transport terminals in Phnom Penh, as shown in Figure A15.2.6. Total daily intercity passengers using these terminals are approximately 81,840. Bus/taxi-bus passengers make up 90% (73,500) of the total intercity public transport passengers. To minimize the traffic congestions in the CBD, the Municipality of Phnom Penh is going to transfer the intercity taxi-bus terminals from the CBD to the suburban area.

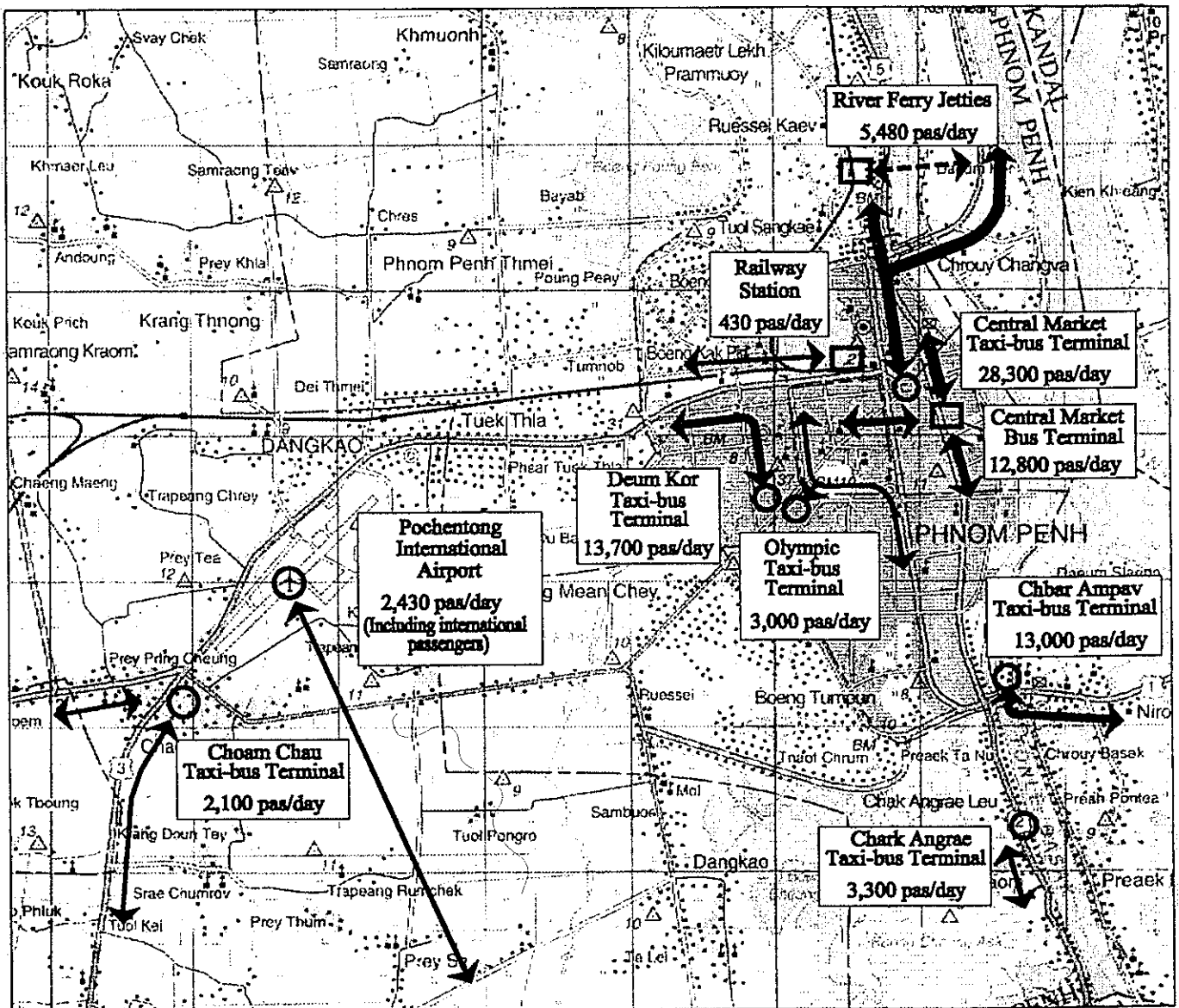


Figure A15.2.6 Intercity Public Transport Terminals

(2) Comparison between Public Transport Systems

A comparison table between various public transport systems, lifted from the 'Urban Transport' report by the World Bank, is shown in Table A15.2.1. Judging from the urban characteristics and transport demand in Phnom Penh, and especially investment cost, the bus system is one of the most appropriate public transport systems for Phnom Penh.

Table A15.2.1 Comparison between Various Public Transport System Characteristics

| Items | Para-transit | Buses and trolley buses | | | | Trams (mixed traffic) | LRT (surface exclusive) | Rapid rail | | |
|--|--------------|-------------------------|----------|----------------|--------------------|-----------------------|-------------------------|------------|----------|--------------|
| | | Mixed traffic | | Bus-only lanes | Segregated busways | | | Surface | Elevated | Under-ground |
| | | Minibus | Ordinary | | | | | | | |
| Vehicle capacity | 4 | 30 | 80 | 80 | | 100 | 200 | 300 | 300 | 300 |
| | to | to | to | to | 120 | to | to | to | to | to |
| | 20 | 45 | 120 | 120 | | 200 | 300 | 375 | 375 | 375 |
| Vehicles per train | n.a. | n.a. | n.a. | n.a. | n.a. | 1 | 3 | 4 | 4 | 4 |
| | | | | | | to | to | to | to | to |
| | | | | | | 2 | 6 | 10 | 10 | 10 |
| Lane/track capacity (passengers per hour) | 1,000 | 4,000 | 10,000 | 15,000 | | 6,000 | 20,000 | | | |
| | to | to | to | to | 30,000 | to | 60 | 50,000 | 70,000 | 70,000 |
| | 4,000 | 6,000 | 15,000 | 20,000 | | 12,000 | 36,000 | | | |
| Journey speed | 12 | 12 | 10 | 15 | 15 | 10 | 15 | 30 | 30 | 30 |
| with stops | to | to | to | to | to | to | to | to | to | to |
| (km per hour) | 20 | 15 | 12 | 18 | 30 | 12 | 25 | 35 | 35 | 35 |
| Capital cost (US\$1,000 per vehicles) | 2 | 25 | 50 | 50 | 50 | 300 | | | | |
| | to | to | to | to | to | to | 800 | 1,000 | 1,000 | 1,000 |
| | 25 | 50 | 100 | 100 | 130 | 600 | | | | |
| Cost of complete system minus vehicles (US\$ million per km) | n.a. | n.a. | n.a. | n.a. | 2 | 3 | 6 | 20 | 45 | 85 |
| | | | | | to | to | to | to | to | to |
| | | | | | 7 | 5 | 10 | 25 | 55 | 105 |
| Total cost including interest (US\$ per passenger km) | 0.02 | 0.02 | 0.02 | 0.02 | 0.05 | 0.03 | 0.10 | 0.10 | 0.12 | 0.15 |
| | to | to | to | to | to | to | to | to | to | to |
| | 0.10 | 0.05 | 0.05 | 0.05 | 0.08 | 0.10 | 0.15 | 0.15 | 0.20 | 0.25 |
| Cost recovery: fare for 5 km (US\$) | 0.10 | 0.10 | 0.10 | 0.10 | 0.25 | 0.15 | 0.50 | 0.50 | 0.60 | 0.75 |
| | to | to | to | to | to | to | to | to | to | to |
| | 0.50 | 0.25 | 0.25 | 0.25 | 0.40 | 0.50 | 0.75 | 0.75 | 1.00 | 1.25 |

n.a. Not applicable

Note: Cost and performance figures assume high levels of utilization and patronage and efficient operation.

a. For trolley buses add approximately 20 percent to the bus costs.

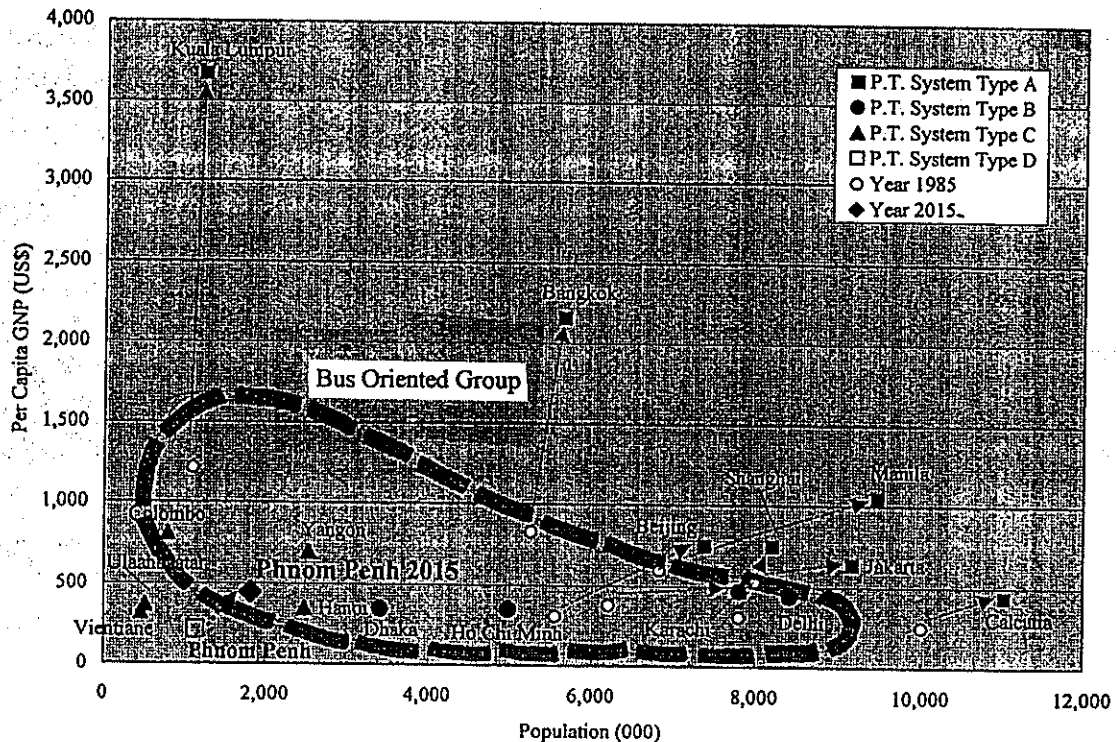
b. Lane/track capacity is the maximum number of passengers that can be carried on a single lane or track past a point during one hour.

c. Journey speed is the average overall speed, which loading and unloading time at stops and station taken into account; journey speed in mixed traffic may be substantially less in congested conditions.

Source: 'Urban Transport' by World Bank in 1986

(3) Comparison between Other Asian Cities

Based on the estimated population of approximately 1.82 million and per Capita GNP of more than US\$447 in 2015, and the trend of other Asian cities, the public transport system in Phnom Penh in 2015 is categorized into the bus system oriented group.



Note

Public Transport Systems in Figure 6.2.7 are as follows:

- A: Rail + Bus or Rail + Bus + Para-transit
- B: Bus Oriented
- C: Para-transit Oriented
- D: Limited to Para-transit

Figure A15.2.7 Population, Per Capita GNP and Public Transport Systems in Asian Cities

A15.2.2 Development of Bus Route Network

(1) Evaluation of Previously Proposed Bus Routes

The bus routes, which were proposed and implemented partly in 1996, are shown in Figure A15.2.8. The characteristics of these bus routes are as follows:

- Total number of routes is ten (10),
- Origin/destination of 80% of total routes is Central Market (this could be attributed to the location of the bus terminal of the proposed bus company);
- Average route length is 8.5 km; the longest route of 11.2 km is Central Market/Pochentong (NR4) route and the shortest at 5.5 km is Central Market/Chav Ampav Market route;
- Most of the roads along routes have 4 lanes and some routes are seen to operate on 2-lane roads; Route type of 60%, 20% and 20% out of total routes are radial, radial/circular and circular routes, respectively;

- Route coverage of 60% and 40% are within CBD and CBD + suburban, respectively;
- Land use along most of the routes is commercial; and
- Average population size along bus routes is approximately 76,000 and population per km is approximately 9,200.

(2) Basic Considerations

- Services of public transport should cover all of the study area, not only by bus but also by bus + para-transit.
- Bus routes within the CBD should be prepared on the major roads with multi-lane, such as Monivong and Russian Blvd., because bus routes on the 2-lane, 2-way roads with mixed traffic affects not only their own operational conditions but also that of other private traffic.
- Basically, bus routes are composed of radial and circular routes due to the trip characteristics of public transport users.
- To consider the convenience of bus users (origin/destination of most of bus users is the central market) and to avoid the large concentration of traffic to the central market, the origin/destination of approximately half of the bus routes would be the central market and the other half, in the suburban bus terminal via central market.
- Extension of bus routes to the suburban area should be based on the future urban expansion.

(3) Proposed Bus Route Network

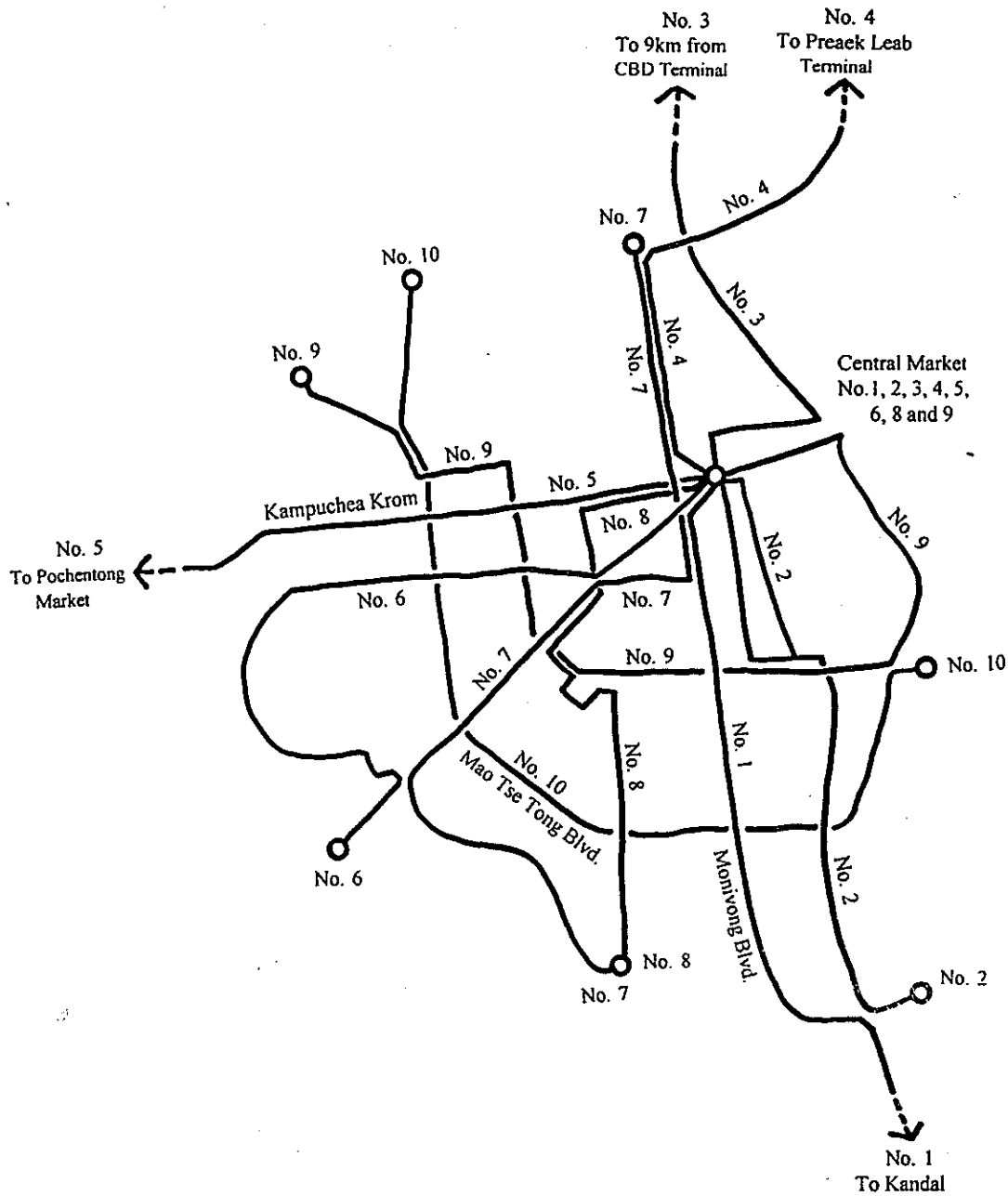
Based on the previously proposed city bus routes and basic consideration as stated earlier, the proposed bus route network by stage (2005, 2010 and 2015) is shown in Figure A15.2.9. Outline of the proposed bus route network is summarized below.

- Proposed bus route network in 2005 should cover the CBD, except for Inner Ring Road and extend to the suburban area along existing National Roads, such as NR2, NR3/4, NR5 and NR6 up to the bus terminals. This is basically the previously proposed city bus route network, except for the Inner Ring Road and collector streets.
- Proposed bus route network in 2010 should cover the CBD and extend toward the southwestern fringe of the CBD due to the development of the southwestern suburban area.
- Proposed bus route network in 2015 should cover the western suburban area, where a new urban area will be developed in the future. And the bus route along NR1 will extend to the proposed new bus terminal, located at NR1/Outer Ring Road intersection.

Table A15.2.2 Proposed Bus Route Length

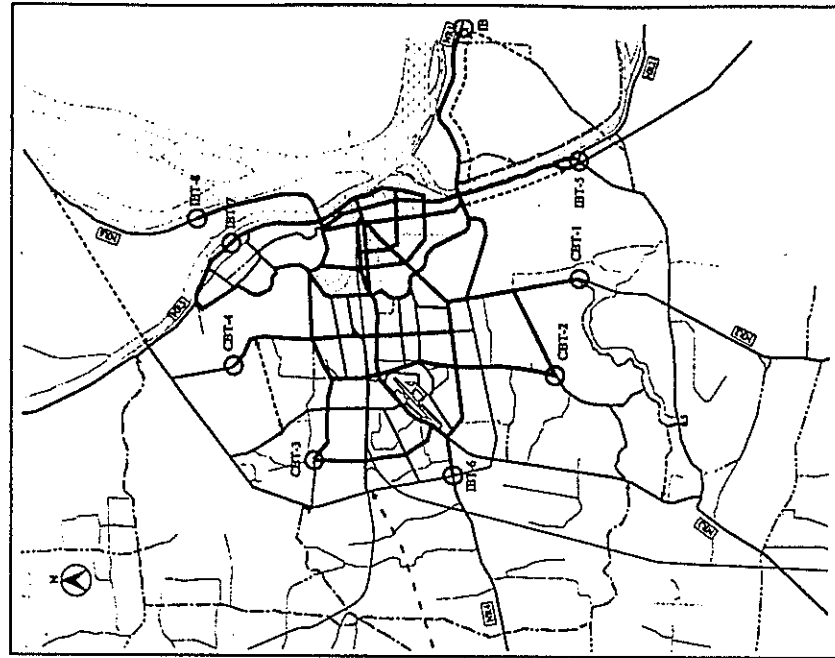
Unit: km

| | Year 2005 | | 2010 | | 2015 | |
|---------------|-----------|--------|-------|--------|-------|--------|
| CBD | 44.7 | 63.0% | 54.2 | 53.1% | 54.2 | 36.6% |
| Suburban Area | 26.3 | 37.0% | 47.8 | 46.9% | 93.8 | 63.4% |
| Total | 71.0 | 100.0% | 102.0 | 100.0% | 148.0 | 100.0% |

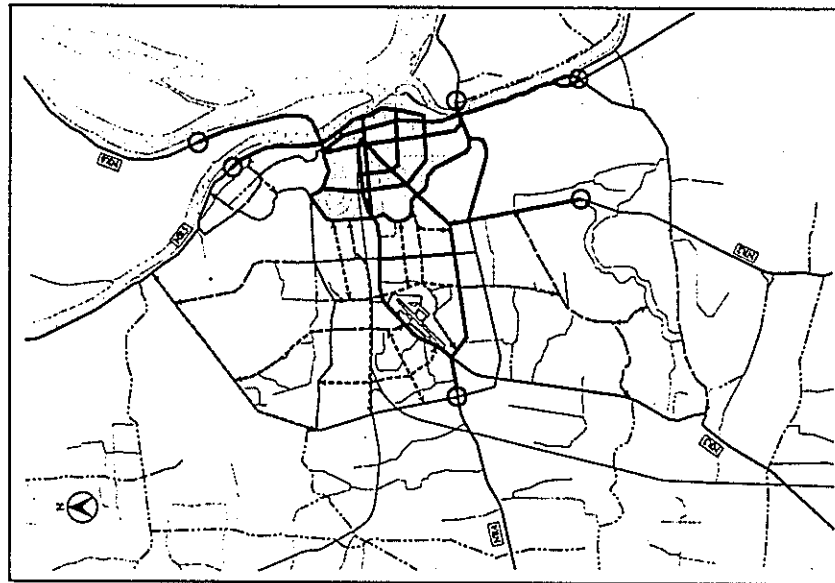


| No. | Name of Route | Origin/Destination | | Route Length (km) | No. of Lane | Type of Bus Route | Service Area | Route Side Land Use | Population along Route (within 200m-urban, 300m-rural from bus route) | |
|---------|--|----------------------|-------------------------|----------------------|-------------|-------------------|--------------|------------------------|--|----------|
| | | | | | | | | | (total population) | (per km) |
| 1 | Monivong-NR2 | Central Market | Kandal | 10.56 | 4 | Radial | CBD+Suburban | Commercial/Industrial | 93,365 | 8,841 |
| 2 | Pasteut/Trasak Paem-Sihanouk-Nordom | Central Market | Chav Ampav | 5.52 | 2 - 4 | Radial | Within CBD | Commercial | 73,695 | 13,351 |
| 3 | Russia Blvd.-Sisovath-NR5 | Central Market | 9km from CBD | 7.28 | 2 - 4 | Radial | CBD+Suburban | Commercial/Industrial | 45,491 | 6,249 |
| 4 | Monivong-NR6 | Central Market | Preaek Lieb Market | 8.78 | 2 - 4 | Radial | CBD+Suburban | Commercial/Residential | 42,747 | 4,869 |
| 5 | Kampuchea Krom-NR4 | Central Market | Pochentong Market | 11.20 | 2 - 4 | Radial | CBD+Suburban | Commercial/Industrial | 67,748 | 6,049 |
| 6 | Charles de Gaulle-Tep Phan-Inner Ring Road-Monireth | Central Market | School along Monireth | 6.84 | 2 - 4 | Radial/Circular | Within CBD | Commercial/Residential | 76,822 | 11,231 |
| 7 | Monivong-Tep Phan-Monireth-Inner Ring Road | Old Stadium | Psa Deum Thka School | 8.34 | 2 - 4 | Radial/Circular | Within CBD | Commercial/Residential | 104,988 | 12,588 |
| 8 | Kampuchea Krom-Tchecoslovaquie-Monireth-Sihanouk-St.163-Inner Ring Road | Central Market | Chav Ampav | 8.64 | 2 - 4 | Radial | Within CBD | Commercial/Residential | 92,748 | 10,735 |
| 9 | Khemararak Phomin-Sisovath/Preah Ang Eng-Sihanouk-Nerhu-Rissia-St.289-St.592 | Central Market | Toul Kouk St.317/St.592 | 9.03 | 2 - 4 | Circular | Within CBD | Commercial/Residential | 98,211 | 10,876 |
| 10 | Sihanouk-Soihearos-Moa Tse Toung-St.289-Samdach Penn | East End of Sihanouk | TV Antenna | 8.51 | 2 - 4 | Circular | Within CBD | Commercial/Residential | 64,034 | 7,525 |
| Average | | | | 8.47 | | | | | 75,985 | 9,231 |

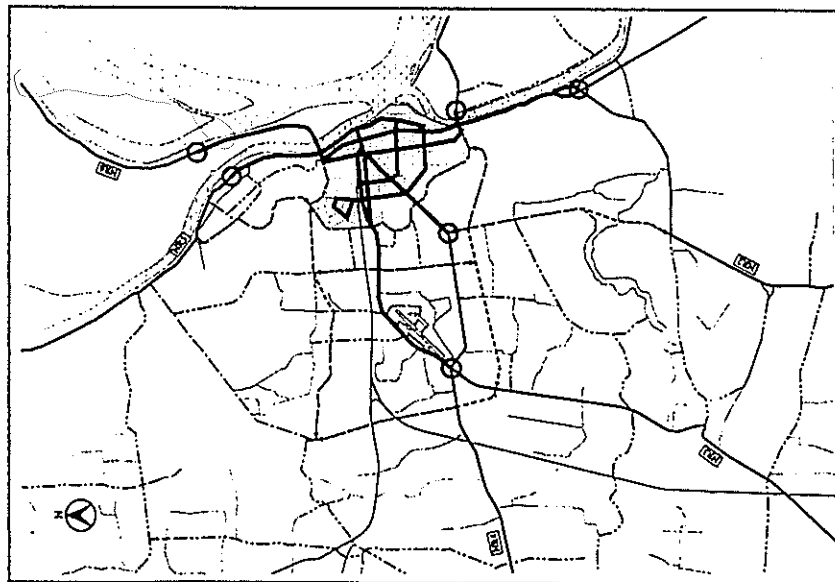
Figure A15.2.8 Evaluation of Previously Proposed Bus Routes in 1996



Year 2015 (Total Bus Route Length = 148 km)



Year 2010 (Total Bus Route Length = 102 km)



Year 2005 (Total Bus Route Length = 71 km)

Figure A15.2.9 Proposed Bus Route Network in 2005, 2010 and 2015

A15.2.3 Bus Demand Forecast

(1) Basic Considerations

- Bus demand forecast is based on the analysis of opinion survey of bus operation from person trip survey, which covered more than 30,000 samples, and on proposed transport policies
- Basic factors, which will affect bus demand are walking distance, waiting time and bus fare.
- It is assumed that the bus service area is within 200m and 300m from the proposed bus routes for CBD and suburban area, respectively.
- It is assumed that the intercity bus passenger, whose origin/destination is the CBD along bus route, will transfer to city bus based on the development of an intercity bus terminal in the suburban area.
- Two (2) public transport policies will be introduced for the bus rider ship demand:
 - a. It is assumed that the trips by motodop between motodop operational zones will transfer to bus trips based on the introduction of operational zone system of motodop. The motodop can operate only within the designated operational zone.
 - b. It is assumed that the trips by motodop/motorumok between zones will transfer to the bus in the future, based on the prohibition of motodop/motorumok operation along major roads in the suburban area. Motodop/motorumok operation in the suburban area will be allowed only on secondary/feeder roads

(2) Demand Forecast

The result of bus passenger demand forecast in 2005, 2010 and 2015 are summarized in Table A15.2.3, and details in the year 2015 are described below and in Figure A15.2.12.

a. Bus passenger demand forecast by opinion survey

The basic procedure of bus passenger demand forecast uses the result of opinion survey for bus operation because there is no data concerning the bus operation in the past in Phnom Penh. Based on the analysis of opinion survey for bus operation, it is known that the factors affecting bus rider ship demand are walking distance, waiting time and bus fare. Considering that the bus route network and bus service area of 200m for CBD and 300m for suburban area from bus routes, a formula was arrived at between waiting time, bus fare and bus rider-ship within the bus service area.

Based on the graph of formula, shown in Figure A15.2.10, the following two issues can be analyzed:

- It is obvious that the waiting time of more than 5 minutes has lower bus rider-ship because of the current high frequency level of motodop.
- It can be found that the bus rider-ship has a big gap between a 500-riels and a 750-riels for bus fare.

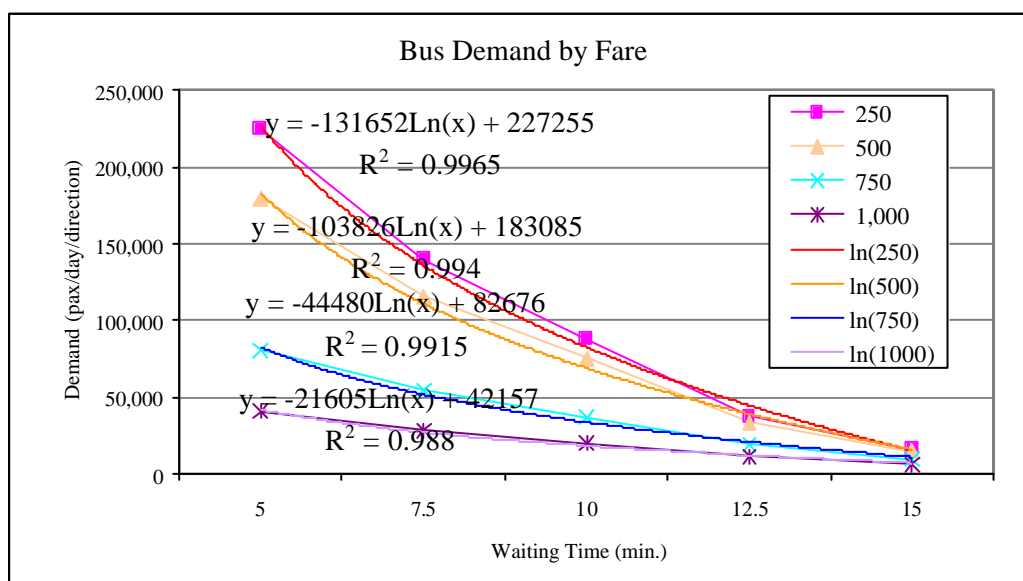


Figure A15.2.10 Relation between Fare, Waiting Time and Bus Rider-ship in 2015

Considering the population in 2015, bus route network, bus rider ship, fare level of 800 riels (it is assumed that flat fare system would be introduced) and waiting time of 7.5 minutes, number of bus passengers can be estimated as follows: These fare level and waiting time are possible performed based on the current fare level of para-transit, performance of intercity bus operator, socio-economic conditions of Phnom Penh and public transport users survey.

$$A (46,419) \times B (2.952) = C (137,029 \text{ trips/day})$$

Where:

A: Bus rider-ship from Figure A15.2.10 (persons/day)

B: Number of trips per person in 2015

C: Number of bus passengers/day based on the opinion survey of bus operation (trips/day)

b. Transfer passenger from intercity bus to city bus

Based on the present number of bus/taxi-bus passengers, relocation of intercity bus terminals and increase rate of intercity passengers, transfer passengers from intercity bus to city bus are as follows:

$$D (73,500) \times E (1.58) \times F (1.045) \times G (48.6\%) \times H (90\%) = I (53,081 \text{ trips/day})$$

Where:

D: Present number of intercity bus/taxi-bus passengers/day (Year 2000)

E: Increase rate of intercity bus passengers (Population increase ratio of 2015/2000)

F: Increase ratio of number of trips/person (2015/2000)

G: Bus service coverage in the city

H: Modal share of bus

I: Transfer passenger from intercity bus to city bus (trips/day)

c. Transfer passenger from motodop who cross the motodop operational zone

Based on the introduction of a motodop operational zone system and OD table in 2000, transfer passenger from motodop who cross the motodop operational zone is as follows:

$$JA (34,288) - KA (3,896) = LA (30,392 \text{ trips/day}) \text{ (Zone A: Chamkar Mon)}$$

$$JB (43,922) - KB (10,688) = LB (33,234 \text{ trips/day}) \text{ (Zone B: Doun Penh and Prampir Meakkakra)}$$

$$JC (29,764) - KC (2,798) = LC (26,965 \text{ trips/day}) \text{ (Zone C: Toul Kouk)}$$

$$\text{Total L} = 90,591 \text{ trips/day}$$

Where;

J: Trips crossing the motodop operational zone in 2000 (trips/day)

K: Duplication of bus passengers by opinion survey

L: Transfer passenger from motodop who cross the motodop operational zone (trips/day)

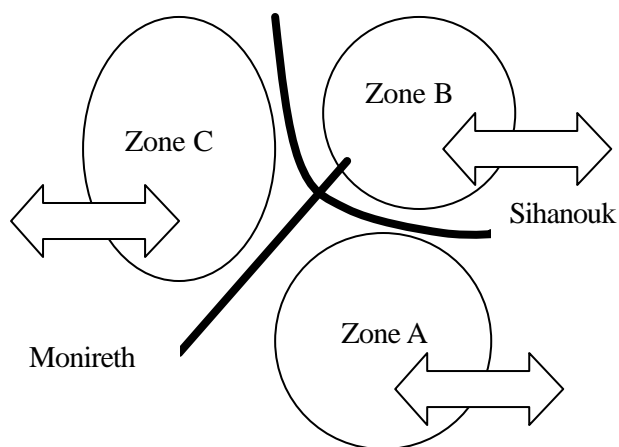


Figure A15.2.11 Transfer Passenger between Motodop Operational Zones

d. Transfer passenger from motorumok/motodop who pass the suburban trunk roads such as National Roads

Based on the prohibition of motorumok/motodop operation along major roads in the suburban area and OD table in 2000, transfer passenger from motorumok/motodop who pass the suburban trunk roads is 52,363 trips/day.

Table A15.2.3 Results of the Preliminary Bus Demand Forecast in 2005, 2010 and 2015

| Items | Year 2005 | 2010 | 2015 | Remarks |
|---|-----------|---------|---------|---|
| Bus Passenger Demand in CBD by Waiting Time and by Fare Level | 34,300 | 79,900 | 137,000 | Waiting Time = 7.5 min., Fare = 800 reils |
| Motodop Passengers between the Operational Zone | 46,600 | 68,600 | 90,600 | |
| Motorumok and Motodop Passengers Cross their Zone | 0 | 26,200 | 52,400 | |
| Intercity Bus Passengers | 29,900 | 41,900 | 53,100 | |
| Total | 110,800 | 216,600 | 333,100 | |

Based on the bus passenger demand, bus passenger OD table and proposed bus route network in 2015, the bus passenger and traffic flow on 2015 bus route network is illustrated in Figure A15.2.13.

A15.2.4 Bus Operation Plan

Based on the proposed bus route network, bus passenger demand forecast and other preconditions as mentioned below, bus operation plan is summarized in Table A15.2.4.

- (1) Bus route network is shown in Figure A15.2.9.
- (2) Bus passenger demand forecast is summarized in Table A15.2.3.
- (3) Main type of bus fleet is minibus.
- (4) It is assumed that the number of daily passenger per minibus is 300, based on the average number of daily passenger per bus in Asian cities of 692 (large-size bus) from World Bank data as shown in Table A15.2.5 (1) and (2).
- (5) It is assumed that the availability of bus is 85% based on the average in Asian cities of 80% from World Bank data as shown in Table A15.2.6.
- (6) It is assumed that the number of staff per bus is 5 based on the average in Asian cities of 8 (large-size bus) from World Bank data as shown in Table A15.2.6.
- (7) It is assumed that bus stop and bus shelter is installed every 400m and 2,000m, respectively.
- (8) Bus terminals will be discussed in Section A15.8 in detail.

Area of depot is based on the capacity of bus terminal and unit bus parking space.

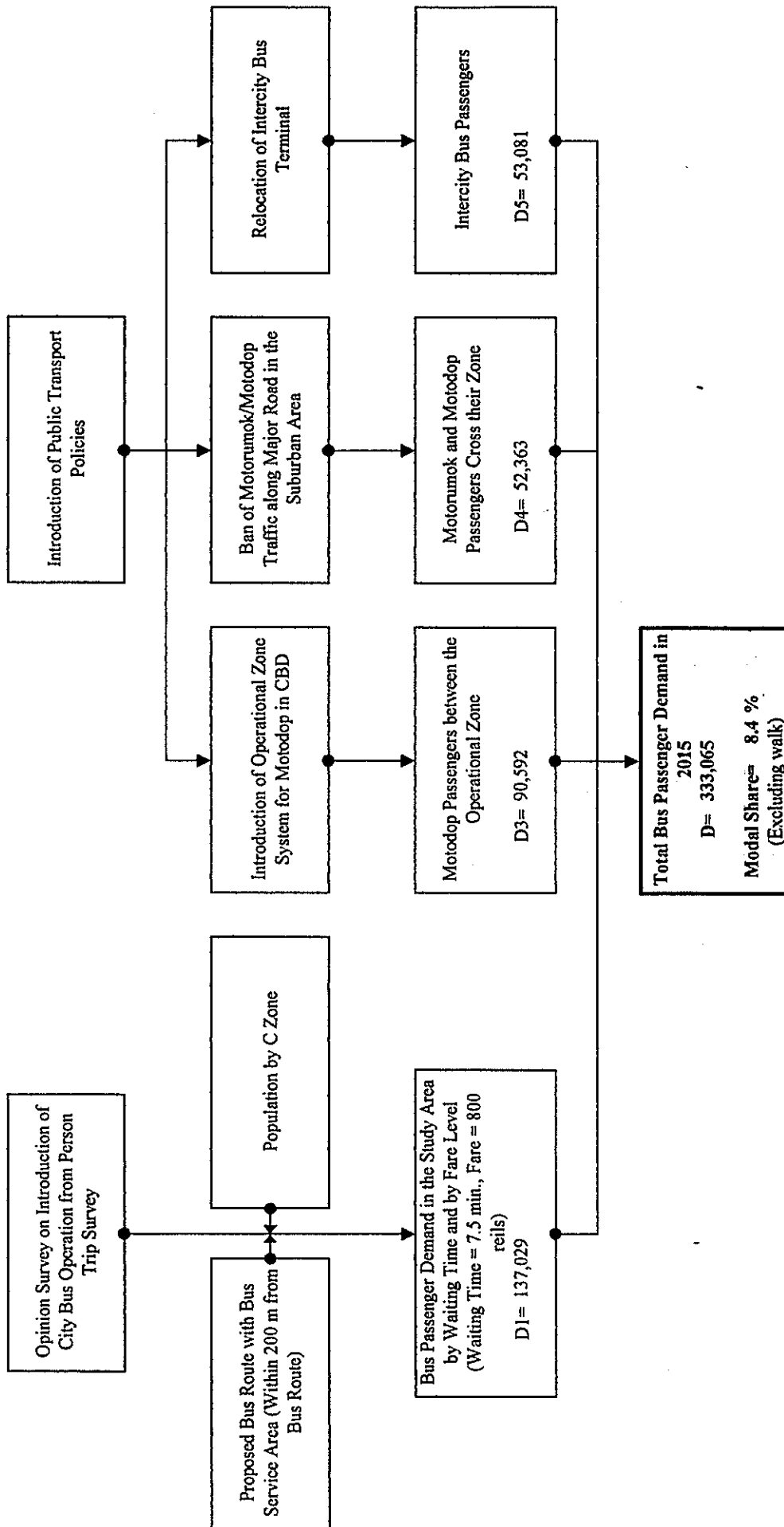


Figure A15.2.12 Bus Passenger Demand Forecast in 2015

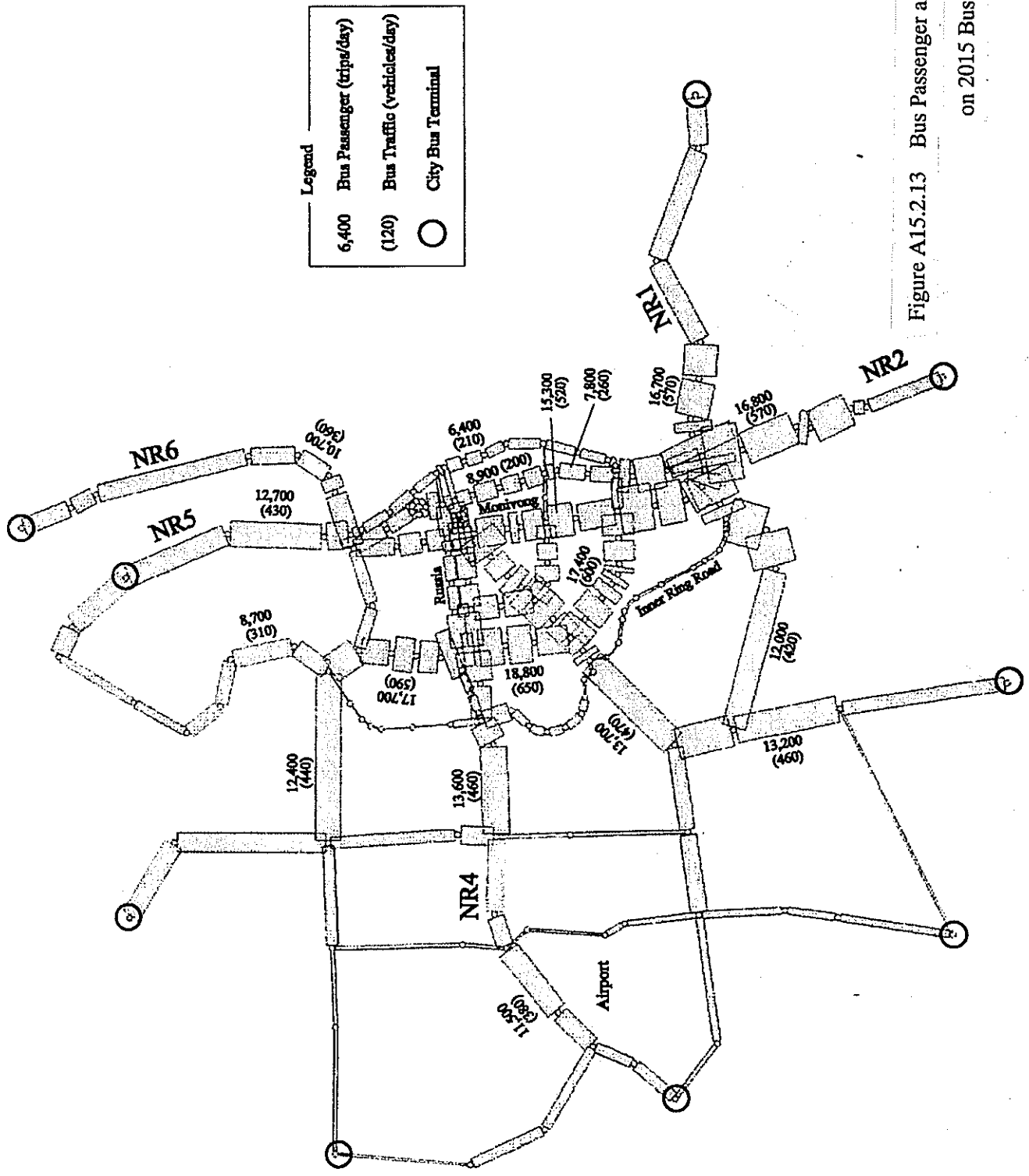


Figure A15.2.13 Bus Passenger and Traffic Demand on 2015 Bus Route Network

Table A15.2.4 Summary of Bus Operation Plan

| Items | Unit | Year | | | Remarks | |
|-------|-------------------------------------|-------------------|-----------------------------|---------|---------|--------------|
| | | 2005 | 2010 | 2015 | | |
| A | Route length | km | 71 | 102 | 148 | |
| B | Passenger demand | passenger/day | 110,800 | 216,600 | 333,100 | |
| C | Type of bus | | Minibus (30 - 40 passenger) | | | |
| D | Daily passenger per bus | passenger/bus/day | 300 | | | |
| E | Number of bus | | 369 | 722 | 1,110 | |
| F | Availability | % | 85 | | | |
| G | Required number of bus | | 435 | 849 | 1,306 | |
| H | Number of staff per bus | | 5 | | | |
| I | Total number of staff | | 2,173 | 4,247 | 6,531 | |
| J | Number of bus stop | | 355 | 510 | 740 | every 400m |
| K | Number of bus shelter | | 71 | 102 | 148 | every 2,000m |
| L | Renovation of existing bus terminal | sq. m | 63,445 | | | |
| M | Development of new bus terminal | sq. m | | 10,000 | 40,000 | |
| N | Total area of bus terminal | sq. m | 63,445 | 73,445 | 113,445 | |
| O | Depot area per bus | sq. m/bus | 75 | | | |
| P | Total area of depot | sq. m | 21,182 | 41,409 | 63,681 | |

Table A15.2.5 (1) Asia's Urban Bus Transport Data: Low-income Countries

| Country | City | Population 1990 (million) | data year | Bus company | Public/Private | Bus fleet | Passengers per day | Passengers per bus | Daily vehicle kilometers | Route kilometers | No. of routes | Average route length (km) |
|-------------------------|------------|---------------------------|-----------|-------------|---------------------------------|---------------|--------------------|--------------------|--------------------------|------------------|---------------|---------------------------|
| Bangladesh | Dhaka | 6.6 | [1988?] | BRTC | Public | 450 | 465,753 | 1,035 | - | 1,116 | - | - |
| China | Anshan | 1.5 | [1988?] | ACBC | Public | 600 | - | - | - | - | 19 | - |
| | Beijing | 10.8 | [1988?] | BCBC | Public | 3,000 | 5,479,542 | 1,826 | - | - | 120 | - |
| | Changchun | 2.2 | [1988?] | CCBC | Public | 400 | - | - | - | - | 20 | - |
| | Chongqing | 3.2 | 1986 | CCTD | Public | 866 | 1,556,164 | 1,797 | 147,945 | 514 | 54 | 9.5 |
| | Dalian | 2.5 | [1988?] | DCTC | Public | 500 | 1,000,000 | 2,000 | - | 140 | 18 | 7.8 |
| | Fushun | 1.4 | [1988?] | FCBC | Public | 400 | - | - | - | - | 30 | - |
| | Guangzhou | 3.7 | 1986 | 1&2 BC | Public | 1,800 | 2,164,384 | 1,202 | - | - | 269 | - |
| | Harbin | 3.0 | [1988?] | HCBC | Public | 600 | - | - | - | - | 19 | - |
| | Jilin | 1.3 | [1988?] | JCTC | Public | 250 | - | - | - | - | 20 | - |
| | Nanjing | 2.6 | [1988?] | NCTC | Public | 500 | 821,918 | 1,644 | - | - | 20 | - |
| | Shanghai | 13.4 | 1985 | STC | Public | 4,579 | 10,980,822 | 2,398 | 933,973 | 9,953 | 276 | 36.1 |
| | Shenyang | 4.8 | 1987 | SCBC | Public | 620 | 1,084,658 | 1,749 | 72,603 | 932 | 54 | 17.3 |
| | Taipei | 3.0 | 1987 | TCB | Public | 1,666 | 964,110 | 579 | 240,822 | 3,490 | 266 | 13.1 |
| | | | 1986 | UOS (9) | Private | 1,709 | 1,538,904 | 900 | 353,973 | 1,557 | 96 | 16.2 |
| | Taiyuan | 2.2 | [1988?] | TCTC | Public | 250 | - | - | - | - | 30 | - |
| | Tangshan | 1.6 | [1988?] | TCBC | Public | 250 | - | - | - | - | 15 | - |
| | Tinjin | 9.4 | 1984 | TCTC | Public | 1,439 | 1,627,397 | 1,131 | 243,836 | - | 59 | - |
| India | Ahmedabad | 3.6 | 1987 | AMTS | Public a | 669 | 667,397 | 998 | 102,712 | 2,368 | 226 | 10.5 |
| | Bangalore | 5.0 | 1982 | BTS | Public b | 937 | 909,589 | 971 | 146,849 | - | 364 | - |
| | Bombay | 9.5 | 1988 | BEST | Public c | 2,379 | 4,309,589 | 1,812 | 457,534 | 2,885 | 224 | 12.9 |
| | Calcutta | 11.8 | [1988?] | CSTC | Public d | 1,172 | 2,465,753 | 2,104 | 136,986 | 482 | 62 | 7.8 |
| | | | [1988?] | BOUB | Private | 2,200 | 2,739,726 | 1,245 | 342,466 | 1,500 | 101 | 14.9 |
| | Delhi | 8.8 | 1984 | DTC | Public | 4,135 | 3,772,603 | 912 | 903,562 | - | 689 | - |
| | Hyderabad | 3.5 | 1987 | APSRTC | Public | 1,159 | 1,021,918 | 882 | 233,425 | 5,583 | 389 | 14.4 |
| | Kanpur | 2.1 | [1988?] | UPSRTC | Public | 200 | 68,493 | 342 | - | - | - | - |
| | Lucknow | 1.2 | [1988?] | UPSRTC | Public | 300 | 68,493 | 228 | - | - | - | - |
| | Madras | 5.7 | 1987 | PTC | Public | 2,089 | 3,024,658 | 1,448 | 406,027 | 881 | 329 | 2.7 |
| | Nabpur | 1.8 | 1986 | MSRT | Public | 100 | 109,589 | 1,096 | 18,630 | 1,107 | 111 | 10.0 |
| Indonesia | Jakarta | 9.3 | [1988?] | PPD | Public | 2,294 | 1,780,822 | 776 | 328,767 | 2,208 | 164 | 13.5 |
| | Surabaya | 2.4 | [1988?] | DAMRI | Public | 160 | 41,096 | 257 | - | - | 30 | - |
| | | | [1988?] | URTB | Private e | 3,200 | 547,945 | 171 | - | - | - | - |
| Korea (DPR) | Pyeongyang | 2.2 | [1988?] | PPATC | Public | 500 | 410,959 | 822 | - | - | 50 | - |
| Myanmar | Yangon | 3.3 | [1988?] | RTC | Public | 350 | 273,973 | 783 | 27,397 | 250 | 11 | 22.7 |
| | | | [1988?] | RRPBCC | Private | 350 | 191,781 | 548 | 27,397 | 92 | 6 | 15.3 |
| Pakistan | Karachi | 7.7 | [1988?] | KTC | Public | 400 | 273,973 | 685 | 54,795 | - | 30 | - |
| | | | [1988?] | KBOA | Private | 1,000 | 547,945 | 548 | 82,192 | - | 30 | - |
| | | | [1988?] | KMOA | Private e | 3,000 | 547,945 | 183 | 136,986 | - | 50 | - |
| | Lahore | 4.1 | 1988 | PRTC | Public f | 884 | 258,082 | 292 | 73,973 | 1,891 | 84 | 22.5 |
| Low Income Total | | 155.1 | | 39 | Public:36/ Private:6 | 47,357 | 51,715,890 | 1,092 | 5,472,849 | 36,949 | 4,344 | 14.5 |

- a. no subsidy provided
- b. fares cover operating costs
- c. cross subsidy from electricity supply services
- d. fares cover 70% of operating costs
- e. paratransit operation
- f. fares cover 40% of operating costs

Table A15.2.5 (2) Asia's Urban Bus Transport Data: Middle and High-income Countries

| Country | City | Population | | Bus company | Public/Private | Bus fleet | Passengers per day | Passengers per bus | Daily vehicle kilometers | Route kilometers | No. of routes | Average route length (km) |
|----------------------------|--------------|----------------|-----------|-------------|----------------------------------|----------------|--------------------|--------------------|--------------------------|------------------|---------------|---------------------------|
| | | 1990 (million) | data year | | | | | | | | | |
| Korea | Seoul | 11.0 | 1985 | SBTC | Private | 8,295 | 7,673,973 | 925 | - | 3,620 | 347 | 10.4 |
| Malaysia | Kuala Lumpur | 1.7 | 1983 | 8 | Private | 969 | 454,795 | 469 | 159,134 | 3,806 | 174 | 21.9 |
| Philippines | Metro Manila | 8.5 | 1983 | Bas Mini | Private | 490 | 160,000 | 327 | 112,603 | - | 38 | - |
| | | | 1984 | MMT | Public | 560 | 82,192 | 147 | - | 767 | 16 | 47.9 |
| | | | [1988?] | Minibuses | Private | 2,500 | 2,054,795 | 822 | 684,932 | 3,000 | 150 | 20.0 |
| Thailand | Bangkok | 7.2 | 1988 | BMTA | Public | 6,031 | 4,973,000 | 825 | - | 5,163 | 223 | 23.2 |
| | | | 1989 | Mimbus | Private | 2,151 | 1,120,000 | 521 | - | a | a | - |
| Middle Income Total | | 28.3 | | 8 | Public:2/ Private:6 | 48,996 | 18,573,548 | 379 | 956,668 | 16,356 | 948 | 18.0 |
| Australia | Brisbane | 1.2 | 1988 | BCC | Public | 589 | 126,027 | 214 | 74,247 | 734 | 94 | 7.8 |
| | Melbourne | 2.8 | 1988 | The Met | Public | 335 | 71,233 | 213 | 47,397 | 390 | 55 | 7.1 |
| | Perth | 1.1 | 1988 | Transperth | Public | 899 | 142,466 | 158 | 126,575 | 1,784 | 328 | 5.4 |
| | Sydney | 3.4 | 1988 | UOS (9) | Public | 1,461 | 517,808 | 354 | 162,192 | 978 | 264 | 3.7 |
| Hong Kong | Hong Kong | 5.4 | 1987 | STA | Private | 2,823 | 2,980,822 | 1,056 | 572,603 | 1,500 | 227 | 6.6 |
| | | | 1986 | KMB | Private | 1,024 | 878,630 | 858 | 149,589 | 1,324 | 116 | 11.4 |
| Japan | Kitakyusyu | 2.3 | 1987 | CMB | Private b | 4,340 | 960,000 | 221 | - | - | 123 | - |
| | | | [1988?] | KKK | Public | 144 | 68,493 | 476 | 27,397 | - | - | - |
| | | | [1988?] | NNT | Private | 700 | 273,973 | 391 | 82,192 | - | - | - |
| | Kyoto | 1.4 | 1984 | KKK | Public | 989 | 520,548 | 526 | 108,767 | 440 | 89 | 4.9 |
| | Nagoya | 2.1 | 1986 | NKK | Public | 1,377 | 605,479 | 440 | 125,479 | 631 | 111 | 5.7 |
| | Osaka | 8.5 | 1988 | OKK | Public | 966 | 317,808 | 329 | 83,836 | 440 | 105 | 4.2 |
| | Sapporo | 1.5 | 1987 | SKK | Public | 690 | 268,493 | 389 | 54,247 | 1,056 | 73 | 14.5 |
| Singapore | Singapore | 18.1 | 1988 | TKK | Public | 1,867 | 879,452 | 471 | 186,849 | 1,020 | 113 | 9.0 |
| | | | 1986 | TIBS | Private | 2,921 | 2,473,973 | 847 | 610,959 | 2,924 | 215 | 13.6 |
| High Income Total | | 50.6 | | 16 | Public:10/ Private:6 | 21,494 | 11,279,726 | 525 | 2,507,124 | 13,221 | 1,936 | 7.8 |
| Asia Total | | 234.0 | | 63 | Public:48/ Private:18 | 117,847 | 81,569,164 | 692 | 8,936,641 | 66,526 | 5,335 | 12.5 |

a. included in BMTA data

Table A15.2.6 Bus Services: City Comparisons, 1983

| City | Ownership | Number of Buses ^a | Avail-ability (Percent) | Per Operation Bus | | | Annual Operating Cost ^b (US\$ Mil.) | Total Annual Passenger Kilometer ^c (US\$) | Annual Operating Revenue ^d (US\$ Mil.) | Fare per 5 km (US\$) | Operating Revenue/Total Cost |
|----------------|-----------|------------------------------|-------------------------|-------------------|------------|--------------------|--|--|---|----------------------|------------------------------|
| | | | | km per day | Staff | Passengers per day | | | | | |
| Abidjan | Mixed | 1,044 | 85 | 183 | 7.1 | 829 | 91.29 | 0.07 | 69.40 | 0.26 | 0.67 |
| Accra | Public | 44 | 24 | 292 | 28.1 | 2,092 | 1.03 | 0.03 | 0.63 | 0.13 | 0.51 |
| Accra | Private | 665 | 73 | 223 | 5.5 | 676 | 10.43 | 0.04 | 17.72 | 0.18 | 1.37 |
| Addis Abeba | Public | 164 | 58 | 205 | 13.1 | 2,467 | 7.96 | 0.02 | 6.59 | 0.07 | 0.67 |
| Ankara | Public | 899 | 67 | 210 | 5.8 | 1,273 | 25.62 | 0.01 | 15.31 | 0.14 | 0.48 |
| Bombay | Public | 2,325 | 92 | 216 | 14.0 | 2,093 | 81.95 | 0.01 | 72.97 | 0.05 | 0.77 |
| Cairo | Public | 2,454 | 69 | 246 | 14.6 | 2,417 | 60.41 | 0.01 | 36.19 | 0.07 | 0.50 |
| Calcutta | Public | 981 | 64 | 133 | 18.0 | 1,641 | 23.05 | 0.01 | 13.09 | 0.04 | 0.45 |
| Dakar | Mixed | 439 | 70 | 287 | 9.6 | 1,193 | 22.97 | 0.04 | 20.41 | 0.26 | 0.76 |
| Guatemala City | Private | 1,600 | 95 | 304 | - | 1,037 | 29.00 | 0.02 | 54.60 | 0.10 | 1.55 |
| Hong Kong | Private | 2,392 | 85 | 243 | 4.7 | 1,610 | 117.96 | 0.03 | 136.10 | 0.13 | 1.00 |
| Karachi | Public | 646 | 65 | 267 | 9.9 | 1,135 | 11.73 | 0.01 | 6.73 | 0.04 | 0.43 |
| Kuala Lumpur | Private | 358 | 80 | 250 | 4.3 | 753 | 12.03 | 0.02 | 12.38 | 0.17 | 1.00 |
| Mombassa | Mixed | 89 | 90 | 315 | 7.5 | 1,640 | 3.93 | 0.03 | 4.48 | 0.11 | 0.96 |
| Nairobi | Mixed | 295 | 84 | 330 | 9.7 | 1,762 | 16.31 | 0.03 | 17.98 | 0.15 | 1.08 |
| Porto Allegre | Private | 1,492 | 95 | 218 | 4.3 | 669 | 46.68 | 0.05 | 65.35 | 0.23 | 1.17 |
| San Jose, C.R. | Mixed | 621 | 80 | 128 | - | 2,013 | 19.39 | 0.02 | 24.24 | 0.07 | 1.04 |
| Sao Paulo | Public | 2,631 | 83 | 284 | 7.4 | 795 | 159.51 | 0.03 | 75.64 | 0.26 | 0.41 |
| Sao Paulo | Private | 6,590 | 83 | 280 | 5.1 | 765 | - | - | - | 0.26 | 1.00 |
| Seoul | Private | 8,310 | 95 | 340 | 3.9 | 1,326 | 398.18 | 0.03 | 443.43 | 0.16 | 1.04 |
| Singapore | Private | 2,859 | 91 | 269 | 3.9 | 374 | 110.23 | 0.10 | 147.75 | 0.24 | 1.32 |
| Athens | Public | 1,768 | 87 | 245 | 6.6 | 910 | 100.36 | 0.05 | 37.39 | 0.23 | 0.34 |
| Berlin | Public | 1,505 | 85 | 199 | 5.8 | 992 | 234.99 | 0.16 | 130.08 | 0.78 | 0.51 |
| Chicago | Public | 2,275 | 93 | 125 | 3.1 | 750 | 339.28 | 0.08 | 194.54 | 0.90 | 0.52 |
| London | Public | 4,901 | 88 | 202 | 6.8 | 842 | 605.90 | 0.17 | 319.21 | 0.61 | 0.48 |
| Paris | Public | 4,005 | 87 | 142 | 4.5 | 419 | 512.00 | 0.25 | 191.45 | 0.30 | 0.37 |
| Sendai | Public | 777 | 92 | 128 | 2.5 | 495 | 57.76 | 0.11 | 59.44 | 0.58 | 0.96 |
| Average | | 1,931 | 80 | 232 | 8.2 | 1,221 | 119.23 | 0.06 | 83.58 | 0.24 | 0.79 |

- : Not Available

Note: The data cover the principal corporation or group of private operators in each city; they do not include paratransit.

a. The number of buses belonging to the principal corporation or group of private operators covered by the survey. The total number of buses operated in the city as a whole is given in Table A-1.

b. Operating cost excludes depreciation and interest charges.

c. Total cost includes operating cost, depreciation, and interest charges. For comparative purposes a uniform method of determining depreciation and interest charges was used to obtain total cost. Passenger kilometers are imputed by using an average trip length of 5 kilometers.

d. Operating revenue includes fare box and advertising revenue but excludes subsidies fares cover 70% of operating costs

e. Cost and revenue data for Sao Paulo private operators are not available, but private operators receive no subsidy from the government and are known to at least break even.

Source: World Bank survey of bus operators; studies and appraisals.

A15.2.5 Restructuring of Intercity Bus System

The terminals of taxi-bus, which is a major transport means of the present road intercity public transport, are located at strategic areas in the CBD, such as large markets. This location is convenient for the taxi-bus users. However, it is necessary to shift from taxi-bus to bus, which is a more efficient public transport mode, and to relocate the bus terminal from the CBD to the suburban area, considering the increase of future transport demand (from 1,995 thousand trips in year 2000 to 3,218 thousand trips in 2015). Considering the above-mentioned conditions, restructuring of the intercity public transport system is based on the following scenarios.

- a. Major transport means of intercity public transport of road will shift from taxi-bus to bus and minibus. Minibus will be introduced for short distance intercity routes, which are mainly covered by taxi-bus nowadays, and air-conditions express bus will be introduced for bus routes from/to major provincial cities, such as Siem Reab, Sihanoukville and Batambang, after the completion of intercity trunk roads in the medium and/or long term.
- b. In the suburban area, an intercity terminal will be developed at a site, which is partially being used as a taxi-bus terminal nowadays, and the taxi-bus terminal in the CBD will be redeveloped into a bus terminal. Basic concept of intercity bus system and bus terminals relocation plan is shown in Figure A15.2.14 and Figure A15.2.15, respectively.
- c. Restructuring of 3 types of taxi-bus modes such as van, sedan and pickup is as follows:
 - Van type of taxi-bus will serve not only as a means of intercity transportation together with the minibus but also as a part of city bus service in the next few years.
 - Sedan type of taxi-bus will be used for city taxi service. However, it will be converted to the more convenient meter taxi with air condition in the future.
 - Pickup type of taxi-bus will be used for feeder system of bus together with the motorumok. This feeder mode will have a designated route but not a designated stop, like a jeepny in the Philippines, and will be allowed to operate along part of trunk roads. However, the motorumok is prohibited to operate along the trunk roads, such as National roads.

Details for planning of intercity bus terminals are described in section A15.8 as mode interchange area.

A15.2.6 Measures to Increase Bus Users

(1) Improvement and Development of Bus Terminal and Bus Stop

Usually, public transport modes are not the convenient door-to-door modes, such as motodop. Therefore, one of the most important measures of increase of bus users is how to provide the smooth change of transportation means at mode interchange areas, such as bus stops and bus terminals. Details of development of mode interchange areas, not only bus stops and bus terminals but also station plaza and other important features, are described in section A15.6.

(2) Introduction of the Trunk Bus System

Considering the population and city size, and road conditions in the CBD, which has the difficulty of road space expansion and new road development, especially in the CBD, minibus is introduced as the main public transport mode. And taking into account the increase of future bus passenger demand and urban environment in Phnom Penh, the new types of bus, which has high transport efficiency and environmentally friendly bus system as a trunk public transport system in Phnom Penh along major public transport corridors, will be proposed.

(3) Traffic Management for Better Bus Operation

Considering the transport characteristics in Phnom Penh, the direct and indirect measures of improvement of bus transport system in Phnom Penh metropolitan area, which will expect an increase of bus passengers, are summarized in Figure A15.2.16.

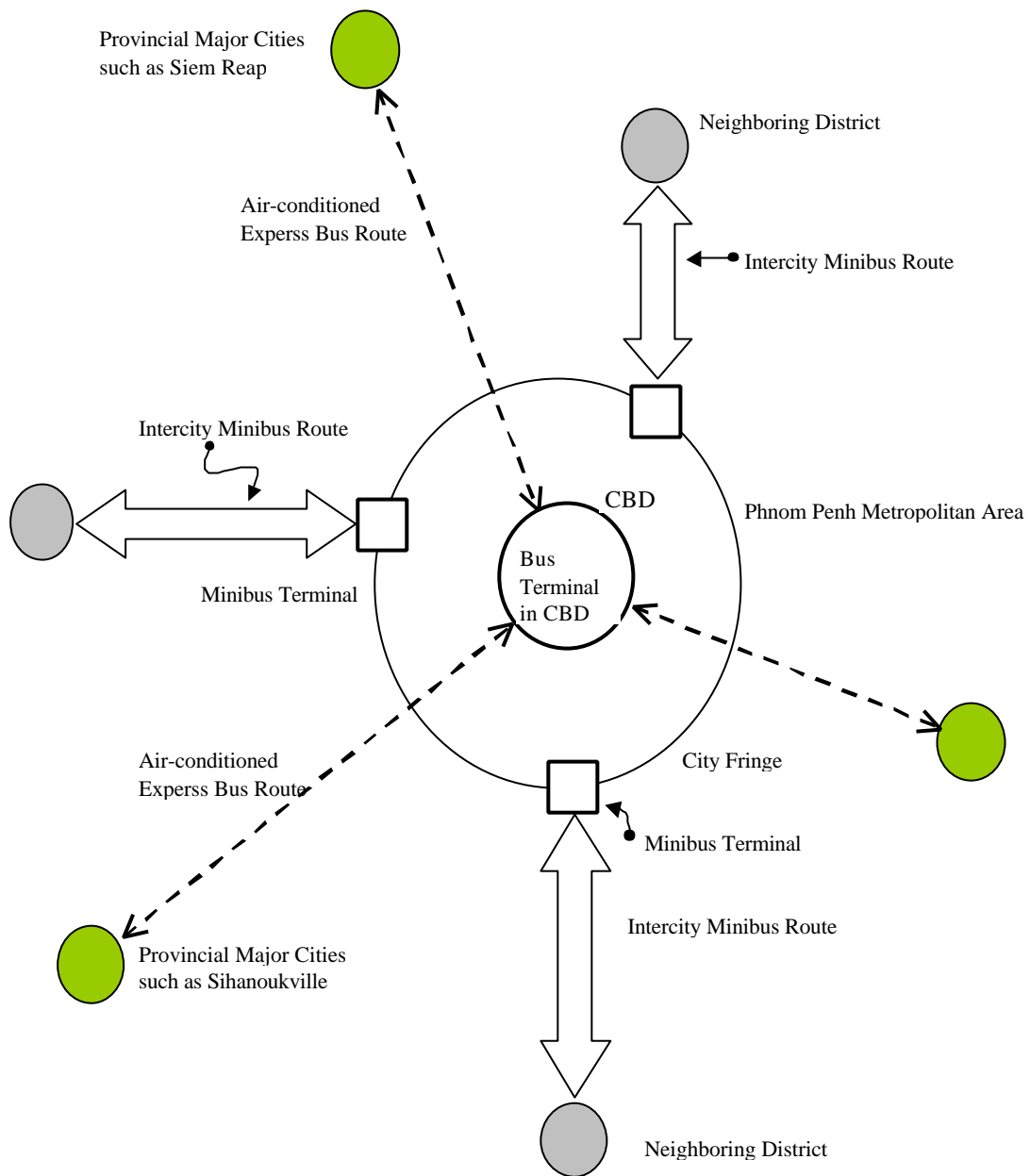


Figure A15.2.14 Basic Concept for Intercity Bus System in the Future

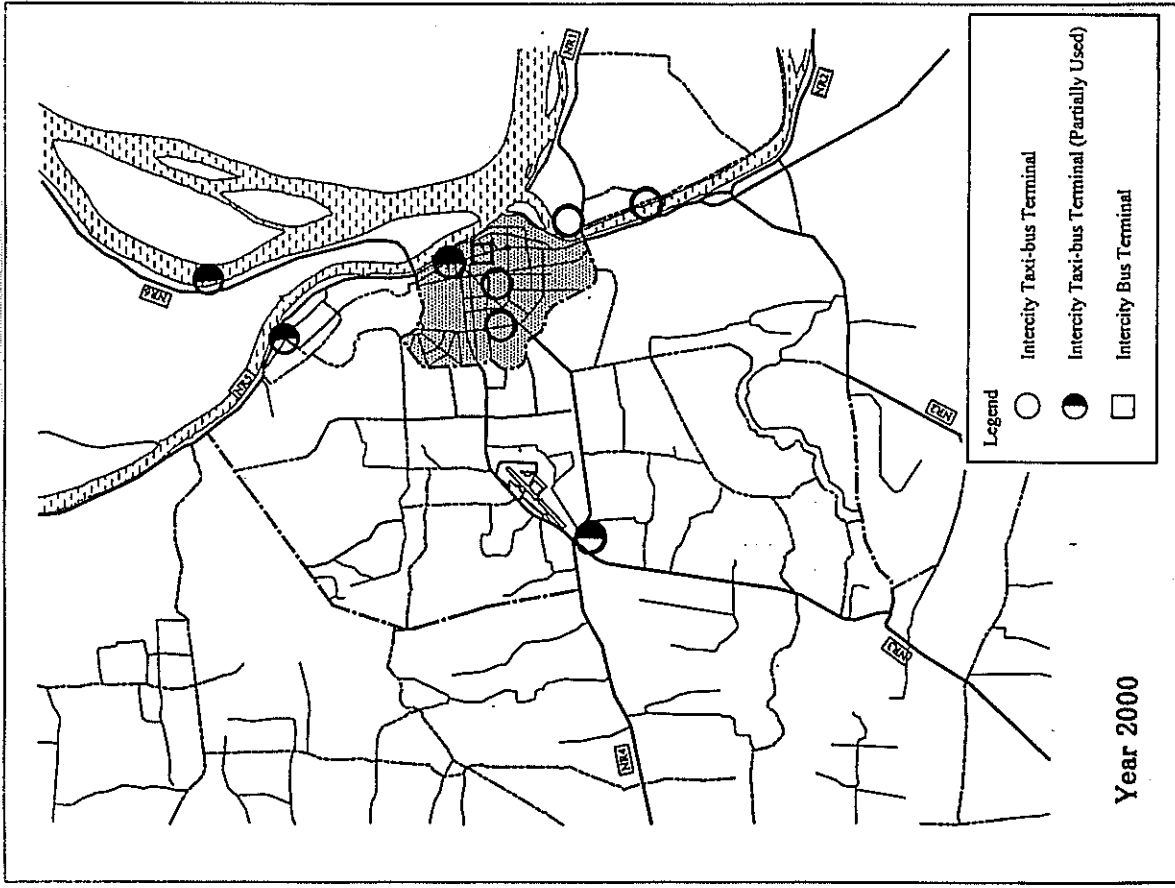
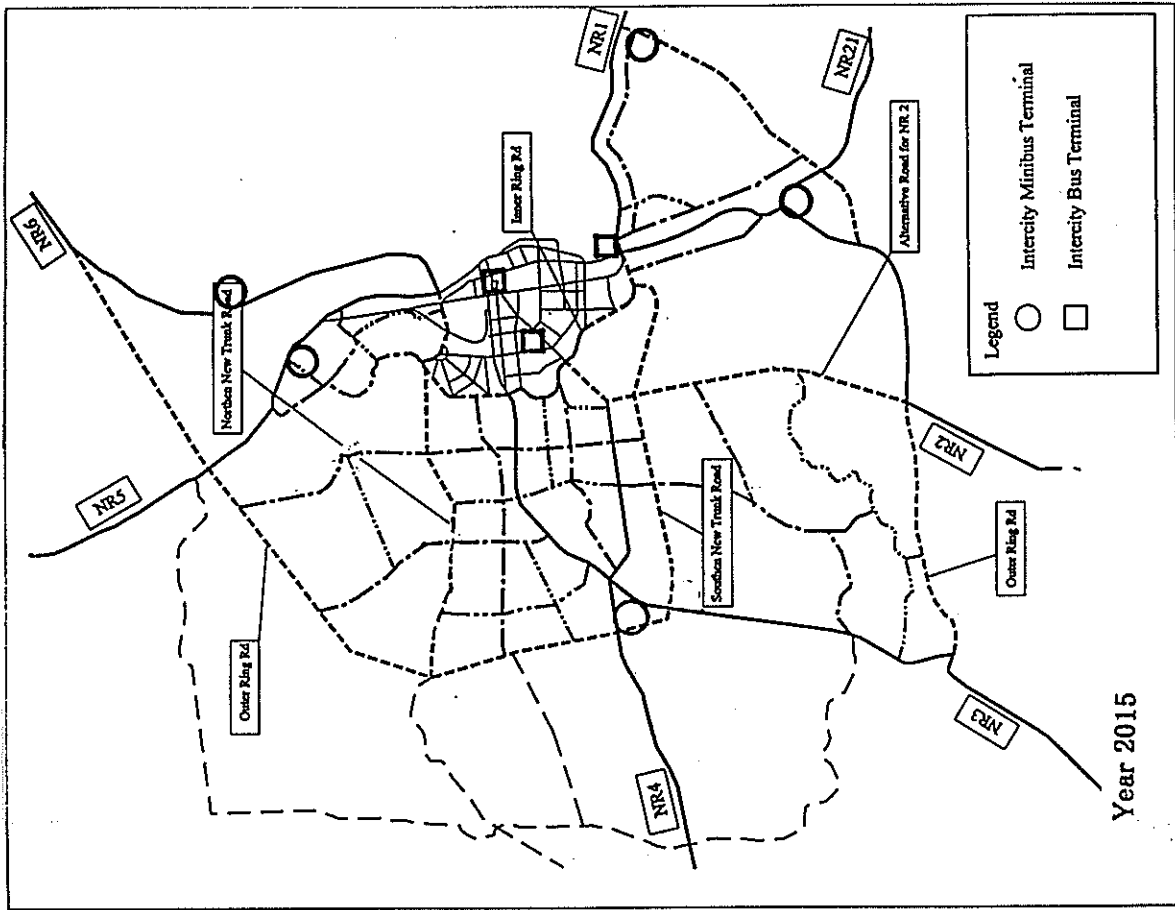


Figure A15.2.15 Relocation of Intercity Bus Terminals

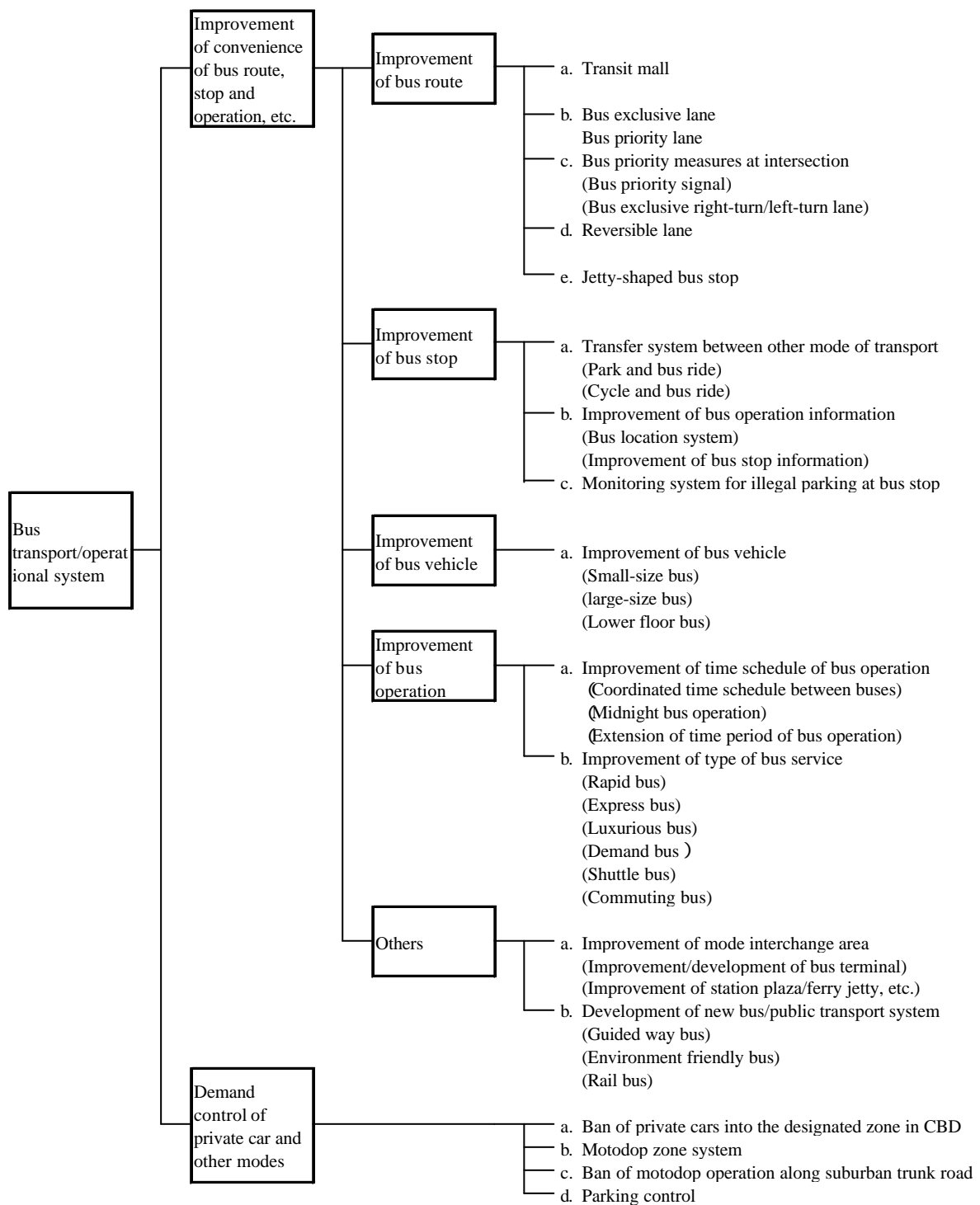


Figure A15.2.16 Measures of Improvement for Bus Transport System to Phnom Penh Metropolitan Area

A15.3 TAXI TRANSPORT

The current taxi transport service in Phnom Penh is provided by airport taxi, hotel taxi and intercity taxi-bus. However, airport taxi and hotel taxi can only be used by airport users and by those staying in a hotel, and only intercity passengers can use taxi-bus. This means that there is no ordinary taxi service in Phnom Penh.

It is necessary to introduce a city taxi service for the convenience of businessmen and those with heavy luggage, and tourists in the future. Required number of taxis in the year 2015 is estimated at approximately 2,600 units, based on the following formula:

$$A (4,450,000) \times B (0.7\%) \div C (2.0) \div D (6.0) = E (2,600)$$

Where:

A: Total number of trips in the study area in 2015 (4,450,000 trips/day)

B: Modal share of taxi (0.7%)

This was based on a comparison made with other cities where person trip surveys had been conducted for transport studies by JICA as shown in Figure 6.3.1. It is assumed that the proportion between bus and taxi share is constant and that the modal share of taxi is 1.0% based on the following formula:

$$\text{Bus: Taxi} = 35.2\% : 3.3\% = \mathbf{11\% : 1\%}$$

Refer to Table A15.3.1 Share of Bus in Phnom Penh in 2015

Considering the transport characteristics in Phnom Penh, such as convenient motodop operation even in the future, it is assumed that the modal share of taxi is reduced by 30%.

C: Occupancy of taxi (2.0 persons/taxi)

D: Number of daily taxi trips with passengers (6 trips/day)

It is assumed that the number of trips of taxi is two-thirds (2/3) those of motodop (9.5 trips/day).

E: Required number of city taxis in 2015

Considering the restructuring of intercity taxi-bus, one alternative is to convert the sedan type of taxi-bus into city taxis over the next few years, and then air-conditioned meter taxis will be introduced in the future.

Table A15.3.1 Modal Share and Other Transport Indicators between Various Cities based on Person Trip Surveys conducted for Transport Studies by JICA

| Country | Egypt | Syria | Pakistan | Malaysia | Thailand | Indonesia | Philippines | Colombia | Paraguay | Panama | Average |
|------------------------------|--------|----------|----------|--------------|----------|-----------|-------------|--------------|----------|------------------|------------------|
| City | Cairo | Damascus | Lahore | Kuala Lumpur | Bangkok | Jakarta | Manila | Barranquilla | Asuncion | Panama | (Excl. Damascus) |
| Survey Year | 1987 | 1998 | 1990 | 1988 | 1989 | 1985 | 1980 | 1983 | 1984 | 1980 and Manila) | |
| Study Area (sq. km) | 642 | 2,500 | 2,250 | 2,800 | 1,640 | 656 | 636 | 514 | 711 | 1,076 | |
| Population (x1,000) | 7,423 | 3,078 | 5,430 | 2,534 | 6,357 | 7,829 | 5,927 | 1,108 | 858 | 759 | |
| Total Trip (x1,000) | 14,350 | 3,954 | 9,780 | 6,420 | 11,501 | 13,120 | 10,630 | 2,581 | 2,169 | 1,474 | |
| Trip Generation Unit (Gross) | 1.85 | 1.58 | 2.14 | 3.225 | 2.19 | 1.95 | 2.22 | 2.69 | 2.96 | 2.41 | |
| Trip Purpose (%) | | | | | | | | | | | |
| To Work | 20.5 | 21.3 | 19.9 | 14.6 | 18.6 | 21.4 | 18.2 | 14.5 | 16.7 | 17.9 | |
| To School | 17.8 | 10.7 | 13.8 | 10.6 | 11.6 | 11.8 | 16.3 | 16.5 | 10.8 | 15.6 | |
| To Home | 48.3 | 49.5 | 44.7 | 42.0 | 42.5 | 43.0 | 47.8 | 48.5 | 46.0 | 43.6 | |
| Business | | 7.3 | 3.7 | 6.3 | 11.0 | 6.5 | 4.2 | | | | |
| Private | | 7.7 | 17.9 | 26.5 | 16.3 | 17.3 | 13.5 | | | | |
| Shopping | 3.8 | 2.9 | | | | | | 7.4 | 8.0 | 4.6 | |
| Others | 9.6 | 0.7 | | | | | | 13.1 | 18.5 | 18.3 | |
| Total | 100.0 | 100.1 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | |
| Modal Share (%) | | | | | | | | | | | |
| Walk | 35.5 | 28.8 | | 27.6 | 15.2 | | | 25.6 | 34.6 | 22.1 | |
| Bicycle | 0.7 | 1.4 | 15.1 | | | 4.0 | | 1.4 | 2.2 | 0.2 | |
| Motorcycle | | | 25.4 | 13.7 | 15.6 | 17.8 | | | | | |
| Car | 19.9 | 15.0 | 28.9 | 32.1 | 27.4 | 18.0 | 15.9 | 10.9 | 14.8 | 26.9 | |
| Track | 0.2 | 1.5 | 0.1 | | | 2.2 | 1.6 | 4.1 | 8.8 | 6.9 | |
| Taxi | 5.5 | 12.6 | 0.2 | 1.7 | 8.3 | 0.9 | | 5.0 | 0.3 | 4.8 | 3.3 |
| Bus | 23.6 | 40.4 | 25.3 | 24.9 | 32.6 | 44.9 | 15.8 | 53.0 | 38.4 | 39.0 | 35.2 |
| Paratransit | | | | | | | 54.5 | | | | |
| Railway | 6.1 | | 1.2 | | | | 0.1 | | 0.1 | | |
| Others | 8.5 | 0.3 | 3.8 | | 0.9 | 12.2 | 12.1 | | 0.8 | 0.1 | |
| Total | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | |

Note: Modal share of taxi in Damascus, Syria includes shared taxi.