CHAPTER 15

PUBLIC TRANSPORT PLAN

CHAPTER 15

PUBLIC TRANSPORT PLAN

15.1 PLANNING CONCEPT

15.1.1 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, are 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 limitations imposed by 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.

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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 expected 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 such as congestion and disturbance of the flow of pedestrians are seen in and around the taxi-bus terminal because of taxi-bus traffic

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

(3) Taxi Transport
- There are no city taxis.
- Various types of vehicle, such as vans, pickups and sedans, comprise intercity taxi-bus.

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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
- 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 one of the most important financial sources for low-income people. Despite of its popularity, its service is inefficient and poses a danger to drivers and passengers alike. The motodop is also a primary contributor to the traffic problems in the city.

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There is a need to introduce a registration system and a designated operational zone for motodop. 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.

- Cyclo is a unique historical mode of transport in Phnom Penh. However, this mode is not efficient in an urban transport setting because of its low speed.

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

- It is dangerous to allow the motorumok to continue plying along the narrow and heavily trafficked trunk roads in the suburban area.

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

(5) Railway Transport

- Utilization of the existing railway is extremely low.

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It is necessary to improve the existing railway. This can be accomplished by strengthening passenger and freight transport systems, by assessing the possibility 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.

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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 the urban environment in Phnom Penh.

(7) Air Transport

- Access to/from Pochentong International Airport is only by airport taxi and private modes.

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

15.1.2 Planning Directions for Public Transport Plan

Based on the direction of the future urban development toward the west, future population (182 million), traffic demand and the basic concept of the urban transport master plan, the planning directions for public transport planning are summarized below, and the comprehensive public transport system in Phnom Penh metropolitan area in the year 2015 is illustrated in Figure 15.1-1.

- 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 a smooth manner as possible. Furthermore, a harmonized comprehensive public transport system should be developed between the main public transport mode and the para-transit mode.
- 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 environmentally friendly and distinctive public transport mode should be introduced as a trunk public transport system along the major public transport corridor.
- Considering the role of the para-transit mode in a transport system, the existing para-transit modes such as the motodop, cyclo and motorumok should be converted mainly into feeder modes to buses.
- The improvement of the transport environment could pave the way for the possible shift

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

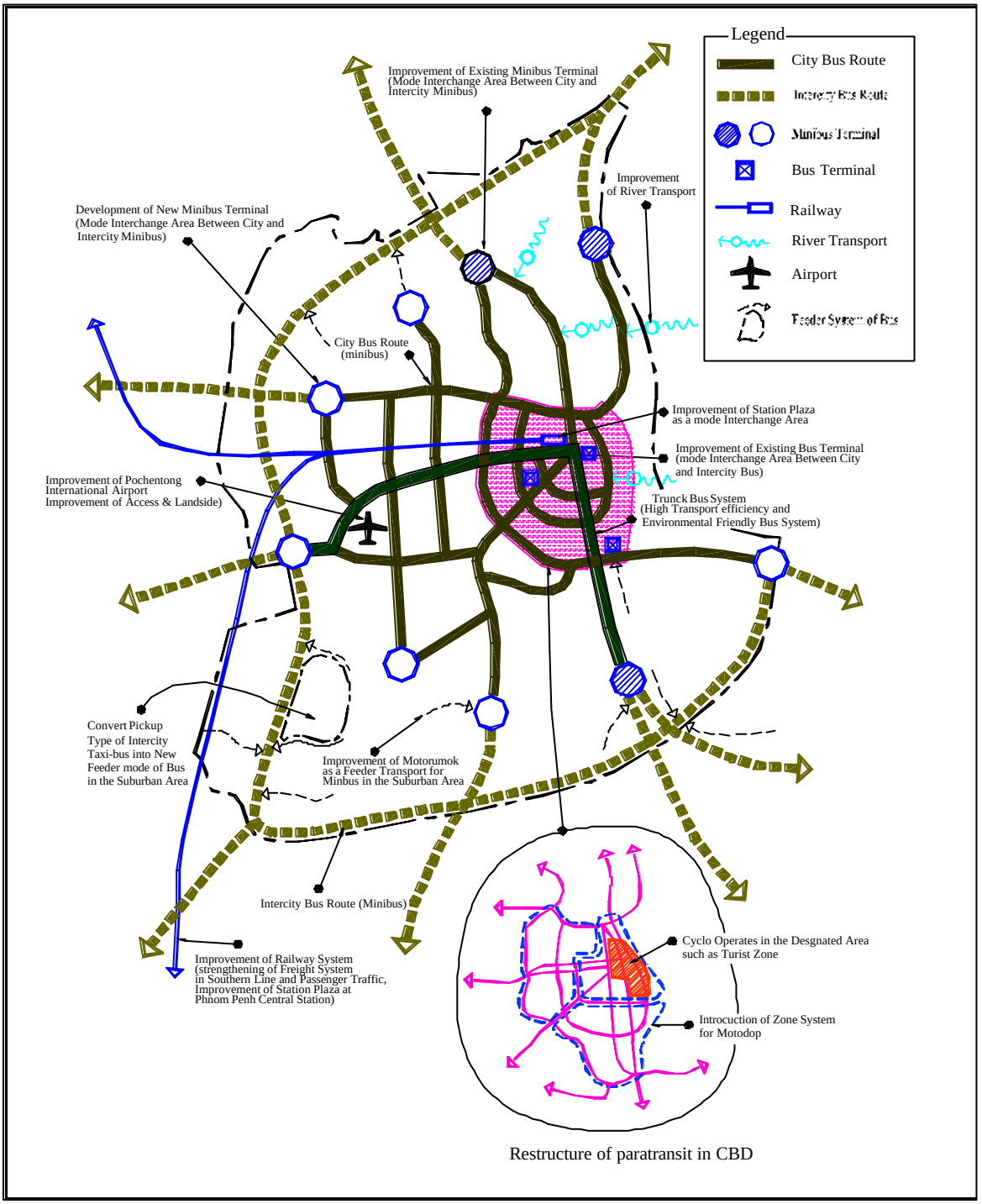


Figure 15.1-1 Proposed Public Transport System in Phnom Penh Metropolitan Area in the Year of 2015

15.2 WORK PROCEDURE

Work procedure of this chapter is shown in Figure 15.1-1. Figures in parenthesis show the section number in this Chapter. Details of sections in this Chapter are presented in Appendix 15.

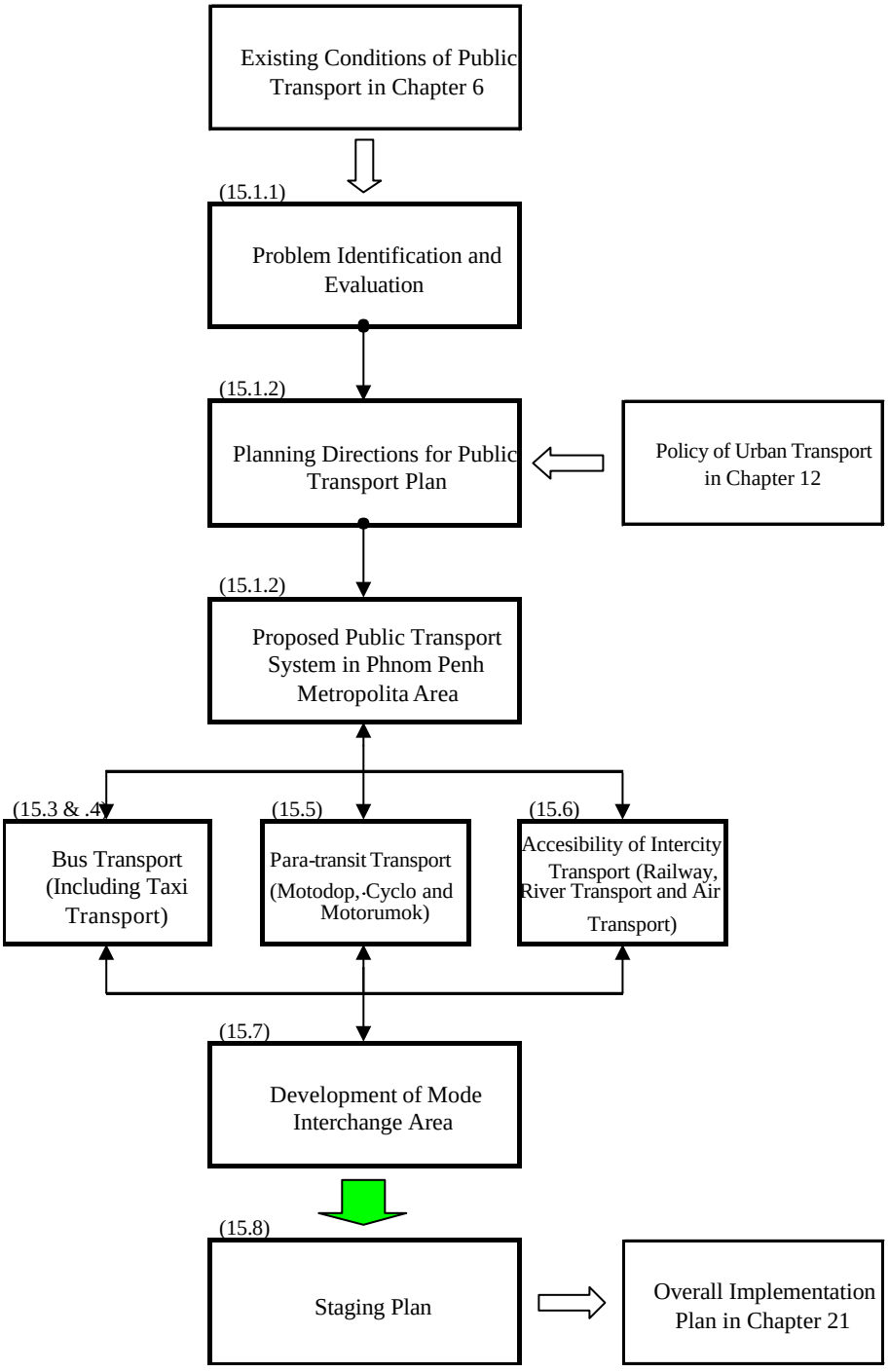


Figure 15.2-1 Work Procedure

15.3 BUS TRANSPORT

15.3.1 Necessity of City Bus System

Considering the size of urbanized area and road conditions, a bus system should be introduced as the trunk public transport system in Phnom Penh. The main reasons to introduce a bus system are as follows:

- The bus system is one of the most flexible and easy-to-develop transport systems and it can even be introduced into a small-scale urban area.
- The bus system can be easily introduced without any drastic change to the existing transport facilities, such as road system.
- The bus system is a public transport system which requires a small initial investment cost.
- Considering the population size, level of economic activity and the experience of urban transport systems in other Asian countries, a public transport system belonging to the bus-oriented system should be introduced into Phnom Penh.

Table 15.3-1 shows a comparison between various public transport system characteristics.

Table 15.3-1 Comparison between Various Public Transport System Characteristics

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

15.3.2 Development of Bus Route Network

(1) Basic Considerations

- Public transport services should cover all of the Study Area, not only by bus but also by combination of bus and para-transit modees.
- Bus routes within the urbanized area should be introduced only on the major roads with multi-lane configuration, such as Monivong and Russian Boulevard, because bus routes on the 2-lane, 2-way roads with mixed traffic adversely affects not only operational conditions but also that of other private traffic.
- Basically, bus routes are composed of radial and circular routes to accord with the trip characteristics of public transport users.
- In consideration of the convenience of bus operation and to avoid a large concentration of traffic at the Central Market, approximately half of the origin/destination of the bus routes should be the Central Market and the other half should be at the suburban bus terminals with routes via Central Market.
- Extension of bus routes to the suburban area should be based on the future urban expansion.

(2) Proposed Bus Route Network

Based on the previously proposed city bus routes and basic consideration as mentioned above, the proposed bus route network by stage (2005, 2010 and 2015) is shown in Figure 15.3-1. The proposed bus route length by stage is shown in Table 15.3-2. An outline of the proposed bus route network is summarized below.

- Proposed bus route network in 2005 should cover the urbanized area, except for the 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 urbanized area and extend toward the southwestern fringe of the urbanized area to cope with 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 should extend to the proposed new bus terminal, located at NR1/Outer Ring Road intersection.

Table 15.3-2 Proposed Bus Route Length

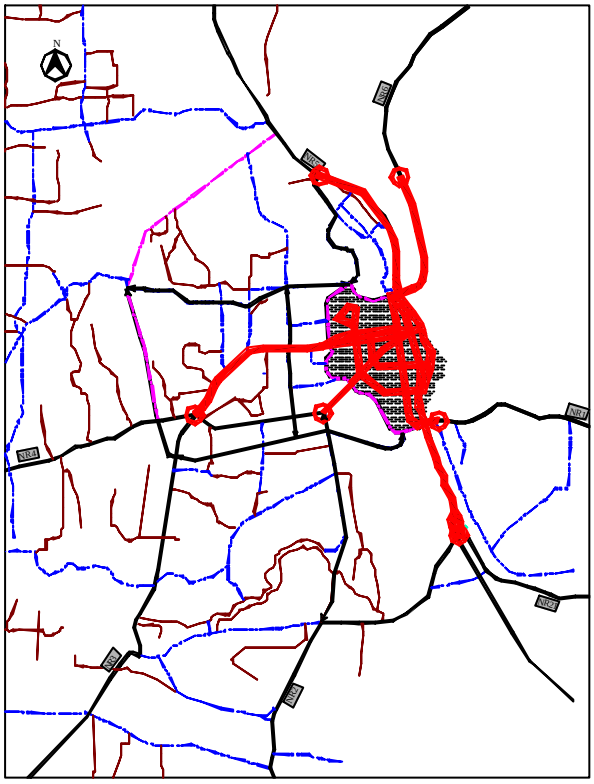
Unit: kr

	Year 2005		2010		2015	
Urbanized Area	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%

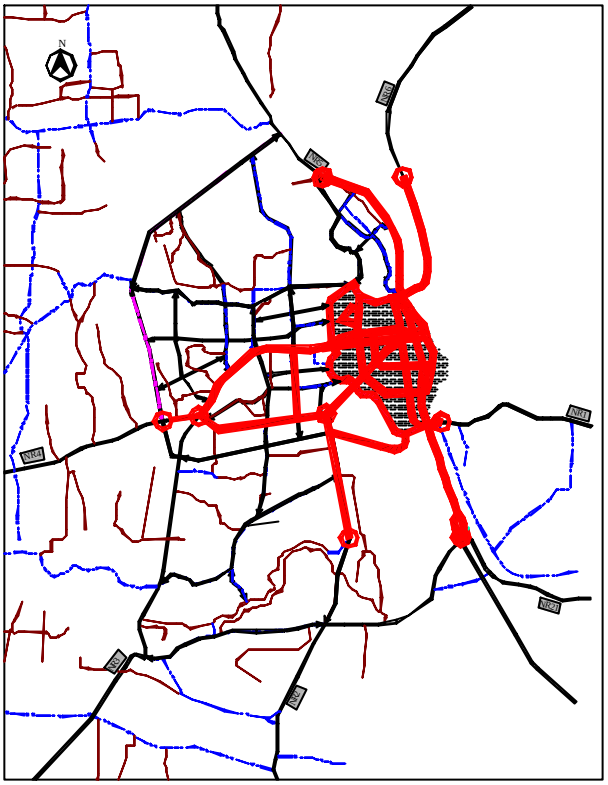
15.3.3 Bus Passenger Demand Forecast

Bus passenger demand forecast is based on the analysis of the opinion survey of bus operation from person trip survey and on proposed transport policies, such as para-transit zone system, following the procedure shown in Figure 15.3-2. *The result of bus passenger demand forecast in 2005, 2010 and 2015 are summarized in Table 15.3-3, and details in the year 2015 are described below.

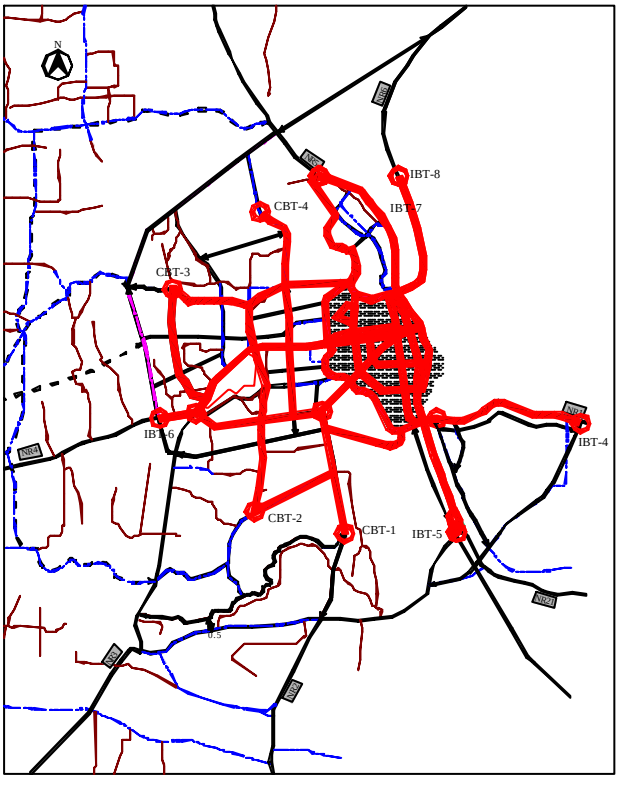
*The result of this bus passenger demand forecast is verified against those estimated by disaggregate model that is constructed based on the result of the Public Experiment. (See Appendix 20.2-4).



Year 2005 (Total Bus Route Length = 71km)



Year 2010 (Total Bus Route Length = 102km)



Year 2015 (Total Bus Route Length = 148km)

Legend

: Proposed Bus Route

CBT: City Bus Terminal

IBT: Intercity Bus Terminal

Figure 15.3-1 Proposed Bus Route Network in 2005, 2010 and 2015

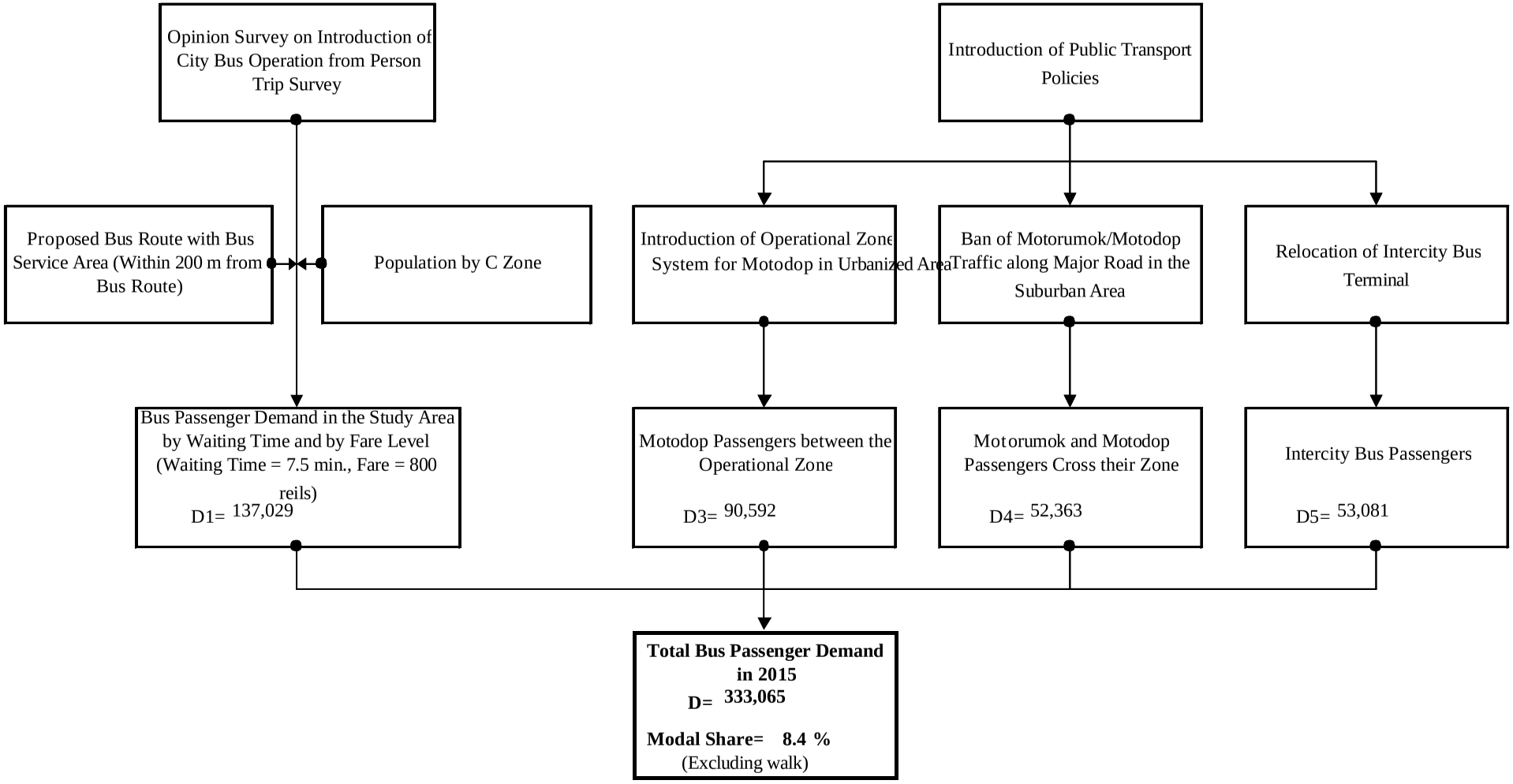


Figure 15.3.2 Procedure on Bus Passenger Forecast and demand in 2015

(1) Bus passenger demand forecast by opinion survey

The basic procedure of bus passenger demand forecast uses the result of the 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 the opinion survey for bus operation, it is known that the factors affecting bus rider ship demand are walking distance, waiting time and bus fare. The relation between bus ridership, waiting time, and bus fare is expressed as shown in Figure 15.3-3. In deriving this relation, the bus service area (the area where passengers can access to bus stops) is assumed to be with 200 m range from the bus route in consideration for the urbanized are and 300 m-range for the suburban area. The bus route network proposed for year 2015 was used in consideration of the "network effect".

From Figure 15.3-3, the following conclusion can be derived:

(i) When waiting time exceeds 5 minutes, the demand for bus decreases substantially. This is attributed to the current high frequency of motodop services.

(ii) There is a big gap in the bus ridership between a 500-riels and a 750-riels bus fare.

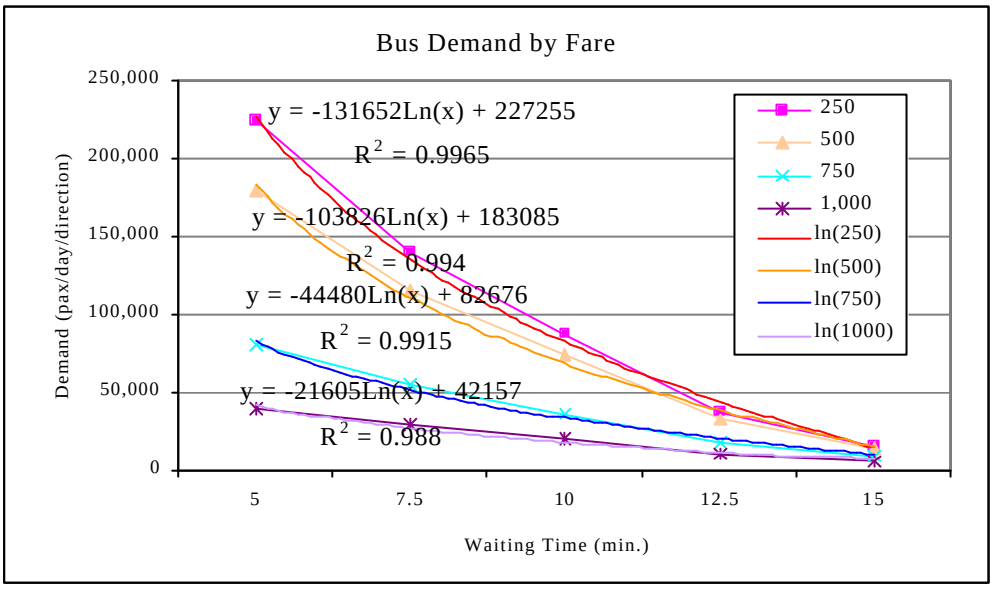


Figure 15.3-3 Relation between Fare, Waiting Time and Bus Rider-ship in 2015

The number of bus passengers can be estimated considering the population in 2015, the bus route network, bus ridership, a fare level of 800 riels (it is assumed that a flat fare system would be introduced) and a waiting time of 7.5 minutes. The fare level and waiting time will be possibly adjusted 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. On this assumption, bus passenger demand in 2015 is estimated to be 137,000 trips/day.

(2) Transfer passengers to/from intercity bus

It is assumed that the intercity bus passenger, whose origin/destination is the urbanized area along the bus routes, will transfer to city bus upon construction of intercity bus terminals in the suburban area. This transfer of passengers is estimated at 53,100 trips/day.

(3) Zone and cross passengers by public transport policies

Two (2) public transport policies are assumed to be introduced in order to encourage bus usage.

(i) A motodop operational zone system is assumed to be introduced in the urbanized area. In this system, motodops are allowed to operate only within their designated operational zones. Accordingly, motodop passengers traveling across the zone border are expected to transfer to bus. The passengers transferring to bus are estimated at 90,000 trips/day.

(ii) In the suburban area, it is assumed that operation of motodop and motorumok on the arterial road will be prohibited. In addition, an operational zone system will be introduced and motodops/motorumoks will be allowed on collector and local roads. Passengers traveling across the zone border, and expected to transfer to bus, are estimated at 52,400.

Table 15.3-3 Results of the Preliminary Bus Demand Forecast in 2005, 2010 and 2015

Item	Year 2005	2010	2015	Remarks
Bus Passenger Demand in Urbanized Area 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	

The bus passenger and traffic flows on the proposed 2015 bus route network obtained through the analysis as described above are shown Figure 15.3-4.

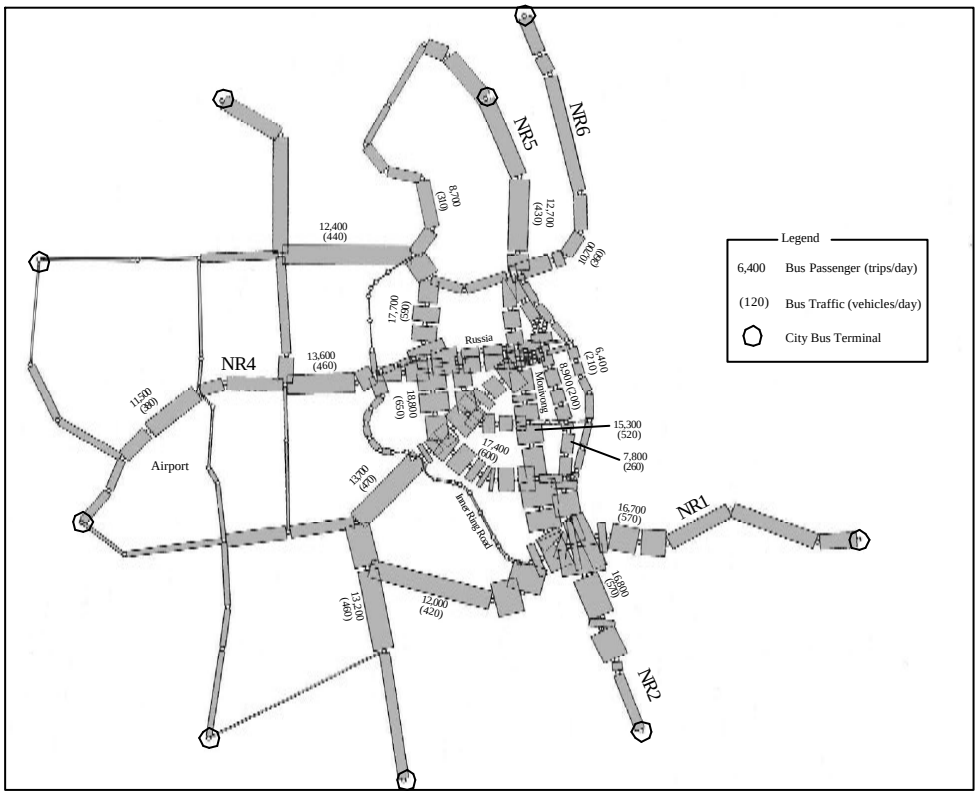


Figure 15.3-4 Bus Passenger Demand Forecast in 2015

15.4 TAXI TRANSPORT

It is necessary to introduce a city taxi service for the convenience of businessmen, those carrying heavy luggage, and tourists in the future. The required number of taxis in the year 2015 is estimated at approximately 2,600 units. 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. Details are discussed in Appendix 15.3.

15.5 PARA-TRANSIT TRANSPORT

15.5.1 Motodop

The operational zone system (the urbanized area is divided into three (3) zones) of motodop, as described below and shown in Figure 15.5-1, will be introduced to reduce traffic in the urbanized area and to pave the way for a smooth city bus service operation. However the complete form of this zone system will be introduced after year 2010 when the improvement of local streets in the urbanized area will be completed.

(i) Motodop shall play the role of feeder transport means of bus.
(ii) Introduction of license system for motodop operation: Motodop drivers should wear the prescribed uniform color coded in accordance with the 3 designated operational zones.
(iii) Motodop shall be banned along trunk roads, such as Preah Monivong, Preah Sihanouk, Monieth and Russian Blvd. However, motodop are allowed to cross main intersections of trunk roads except for the above-mentioned roads.
(iv) A motodop stand/pool will be provided at major bus stops and bus terminals for the smooth transfer between the two modes.

15.5.2 Cyclo

Cyclo will be preserved as a unique historic transport mode, which can operate only in designated areas, such as tourist zone. Details are as follows:

(i) Cyclo shall be preserved as a unique historic transport mode which can operate only in designated areas, such as tourist zone.
(ii) Number of cyclos shall be reduced from 1,200 to 500 in the year 2015, and cyclo frames shall be painted in a unique color to attract tourists.
(iii) Proposed zone for cyclo operation is the area to the east of Preah Norodom Blvd. between Preah Sihanouk Blvd. and Wat Phnom.
(iv) It is proposed that the avenue along the Tonle Sap River (a part of Preah Sisovath Boulevard) became a unique road development such as a transit mall, which shall be open for the operation of buses, cyclos and pedestrians.

15.5.3 Motorumok

Motorumok shall play the role of feeder transport to the bus system in the suburban area with a ban on motorumok operation along suburban trunk roads, such as National Roads.

An additional, new feeder system, which is the mode between bus and motorumok in the future, is proposed due to the sparse road network density (long distance between bus stops and houses) in the suburban area. This mode can be converted from the pickup type of taxi-bus.

The motorumok stand/pool shall be developed at major bus terminals and bus stops for the convenience of transfer between the two modes.

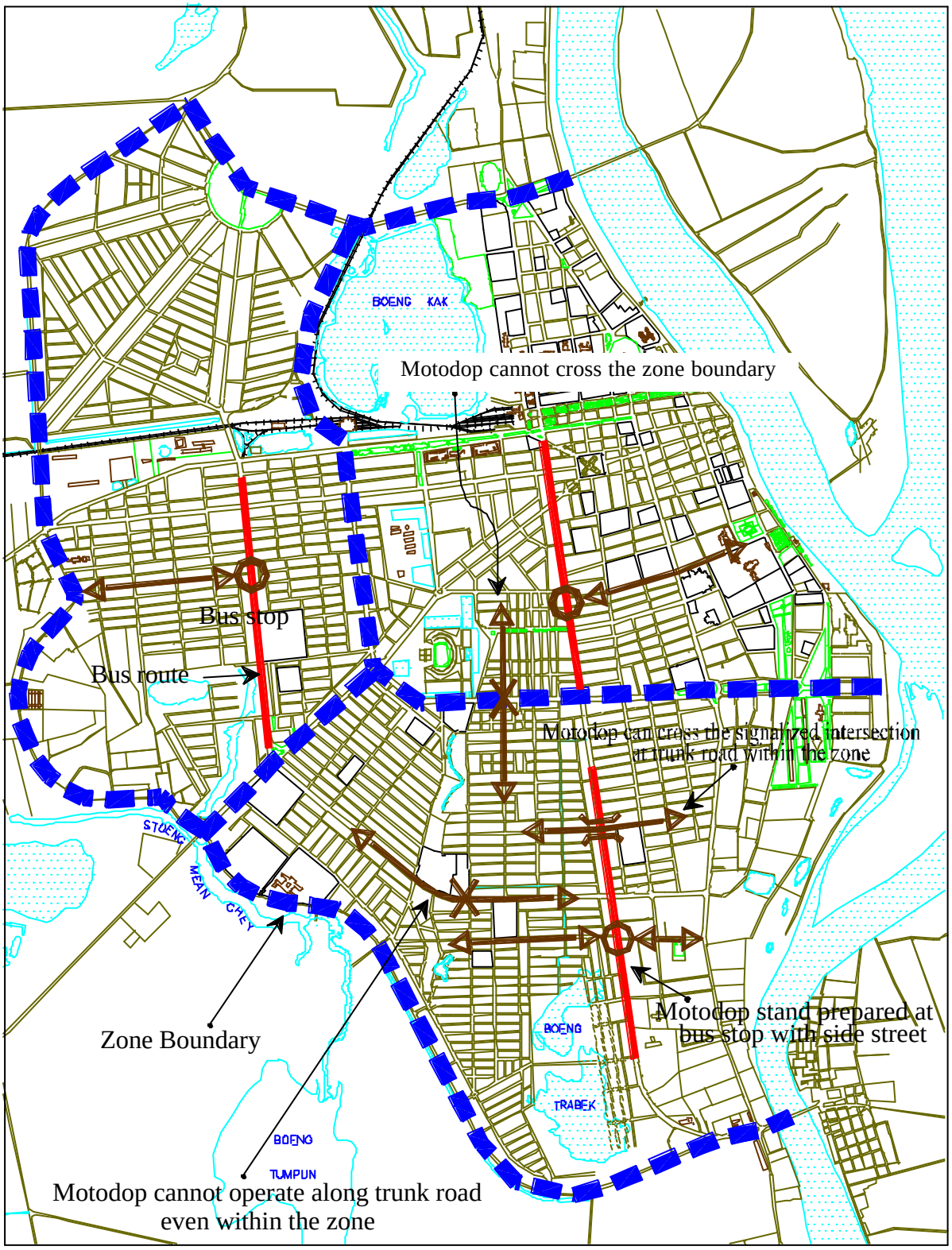


Figure15.5-1 Concept of Motodop Operational Zone in Urbanized Area

15.6 ACCESSIBILITY OF OTHER TRANSPORT MODES

The accessibility of other modes with road transport is presented in outline below, given that the Study focuses only on road transport.

(1) Railway Transport

To provide an efficient mode interchange area for access from the urbanized area to railroad, improvement of the Central Station area is recommended. This improvement is expected to increase not only railway passengers but also other public mode users by paving the way for a smooth transfer of passengers between modes.

In the case of the increase of population along the railway line in Phnom Penh, the possibility of introduction of an urban public transport system using the existing rail track, such as rail bus or dual mode bus, should be considered.

(2) River Transport

It is important to improve not only jetty facilities but also the feeder transport system between the ferry and trunk public transport for the convenient access to/from the riverside area and for the improvement of the urban environment in Phnom Penh. Refer to Figure 15.6-1 for a schematic illustration.

(3) Air Transport

Considering the future increase of air passengers of Pochentong International Airport, it is necessary to improve the landside access to/from the airport, especially by introducing a public transport system, such as bus service.

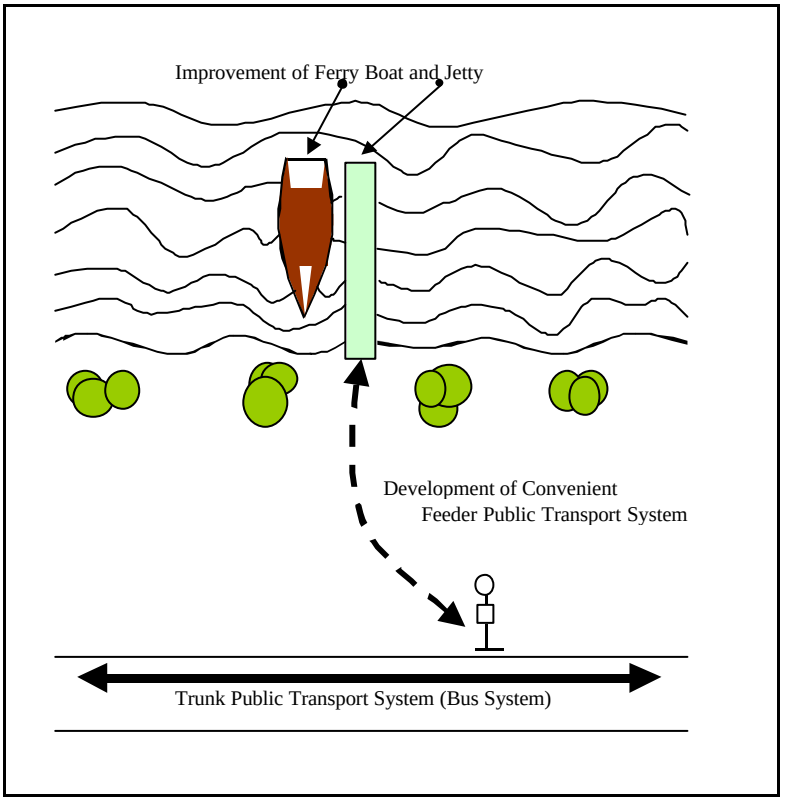


Figure 15.6-1 Planning Concept of River Ferry Jetty

15.7 DEVELOPMENT OF MODE INTERCHANGE AREA

One of the most important issues to improve the public transport system is to develop smooth transfer at mode interchange areas, such as bus terminal, railway station. Therefore, it is necessary to discuss the location and development of efficient and convenient mode interchange areas.
The planning directions for the development of mode interchange areas are described below.

(i) Mode of intercity land public transport should be converted from taxi-bus to bus and minibus to cope with the future increase of intercity passenger flow.
(ii) Existing taxi-bus should be converted as follows:
Van type: not only inter-city public transport but also city public transport for the next few years
Sedan type: city taxi for the next few years
Pickup type: new feeder system of bus together with Motorumok
(iii) The three (3) existing major taxi-bus terminals, located in the urbanized area at Central Market, Dang Kao Market and Chbar Ampav Market, should be redeveloped into intercity bus terminals.
(iv) Minibus should be introduced into the intercity public transport system for neighboring districts. In addition, not only should the existing taxi-bus terminals, located in the suburban area such as Preah Leap and Chaom Chao Terminals, be improved, but also new bus terminals should be constructed up to the year 2015.
(v) Basic consideration of relocation of new bus terminals is to minimize the traffic congestion in the urbanized area.
(vi) Types of mode for using the bus terminal are bus, minibus taxi, motodop, motorumok and private car, and these modes will vary depending on the type of terminal and location.

Refer to Figure 15.7-1 for an illustration of the mode interchange area at a minibus terminal.

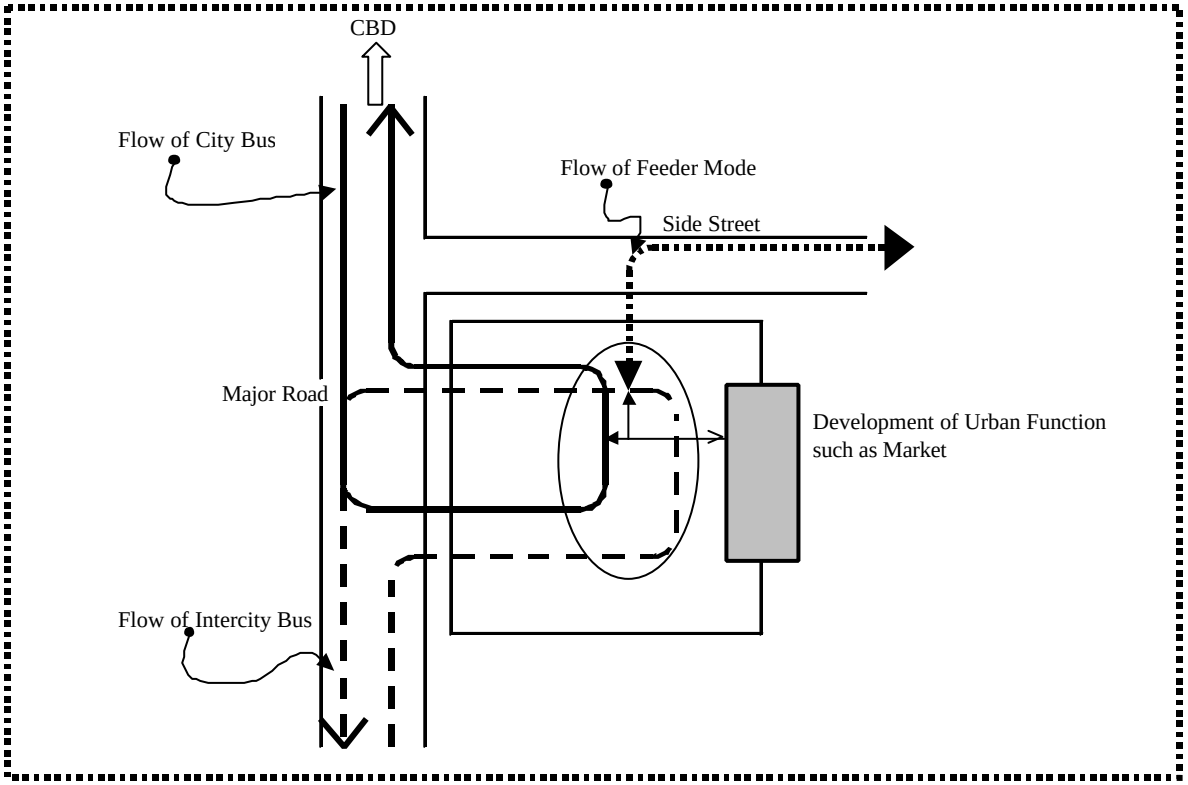


Figure 15.7-1 The Concept of Mode Interchange Area at a Minibus Terminal

15.8 STAGING PLAN

15.8.1 Preliminary Cost Estimate

The estimation of preliminary cost is based on the following conditions:

(1) The year 2000 price is applied for the unit cost.
(2) The unit cost of the bus fleet is the price of airconditioned minibus providing the intercity operation.
(3) Other unit costs, such as bus terminal development, are based on the actual cost.
(4) Improvement costs of other modes, which are not controlled by the Municipality of Phnom Penh, like air transport, are not included.

15.8.2 Staging Plan

To achieve the Master Plan by 2015, the public transport plan should be implemented in stages. Basic considerations of the staging plan are as follows:

(1) The Master Plan (from year 2001 to year 2015) is divided into three (3) stages, namely, Short-term (2001 – 2005), Medium-term (2006 – 2010) and Long-term (2011 – 2015).
(2) City bus route network plan, which is one of the most important factors in the public transport system, is proposed based on the speed of urban development and staging plan of road network development.
(3) Investment cost in each stage is almost the same because the main factor of estimated investment cost is the cost of the bus fleet, which increases in proportion to growth of bus passenger demand. The implementation plan of the Master Plan, which takes into account the possible total investment cost and the coordination of other sectors, is discussed in chapter 21.

Considering the above-mentioned factors, the preliminary cost estimate by stage is shown in Table 15.8-1.

Table 15.8-1 Cost Estimate of Public Transport for the Master Plan by Stage

Unit: 1,000 US$ in year 2000 price

Items					Short-term 2001 - 2005	Medium-term 2006 - 2010	Long-term 2011 - 2015	Remarks
1	a	Bus	Bus Fleet	Minibus	17,400	16,560	18,280	
	b			New Bus System				This is beyond the year 2015
	c		Bus Terminal	Improvement	952			
	d			Development		300	1,200	
	e		Bus Stop		89	39	58	
	f		Bus Shelter		199	87	129	
	g		Bus Depot		635	607	668	
2		Taxi	Taxi Fleet		12,600	13,200	13,200	By private sector
3		Motodop	Introduction of Operational Zone System for Motodop		25			Policy measures
4		Cyclo	Introduction of Operational Zone System for Cyclo		25			Policy measures
5		Motorumok	Ban of Motorumok Operation along Trunk Roads in the Suburban Area		25			Policy measures
6		New Feeder Pickup	Convert Pickup Type of Intercity Taxi-bus into New Feeder Mode of Bus in the Suburban Area		25			Policy measures
7	a	Ferry Jetty Improvement	Boat		40	50	40	By private sector
	b		Jetty		48	47	48	By private sector
8		Railway Rehabilitation						By Royal Railway of Cambodia
9		Airport Access Improvement						By State Secretariat of Civil Aviation
10		Development of Mode Interchange Area	Station Plaza Improvement		92			
Total by Stage					19,466	17,592	20,334	= 1 + 10

CHAPTER 16

TRAFFIC MANAGEMENT PLAN

CHAPTER 16

TRAFFIC MANAGEMENT PLAN

16.1 PLANNING CONCEPT

One of the advantages of traffic management is to implement various countermeasures in the short term and at low cost in order to alleviate the various transportation problems. The necessity for traffic management can be summarized as follows.*

(i) Existing traffic facilities in the Study Area are not used effectively. If traffic management and operation were improved, these would contribute to the effective use of existing facilities and traffic capacity would increase substantially.
(ii) Traffic management in the Study Area such as of road facilities, traffic operation, and traffic safety plan, is still in the developing stage. Modernization of traffic management and operation is necessary so that the city will become an international city in near future.
(iii) An aim of traffic management is to assure safe, comfortable and speedy traffic movement. Among these aims, traffic safety is the fundamental requirement of the citizens.

16.1.1 Present Traffic Problems

At present, traffic delay and congestion are observed frequently in several areas in the Study Area and traffic accidents are increasing. Examination of causes of the problems are necessary in order to formulate a traffic management plan. They are summarized as follows.

(i) Traffic engineering and technical perspective
- Disorderly traffic flow due to the mixed traffic
- Inefficient traffic processing capacity at roads and intersections
- Undeveloped vehicle directorial facilities at intersections
  - ・Inadequate geometric configuration
  - ・Insufficient traffic safety facilities
  - ・Insufficient pedestrian crossing facilities and pedestrian refuge islands
- Undeveloped and insufficient signal control facilities
- Inadequate traffic regulations
- On-street vendors and on-street commercial activities

(ii) Traffic safety perspective
- Insufficient traffic safety education
- Lack of driver's discipline to observe traffic regulations
- Inconsistent traffic enforcement

16.1.2 Objective of Traffic Management Plan

The objectives of the traffic management plan are to prepare comprehensive measures to achieve a safe, smooth and comfortable traffic environment for road users. The measures should be prepared based on a careful study of the traffic problems currently occurring, and expected to occur, in the future in order to cope with these problems.

16.1.3 Basic Direction of Traffic Management Measures

Traffic problems have been becoming more pronounced year after year. Implementation of remedial measures is an urgent task. In particular, the implementation of balanced 3-E measures (Traffic Engineering, Education and Enforcement) is key. The 3-E concept applied to the Study Area is summarized below.

* Additional information on the Chapter is included in the attached report: "Approach to Traffic Management in Phnom Penh"

(1) Measures of Traffic Engineering

(i) Improvement of intersection and road section

It is important to increase traffic capacity by improving intersections since the most serious factors to disrupt main traffic flow are the small traffic capacities of intersections. In addition, improving traffic facilities and the traffic operation system of roads are necessary so that the obstructions to traffic flow are eliminated and smooth traffic flow can be achieved.

(ii) Improvement of traffic signal

The number of existing traffic signals are insufficient, and the existing signals are out-dated and inefficient. Therefore, the modernization of the existing traffic signal control system and installation of signals at certain intersections are important. These measures will contribute to a decrease in traffic congestion at intersections.

(iii) Setting up traffic accidents data managing system

To decrease traffic accidents efficiently, it is very important to prepare effective remedial measure based on traffic accident data analysis. Setting up a traffic accidents data-managing system which records detailed information is a vital requirement.

(2) Promotion of Traffic Education

One of the reasons for the drastic increase in traffic accidents is undisciplined behavior of the drivers and pedestrians. Thus the promotion of traffic safety and traffic education is an essential task.

(3) Strengthening of Traffic Enforcement

At present, drivers' observance and attitude to traffic regulations are extremely poor. Strengthening of traffic enforcement is necessary. Improvement in this area is important not only for the safety of the citizens but also for attracting foreign tourists.

16.2 TRAFFIC ENGINEERING MEASURES

In this section, traffic engineering measures are described.

16.2.1 Road Improvement and Traffic Operation

In general, most of the congestion occurs at intersections rather than at road sections. Moreover most of the congestion, as well as traffic accidents, usually occur at the intersections in the urban areas. In the case of the Study Area, however, congestion is also observed at road sections. Thus, if obstructions at road sections are eliminated or reduced, a smoother traffic flow and decrease in traffic accidents can be expected.

(1) Segregation of slow-speed vehicles from high-speed vehicles

For left-turn operation at intersections (both signalized intersections and non-signalized ones), the slow-speed vehicles (bicycles, cyclo and so forth) should be completely segregated from the other vehicles. This means that these slow-speed vehicles should cross the intersection in two stages or steps similar to pedestrians as shown in Figure 16.2-1. This measure will become somewhat inconvenient for drivers of such vehicles but it will bring much-needed safety.

(2) Pavement markings

Pavement markings are an important traffic facility in addition to a good road surface for the smooth flow of traffic. A yellow centerline can prevent disorderly traffic; otherwise drivers cannot recognize which lane to drive in and may drive on the opposite-lane.

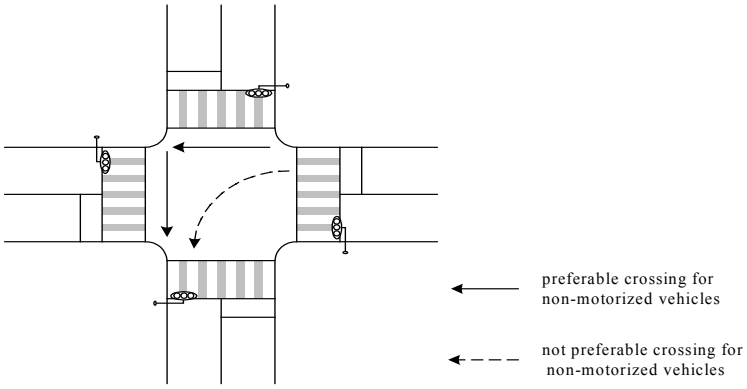


Figure 16.2-1 Segregation of Slow / High-Speed Vehicles

At present, there is no rule to regulate opposite-lane driving and this can cause traffic accidents and/or congestion. White broken line markings contribute to the segregation of four-wheel vehicles from the two-wheelers and hence to achieve smoother traffic flows. Stop lines and intersection markings contribute to protect pedestrians from danger and to reduce conflicts between other vehicles.

Following the improvement of road surfaces, pavement markings have to be introduced to all the main arterial streets and the National Roads No.1 to No.6 in the Study Area. However, the usable period of the markings is short and, even if plastic material is used for marking, regular remaking is necessary as the markings deteriorate and become unclear in about 1 to 2 years. Regular maintenance is required in order to keep pavement markings continually in good condition. The pavement markings on National Road No.2 in particular should be kept in good condition since this road suffers one of the highest accident frequency rates in the Study Area.

(3) Exclusive Left-turn Lane

Exclusive left-turn lanes need to be provided depending on the demand of left turning vehicles. With an exclusive left turn lane, traffic processing capacity and safety are expected to be improved unless the volume of left-turning traffic is extremely heavy and poses an obstruction to through traffic.

It is recommended at major intersections that left-turn vehicles be controlled by providing an exclusive left-turn lane with a left-turn phase of traffic signal before consideration is given to prohibiting left-turn. (See Figure 16.2-2) If congestion still occurs after such control is implemented, then left-turn prohibition should be considered.

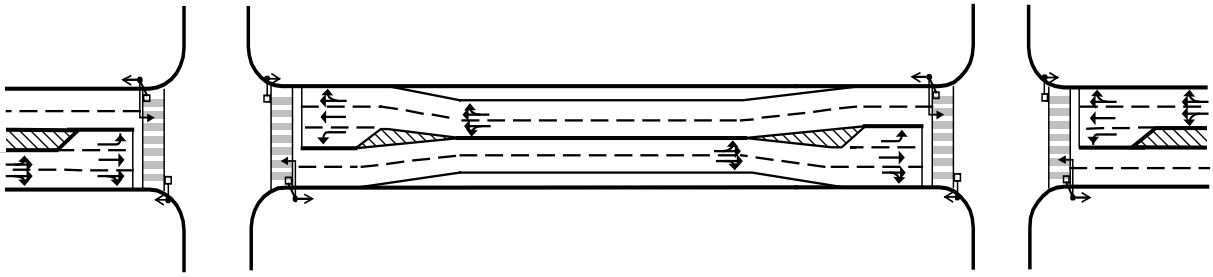


Figure 16.2-2 Basic Design of Exclusive Left-turn Lane

(4) Raised Medians

Raised medians provide a higher level of traffic safety and improve operations for through traffic on multi-lane street. (See examples in Pictures 16.2-1 and 2)

The benefits of the medians are:

- physically separating opposing traffic,
- restricting access to/from the arterial,
- providing pedestrian refuge areas.

The use of raised medians along multi-lane arterial streets will be highly beneficial in the Study Area given that it is possible to restrict both driving on the opposing lane and left-turning to/from a minor road or drive-way. However, when driving discipline improves, the median may not be needed. At that stage the raised median should be removed given that the existing arterial streets have limited width and more efficient use of existing streets is necessary.

Picture 16.2-1 Example 1 of Raised medians

Picture 16.2-2 Example 2 of Raised medians

(5) Sidewalk and Crosswalk

Although sidewalks are provided in the urbanized area in principle, sidewalk maintenance is effectively not carried out. Pedestrians have to walk on the roadway given that sidewalks are not continuous and are obstructed. Thus improving sidewalks and eliminating the obstructions to provide continuous walkways are recommended. However, it is very difficult to implement this in the short due to time and financial constraints. A gradual or step-by-step approach is recommended.

Zebra markings are currently used for crosswalks in road sections. However, only pavement marking is provided, and this is insufficient in the case of national roads in the suburban area. The following facilities are required.

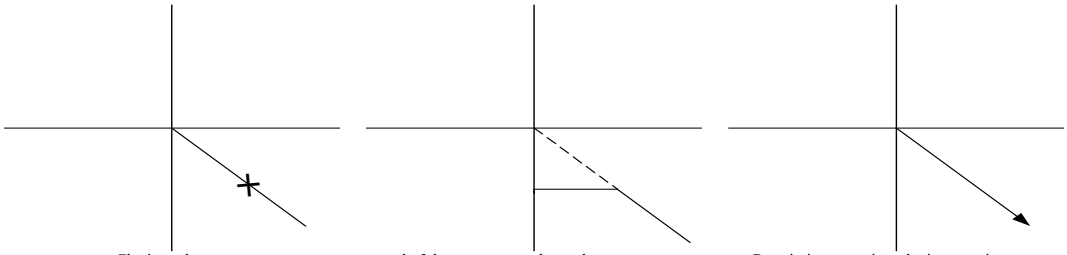
- Crosswalk signs on an arm pole at and in front of intersections.
- Pavement markings to clearly indicate the stop lines.
- Lighting for nighttime
- Illuminated signs for nighttime

In addition, “pedestrian-only” signals are required depending on the number of pedestrians and traffic volume.

(6) Intersections and Roundabouts with Irregular Configuration

Congestion occurs frequently and traffic accidents happen repeatedly at intersections with complex configurations involving five (5) legs or more. Thus, these intersections need to be improved in such a way that intersection legs are reduced to give a simple 4-legged intersection. The following figures show possible methods for such alterations.

a. Closing a leg
b. Two legs are merged together before entering the targeted intersection
c. Restricting entry into the intersection（e.g. one way）



a. Closing a leg

b. 2 legs are merged together before entering the targeted intersection

c. Restricting entry into the intersection

Example – Intersection of Russian Blvd with Kampuchea Krom Blvd and St.271
This 5-legged intersection is an example where congestion happens during the peak hours and traffic accident occurs frequently. An improvement is clearly warranted at this intersection.

An appropriate measure is to put signal control into operation. In such a case, the arrangement of the traffic flow to form a 4-legged intersection as shown in either one of the schemes given in Figure 16.2-3 should be implemented.

- One-way operation on the adjoining roads of Russian Blvd and Kampuchea Krom Blvd.
- Closure of Kampuchea Krom Blvd.

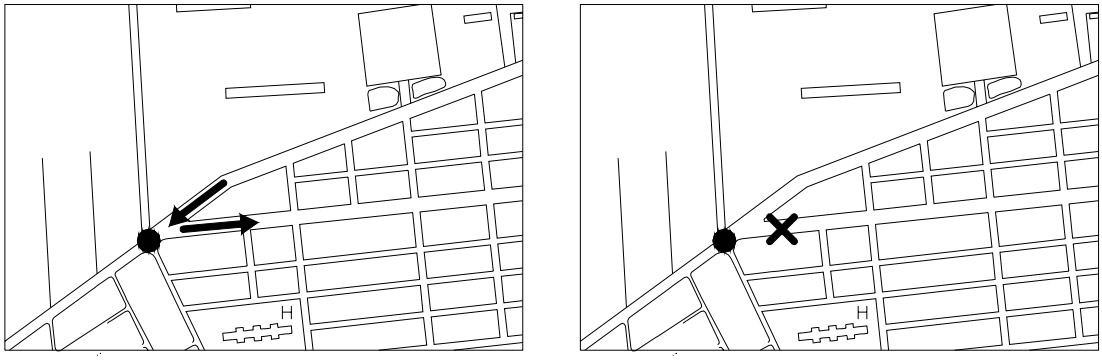
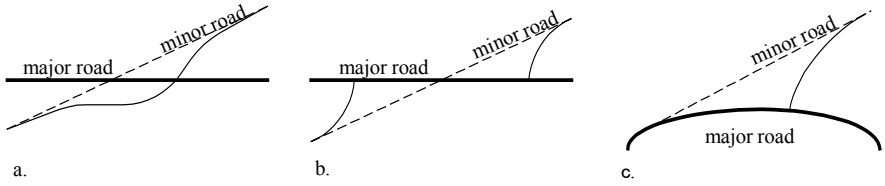


Figure 16.2-3 Examples of Improving the Intersection of Russian Blvd & Kampuchea Krom Blvd./St.271

(7) Intersecting Angles of Intersection
Intersecting traffic flows should cross at a right angles or as close to right angles as possible. This arrangement shortens the length of the crossing and reduces the traffic weaving area. In addition, this improves traffic safety and traffic capacity given that drivers perceive the road more clearly and are able to make an appropriate judgment. The following measures are recommended as examples.



Example (1) – Intersection of Monivong Blvd with St.271 (Inner Ring Road)
At this intersection one arterial street intersects with another arterial street at an acute angle. An appropriate measure is to alter the acute intersecting angle to a right angle or close to a right angle, and introduce signal control. (See Figure 16.2-4)

Example (2) – Intersection of Sihanouk Blvd with St.199 and St.264 (near the Olympic Market)
Although this is a 4-legged intersection, the intersecting angle of Sihanouk Blvd and St.264 is acute and congestion happens frequently at peak hours.
An adequate measure is that St.264 be changed to a one-way operation, prohibiting any outflow traffic. In this case, traffic operation will be devised in such a way that traffic on St.264 can be complemented with that on St.199. In addition, it is preferable to introduce signal control at this intersection. (See Figure 16.2-5)

(8) Treatment at Roundabouts
Data analysis carried out on roundabouts in the urbanized area has shown that radii of rotary-islands are too small and traffic processing capacities of such facilities are smaller than those of signal-controlled intersections. In addition, it is very difficult for pedestrians to cross the roundabouts. Thus, signal control is recommended to be introduced to 4-legged roundabouts, whenever possible.

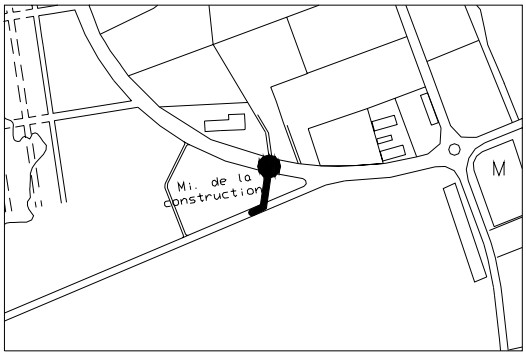


Figure 16.2-4 Example of Intersection Improvement: Monivong Blvd/St.271

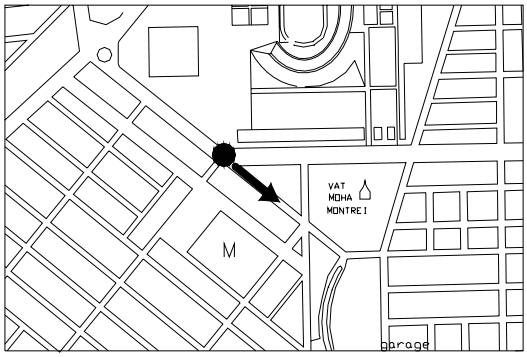


Figure 16.2-5 Example of Intersection Improvement: Sihanouk Blvd/St.199 & 264

(9) Prohibition of Parking in and near Intersections
The Traffic Law abates parking in/around intersections. Even if there are no designations around intersections, drivers are not legally allowed to park in such areas. It is however recommended to install yellow curb markings around intersections in order to clearly indicate parking prohibitions.

16.2.2 Traffic Signal Control

(1) Improving Signal Operation
It is not necessary to introduce a high level signal system within the next five (5) years, but the existing local controllers of signals should be replaced by an up-to-date type of local controllers with required functions, and such new controllers should be used at all new intersections that are due to be signalized.

1) Minimum functions required for local controller
The following functions are required for the new controllers:
- Time-of-day signal control (with a minimum of three (3) patterns for a week and five (5) patterns for a day)
- Number of signal phases (at least, phases for through vehicles, left-turning vehicles, exclusive pedestrian signal, blinking red and yellow lights etc.)
- Coordinated function for progressive signal control between adjacent intersections
- Function of operation with emergency signal timing during malfunction

2) All red signal display
It is recommended that an all-red signal display after the yellow signal be introduced in order to achieve total clearance of vehicles and pedestrians within the intersection.

3) Location of signal heads and other control devices
It is recommended to review and make appropriate revision to the installation standard of traffic control devices at an intersection such as location of signal heads, location of pedestrian crossings, stop lines markings and no-parking curb markings.

(2) Future Plan of Signal Control and Operation
In parallel with increase in traffic demands and improvement of the road network and facilities, traffic signal operation should be improved. Thus, a staged improvement plan is proposed for the traffic signal facilities, considering the future increase in traffic demand and effective signal operation. Figure 16.2-6 shows a stage plan for signal improvements.

Stage 1: From 2001 to about 2002
- To operate signals with an isolated control according to a time schedule.
The cycle time and splits can be changed based on time-of-day parameters for weekday, Saturday, Sunday and public holiday.
- To signalize all the 33 intersections (where the traffic volumes are exceeding the capacities).

Stage 2: From 2003 to about 2007

- To operate signals along main routes using a progressive control in accordance with a time schedule.
- The cycle time, splits and offsets should be adjusted based on time-of-day parameters for weekday, Saturday and Sunday in order to permit continuous operation of groups of vehicles at a planned speed.
- Local signal controller may have a built-in time clock to automatically adjust phasing in order to coordinate with other signal timings. It is not necessary to install communication cables for synchronizing the controllers.
- To operate signals at the other intersections using the same isolated control as Step 1
- To install approximate1y 23 sets of coordinated signals and approximate1y 7 sets of isolated signals

Stage 3: From 2008 to about 2015

Stage 3 of the Traffic Control System should comprise of 2 main functions: Area signal control system and traffic information system. It is proposed to introduce a computerized area signal system with a centralized traffic control center for Phnom Penh.

a. Area signal control system

This system adopts a traffic-responsive technique for generating coordinated signal timing or selecting a pattern of coordinated signal timings for the city network on a real time basis. Traffic flows at the main intersections are measured by vehicle detectors and used to decide such signal timings as cycle, split and offset by centralized computers for all the intersections covered by the system.

- To install approximate1y 54 sets of signals,
- To centrally and remotely operate approximate1y 117 sets of signals from a traffic control center through a public communication cable network, which will be provided in the future.

Figure 16.2-7 shows intersections to be signalized in Stage 1 to Stage 3.

Stage Time Period	Signal Control Method	Intersection Group	Number of signalized Intersections
Stage 0 -2000	Isolated Control under Fixed Parameters	Each Intersection	21 Total 21
Stage 1 2001-2005	Isolated Control under Time of day Parameters	Each Intersection	12 Total 33
Stage 2 2006-2010	Coordinated Control under Time of day Parameters	Intersections along Main Route	23 Total 56
	and Isolated Control under Time of day Parameters	Each Intersection	7 Total 63
Stage 3 2011-	Computerized Area Control under Detector Data	Intersections in Area	54 Total 117
	and Traffic information system		

Figure 16.2-6 Staging Implementation Plan of Traffic Signal Operation

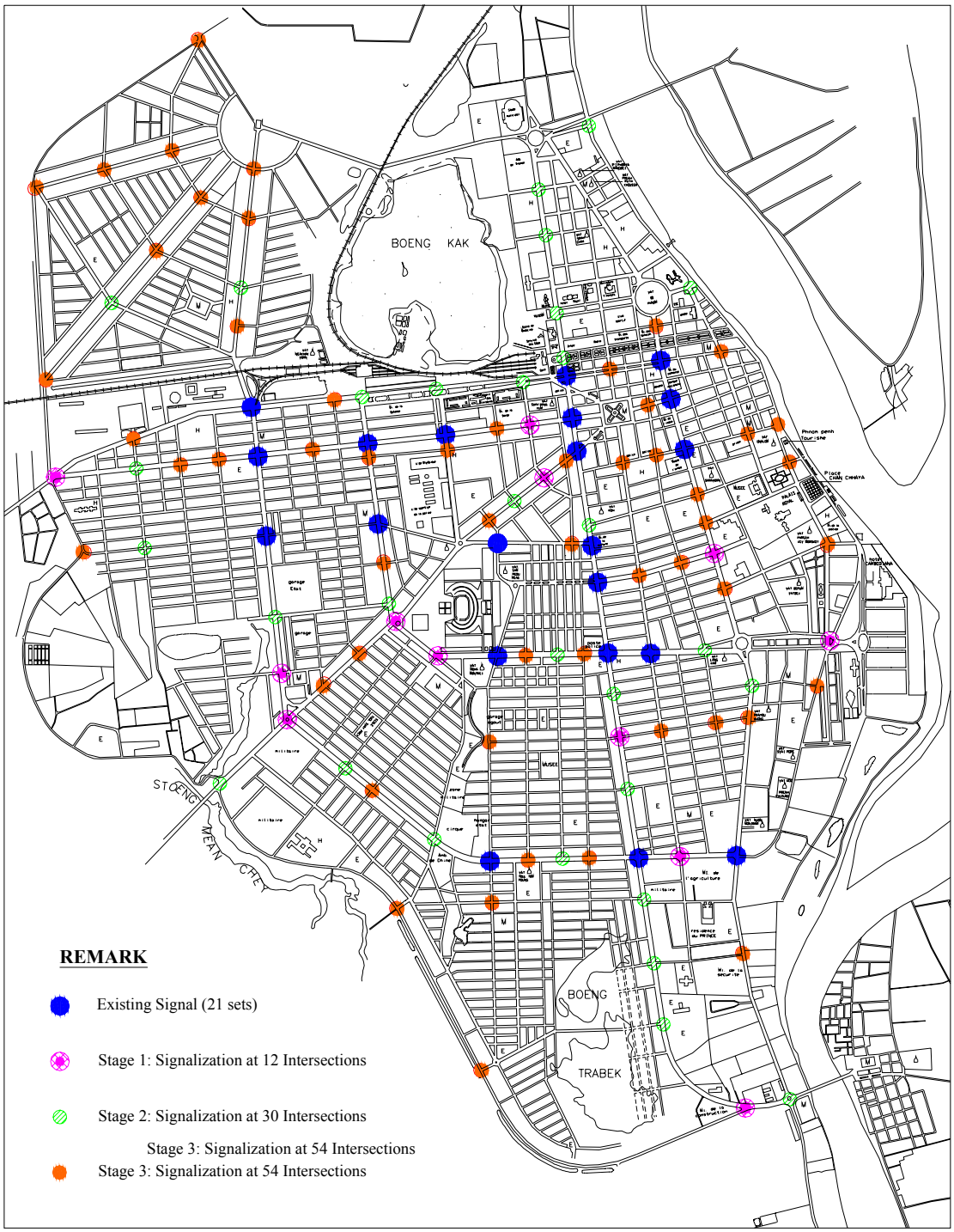


Figure 16.2-7 Intersections to be signalized in Stage 1 to Stage 3

b. Traffic information system

It is a common practice that information services are provided through changeable message signs and/or radio broadcast based on the continuous traffic monitoring by vehicle detectors or TV cameras.

Information collection.

- Traffic information : Traffic volume, occupancy rate, estimation of jam length and time
- Weather information : Rainfall, wind velocity
- Information traffic regulation : Temporary regulation due to festival, road works flood, etc.

- Other methods for disseminating traffic information
  - Telephone guide and facsimile guide
  - Route guidance system:
  - Guidance system of parking locations

c. Assumptions for computerized area signal system

To introduce a computerized area signal system, the decrease of motorcycle usage on streets and extent of a communication cable network in Phnom Penh in the future has to be assumed or forecast as follows:

- Decrease of motorcycle usage on streets
  If motorcycle usage is less in the future, it is capable of applying either type of vehicle detectors using loop coil or supersonic to the streets of Phnom Penh in order to operate real-time signal control in respond to demands.
- Communication cable networks
  It is expected that a large- scale public communication cable network will cover the city of Phnom Penh by about 2010. A computerized area signal control can be operated efficiently and sufficiently using this cable network.

16.2.3 Uniform Traffic Control Devices

(1) Preparation of Uniform Traffic Control Device Deployment Guidelines

The MPWT is still in the process of preparing uniform traffic control device deployment guidelines. However, there are some sections of this guideline that will not be able to reflect the current changing traffic situation in Cambodia based on actual traffic survey results. For this reason, this guideline when completed, should be regularly and repeatedly reviewed, updated and improved. For all road users, uniform standards in the deployment of various traffic control devices is most desirable.

(2) Cooperative Efforts of Traffic-Management-Related Agencies

Traffic management cannot be entirely undertaken by just the MPP above. Cooperation with the national level ministries as well as private organizations is necessary. At the national level, ministries such as the MPWT and Police Agency are obvious candidates for involvement but others like Ministry of Education, Ministry of Social Welfare Services must also be involved. In the private sector, active involvement must also come from driving schools, insurance companies and emergency/first-aid hospitals.

In addition, within MPP, cooperation from all sections is needed. For instance, traffic signal and traffic control device sections are separate units within MPP. Full cooperation from all such sections or divisions is absolutely necessary for operating a consistent traffic management practice in the city. Presently, traffic management in MPP is not undertaken by a specific unified division, but rather by the cooperative efforts of various related sections. Considering that traffic management is very important for the city, an independent division must be set up in MPP to undertake all the tasks.

16.2.4 System of Traffic Accident Data Base and Analysis

At present, annual statistical traffic accident data are collected manually. However, these data alone

are not enough to allow traffic engineering analyses to formulate remedial measures for reducing accidents.

Therefore, it is necessary to introduce a system for integrating such processes by building a database on accidents, investigate causes of accidents using analytical programs and examining suitable remedial measures in a unified way. The system recommended by this Study aims at decreasing traffic accidents effectively in the short term by giving priority to the identification of appropriate measures required at high accident locations.
A function comprising the following four components shall be included in the system.
a. Setting up a database on traffic accidents
b. Identifying high accident locations
c. Analyzing high accident locations
d. Examining the remedial measures

An equipment configuration of the suggested system is shown in Figure 16.2-8.

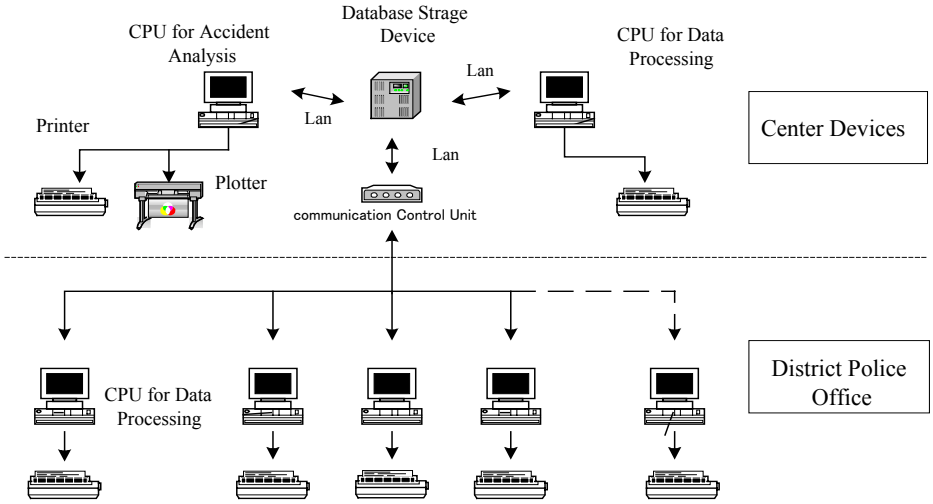


Figure 16.2-8 Equipment Configuration of Accident Analysis System

The introduction of this advantageous system would further enhance the effects of the road improvements and traffic control measures, based on the analysis of various traffic accident factors which are largely being ignored at present.

After this system has become functional, it is also possible to easily combine the installed database with other databases, such as databases on vehicles and drivers, traffic volumes and road inventory.

16.3 PARKING FACILITY

At present, there are many vehicles parked on the sidewalks, obstructing the safe passage of pedestrians. Therefore, several measures, such as on-street parking prohibition, should be introduced in order to reduce the frequent diversion of pedestrians onto the carriageway and the corresponding congestion of the affected road sections. In addition, since it is expected that traffic demand will increase rapidly in the future, securing adequate parking spaces will be an important issue of traffic management in the future.

Based on basic parking supply data and number of parking vehicles predicted in future (in 2015), this section discusses the adequacy of the present parking facilities, and the necessity of off-street parking facilities in the future. The study area for parking facility is restricted to the urbanized area bounded by Sihanouk Blvd Nerhu Blvd Ave., Daun Penh (St.90), and Bassac River.

16.3.1 CBD Parking Supply and Demand in 2015

Based on the results of the Parking Condition survey described in Section 4.9 and future traffic demand described in Chapter 11 it is estimated that parking supply (potential parking) in the urbanized area will be 10,177 vehicles for the case of parking prohibition on major arterial streets and 11,875 vehicles without parking regulation on these streets. The following data are used in the estimation:

- On-street parking capacity estimated on a map with a scale of 1/5000.
- Off-street parking in the vicinity of government and other public offices and other buildings (stadium, etc.) determined for each area from a map with a scale of 1/5000.

Conversely, peak hour parking demand in the CBD is predicted at 5,118 vehicles in 2000 and 8,183 vehicles in 2015 in the case of parking prohibition on major arterial streets, based on the data of traffic generation/attraction by each zone in the future predicted in Chapter 11.

16.3.2 Need for Off-Street Parking Facilities

(1) A balance between parking demand and supply in morning peak periods
Table 16.3-1 shows a balance between parking demand and supply during morning peak hour by each zone in year 2015.

It is assumed here that on-street parking in major arterial streets is prohibited in order to maintain smooth traffic flow on the streets in the future, and sidewalk parking is absolutely prohibited.

(2) Zones where parking facility will be insufficient in the future

- The existing supply of parking in the entire study area is larger than the demands in 2000 as well as in 2015.
- However, the parking facilities are already insufficient in the zone around Central Market at present. (Even though it seems that there is no apparent problem given that these parked cars can be accommodated on the major arterial streets where parking is permitted at present)
  - [13][14] Phsar Thmei I & II, [28] Monourom --------- 178
- The zone names and shortage of parking in 2015 are estimated as follows:
  - [13][14] Phsar Thmei I & II, [28] Monourom --------- 578
  - [15] Phsar Thmei III, [16] Boeng Reang --------- 202
  - [17] [20] Phsar Kandal I, II, [21] Phsar Chas --------- 393
  - [24][25][26][27] Ou Russey I, II, III & IV --------- 363

Thus, it is necessary to provide parking facilities in the future. The zones where shortage of parking capacity will occur are shown in Figure 16.3-1. Detailed analysis of parking demand and parking plan are shown in the Attached Report 2 “Traffic Management Plan” Section 2.3.

Table 16.3-1 Balance of Supply and Demand of Parking Cars in One Hour

Morning Peak Hours (7:00-10:00)

Area Number and Name	Area	Balance of Supply and Demand of Parking Cars in one hour				
		Supply	2000		2015	
			Demand	Balance	Demand	Balance
1 [13][14] Phsar Thmei I, II [28] Monourom	0.45	657	834	-178	1,235	-578
2 [15] Phsar Thmei III [16] Boeng Reang	0.72	1,565	1,142	424	1,767	-202
3 [17][20] Phsar Kandal I, II [21] Phsar Chas	0.66	530	488	42	924	-393
4 [18] Chey Chumneah	0.77	827	95	732	155	672
5 [19] Chakto Mukh	1.11	1,795	550	1,245	839	955
6 [22] Vat Phnom	0.64	1,002	446	556	547	455
7 [24][25][26][27] Ou Russey I, II, III & IV	0.31	574	570	4	937	-363
8 [29] Mittapheap	0.40	702	266	436	406	296
9 [30] Veal Vong	0.96	2,030	554	1,476	1,095	934
10 [31] Boeng Prolit	0.37	495	173	322	278	217
Total	6.4	10,177	5,118	5,059	8,183	1,994

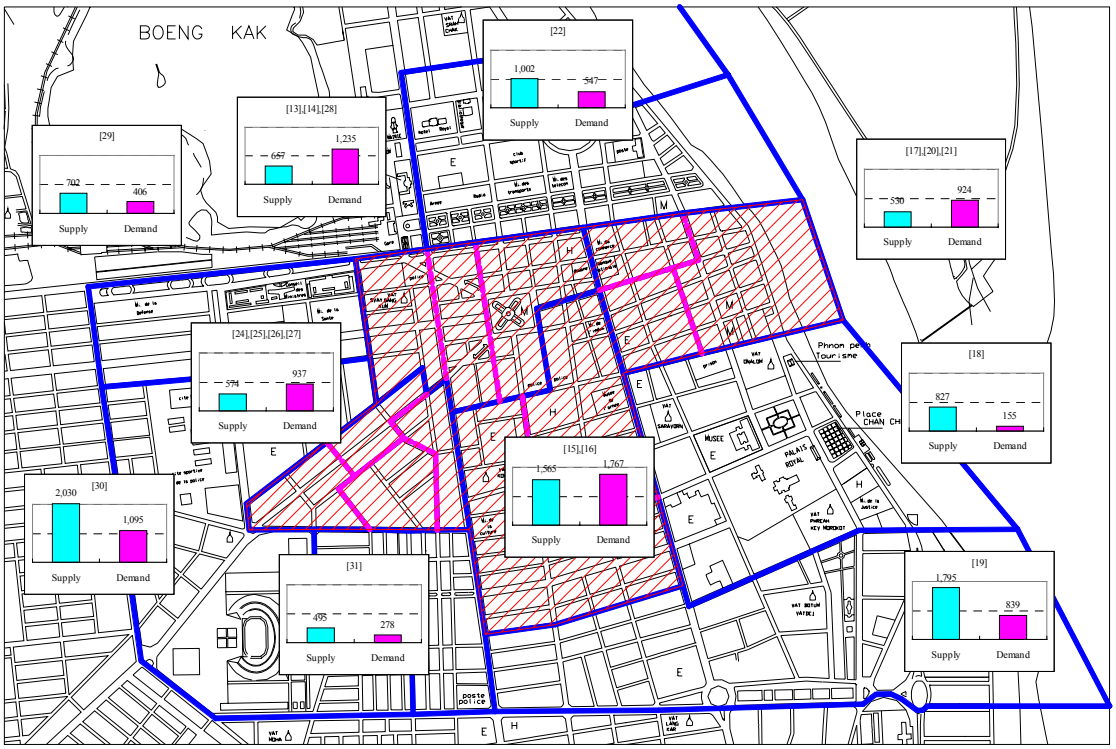


Figure 16.3-1 Balance of Parking Supply and Demand in Urbanized Area Zones in 2015

16.4 TRAFFIC SAFETY EDUCATION

In this section, enhancement of traffic safety perception and education is discussed. The discussion includes the suitable type of educational activities appropriate to the audience categories. These are examined based on the present traffic accident condition, characteristic of accidents and result of daily traffic observation as well as the result of the Traffic Campaign carried out in the Study.

Recommended remedial measures on traffic safety education are as follows:

(1) Implementing regular traffic safety campaign
One of the effective methods to overcome the problem of high traffic accidents is a traffic safety campaign targeted at all citizens, namely the general public, school children, parents and drivers. A traffic safety campaign is suggested to be carried out repeatedly and regularly as one of the effective means and first priority in the Study Area, as proven by the actual performances of the Traffic Safety Campaign held by the MPP and Study Team.

(2) Training for instructors on traffic safety education
One of the reasons that current traffic safety education has almost no impact on the public is the absence of adequate and qualified instructors. It is indispensable to train instructors for such tasks. There are three (3) types of instructor groups to be trained as listed below.
- Teachers at regular schools
- Traffic police to be trained on traffic safety education,
- Instructors at private driving schools to be trained on traffic safety education

(3) Establishing traffic safety instruction patrol unit at the Traffic Police Department
Traffic safety education for pupils and children in schools should be promoted by establishing a traffic police and instruction patrol unit at the headquarters of the Traffic Police Department. A group of instructors would visit all kindergartens, primary schools, secondary schools and high schools in the city regularly and provide traffic safety education to them.

These professional instructors are to be organized under the police patrolling unit and should report to the patrolling unit. Female police officers are most suitable for such tasks.

(4) Introducing traffic safety education to the school education curriculum
After introducing the traffic safety education workshop for schools teachers, training for professional traffic safety instructors and establishing the required police unit, it is recommended that safety education is brought in to be a part of the school education curriculum. Traffic safety education for children is worth doing, as it is useful for their entire lives. This is particularly essential in the case of Cambodia, since there is no opportunity for motorcyclists, who occupy the largest share among drivers, to learn traffic safety, traffic rules, and safe driving skills. Thus traffic education at schools is a highly effective measure to improve this situation.

(5) Construction of Traffic Park for a Traffic Safety Education
A traffic park is a useful facility for children to familiarize themselves with the simulated traffic situations. One of the purposes of a traffic park is to learn the traffic rules and acquire ways of protecting themselves from traffic accident while playing safely in the facility. There are successful examples of traffic parks in Singapore and Japan.

16.5 TRAFFIC ENFORCEMENT

Measures to strengthen traffic enforcement are recommended in order to improve the current traffic situation where traffic accidents are likely to increase rapidly in the near future.

Issues focusing on drivers in the Study Area are extracted based on characteristic of traffic accidents, driving behavior, and the current condition of traffic regulation and enforcement.

In this section, urgent remedial measures based on the analysis so far are described.

(1) Strengthening of driving instruction and enforcement for illegal drivers
It is unrealistic to expect immediate results by stepping up traffic enforcement on illegal driving, considering the drivers' habits. Thus, it is suggested that a grace period of about one year for enforcement be given with a focus on providing instructions on proper driving during that time. The objective is not to punish illegal driving but to provide instructions on proper driving manners.

It is more effective to select certain regulations and enforce them emphatically at a selected time period, day of week etc. rather than trying to enforce all the rules. This method of selective enforcement makes a greater impression on drivers and is easier for the enforcement officers to conduct their duties.

In selecting the regulations to be enforced, violations or causes of traffic accidents that most frequently occur can be listed, based on analyses of traffic accidents, and then given a priority ranking. Those with high priority will then be selected for enforcement.

The recommended areas for selective enforcement based on site observations and the survey data are as follows:

- Driving on the opposing roadway
- Drunken driving
- Ignoring traffic signal
- Ignoring pedestrians on crosswalk
- Parking in or near intersections

(2) Strengthening illegal parking enforcement and disclosure of model intersection
A parking ban can be set up at road sections where parked vehicles obstruct traffic flow.

However, if the enforcement cannot be carried out accurately, the law will exist only in name. Illegal parking around intersections in particular adversely affects traffic safety and road efficiency. Thus enforcement at intersections must be emphasized.

(3) Maintenance and plenitude of enforcement equipment
Both the quantity and quality of the enforcement equipment retained by Phnom Penh Central Traffic Police are insufficient. The maintenance of an adequate quantity of enforcement equipment in good condition is essential and must be urgently raised for discussion. The following items in particular are needed to reduce congestion and accident.

- Communication telephones between police officers on site
- Microphones installed at major intersections for drivers' and pedestrians' guidance
- Respiratory alcohol detector
- Speed enforcement equipment such as radar speedometer

(4) Introducing a penalty system for traffic rule violations
Introducing a penalty system for traffic rule violations is essential in Phnom Penh. The introduction of the system may face some problems; for example, difficulty in collecting fines.

However, the aim of the penalty system is not just the collection of fines but also to achieve several other objectives such as discouraging dangerous driving, encouraging good driving, and uncovering organizations that employ dangerous drivers.

A record system using a computerised LAN is recommended to register each driver's license and centrally control traffic violation.

16.6 STAGING PLAN

This section deals with staging plans and a preliminary cost estimate for implementing the traffic management plan proposed by this Study. The preliminary cost of each countermeasure is estimated using year 2000 as the base year and under the following basic conditions.

(1) Staging Implementation Plan
Table 16.6-1 shows the proposed staging implementation plan based on the urgency of each countermeasure.

(2) Preliminary Cost Estimate
Table 16.6-2 shows the total estimated project cost for each countermeasure every five years until 2015. In the total cost, road improvement costs are excluded. Personnel cost for traffic education and enforcement are also excluded.

The following measures are not included directly in countermeasures which the Phnom Penh City implement.

- Construction of off-street parking facility (assumed to be carried out by private sectors)
- Establishment of a penalty system for driving violations (assumed to be carried out by the Central Government)

Table 16.6-2 indicates that the Short-Term period from 2001 to 2005 requires US$4.5million, the Medium-Term period from 2006 to 2010 requires US$ 3.0million, and the Long-Term period from 2011 to 2015 requires US$7.7million. This amounts to a total of US$15.3million in 15 years. The cost of the signal system amounts to about 84% of the total cost.

Table 16.6-1 Staging Implementation Plan

Proposed Countermeasures		2001 - 2005	2006 - 2010	2011 - 2015
TM-1	Traffic Signal System 1-1 Improvement of Traffic Signs 1-2 Traffic Signal System			
TM-2	Accident Anaysis System			
TM-3	Parking Facilities 3-1 Construction of Off-Street Parking Facilities 3-2 Installation of On-Street Parking Lots			
TM-4	Enforcement Equipment			
TM-5	Enforcement Capacity and Penalty System (National-level measure)			
TM-6	Public Education 6-1 Implementation of Traffic Safety Campaign 6-2 Training of Instruction for Traffic Safety 6-3 School Education and Curriculum 6-4 Patrol System for Traffic Safety Education 6-5 Traffic Park			

Table 16.6-2 Cost of Implementing Plan in each Five Years

Proposed Countermeasures		Cost ($1,000)			
		2001-2005	2005-2010	2010-2015	Total
TM-1	Traffic Signal System 1-1 Improvement of Traffic Signs 1-2 Traffic Signal System	 50 2,782	 62 2,529	 59 7418	 171 12,729
	Sub-total	2,832	2,591	7,477	12,900
TM-2	Accident Analysis System	527	0	0	527
TM-3	Parking Facilities 3-1 Construction of Off-Street Parking Facilities (Private Sector) 3-2 Installation of On-street Parking Lots	 (8,810) 100	 0 100	 (1,224) 0	 (10,034) 200
	Sub-total	8,910	100	1,224	10,234
TM-4	Enforcement Equipment	500	0	0	500
TM-5	Enforcement Capacity and Penalty System (Nationwide measures)	0	(3,000)	0	(3,000)
TM-6	Public Education 6-1 Implementation of Traffic Safety Campaign 6-2 Training of Instruction for Traffic Safety 6-3 School Education and Curriculum 6-4 Patrol System for Traffic Safety Education 6-5 Traffic Park	 191 24 52 116 200	 191 24 52 58 0	 191 24 52 0 0	 573 72 156 174 200
	Sub-total	583	325	267	1,175
Total including Private Sector and Nationwide Measures		13,352	6,016	8,968	28,336
Total excluding Private Sector and Nationwide Measures		4,542	3,016	7,744	15,302

( ) value shows an estimated cost of measures to be implemented by private sector or at national level